Central Bank Swap Lines, Bank Risk Management and Currency Choice in Trade *

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Abstract

The internationalization of emerging market currencies, especially the Renminbi (RMB), is of significant interest to both the academic and policy worlds. This paper investigates the role of central-bank local currency swap lines in promoting the use of local currencies in trade invoicing. While the existing literature has emphasized the direct role of swap lines in trade invoicing, we suggest an indirect role of risk reduction through banks' currency risk management. Using exporter-trading partner-year level data on currency invoicing from South Korea during 2006-2019, we show that signing swap lines between Korea and China likely played a role in the rise of the RMB in the invoicing share among Korean exporters. Conversely, the expiration of a swap line between Korea and Japan likely contributed to a decline in the Japanese yen (JPY) invoicing share. We exploit the firm-level heterogeneity in our analysis by showing that Korean exporting firms whose main banks had more ex-ante exposure to China exhibited a greater increase in RMB invoicing. Additionally, Korean banks raised the interest rates on RMB deposits but lowered those on JPY deposits. Our theoretical model suggests that the financial safety net provided by the swap line incentivizes banks to provide higher interest rates for deposits in the partner's currency, and hence promotes the use of the same currency in trade invoicing.

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1 Introduction

It is well established that an international currency's issuing country enjoys "exorbitant privileges", such as seignorage revenues, lower cross-border transaction costs, macroeconomic flexibilities, paying lower returns on external liabilities, etc.[1] Yet, a SWIFT report published in December of 2021 shows that only a few currencies (of approximately 150 national currencies) accounted for more than 1% of global payment. Notably, the RMB experienced the most dramatic change in the ranking of currencies, as measured by the share of global payment, from 35th in October 2010 to 4th by the end of 2021. In this paper, we propose that central banks' local currency swap lines can facilitate the internationalization of a currency by providing a safety net to a partner country's banking system.

Central bank swap lines have recently emerged as a tool to provide financial safety net, complementing the traditional tools such as foreign exchange reserves (Gopinath (2017), Denbee et al. (2016)). The function of a swap line is to allow either central bank to borrow fund from the counterpart at a low or zero interest rate to stabilize the financial market. South Korea, as a country that experienced acute financial stress during the Asian Financial Crisis in 1997-1998, actively participated in signing central bank swap lines. The majority of South Korea's swap lines were in local currencies instead of US dollar (USD) swaps, which means the central bank's borrowing when initiated is in the partner country's currency. As of 2019, South Korea has signed currency swap agreements with major economies such as China, Japan (expired in 2013) and the US (only temporary as a response to the global financial crisis), but not with other regions like United Kingdom and the Eurozone. It is noteworthy that South Korea was the first local currency swap agreement partner to China, a rising economic power that actively pursued bilateral currency swaps in an effort to reduce reliance on US dollars. Korea's swap line with Japan, on the other hand, was terminated due to political rather than economic reasons. Therefore, these plausibly exogenous variations in South Korea's swap lines serves as a quasi-experiment to study their impacts.

Our study capitalizes on South Korean customs' trade data on currency invoicing from 2006 to 2019 to study the impact of local currency swap lines on currency choice in international trade. A comparison with the official aggregate data shows that our customs sample data is effective at capturing South Korea's overall trade and currency-invoicing patterns. Consistent with Gopinath (2015) and Gopinath et al. (2020), we observe that

[1] See Blinder (1996), Fischer (1982), Schmitt-Grohé and Uribe (1999), Goldberg and Tille (2016), Gourinchas and Rey (2022), Eichengreen (2011), Eichengreen et al. (2017), Cohen (2012).

USD is used dominantly for invoicing in trade with all trading partners and that other currencies issued by a third country were used scarcely. However, there has also been noticeable changes in major currencies' shares, such as RMB, USD and JPY.

We first investigate the empirical patterns based on firm-country-currency level regressions. In specific, we calculate four types of currency shares for each South Korean exporting firm to each export destination: (i) export destination currency (a.k.a. local currency), (ii) vehicle currency (USD), (iii) Korean Won and (iv) all else. We perform event-type analysis that utilizes the timing of swap lines that South Korea newly signed or expired. We find that South Korean exporters increased (decreased) significantly their RMB (USD) invoicing share after the Korea-China swap line was signed. This pattern became even more conspicuous after the expansion in the value of the swap line. In contrast, the share of JPY (USD) invoicing in Korean exports to Japan dropped (increased) significantly after the expiration of the swap line with Japan. It is noteworthy that the currency invoicing patterns in exports to other countries were largely unaffected by Korea's swap lines with other countries.

We demonstrate the robustness of these findings by extending intensive margin to extensive margin analysis and perform regressions at a more refined firm-product-destination level, which can account for potential compositional shift in South Korean exports' bundle. Adding additional control variables suggested by the literature has little impact on our baseline results. We also explore whether Chinese importers' state ownership helped promote the use of RMB and do not find substantive evidence to support that those products with larger Chinese state owned enterprises' import share see bigger increase in RMB share in South Korea's export to China.

A battery of robustness tests show that our main findings are robust. Specifically, we investigate the extensive margin of invoicing patterns, estimate our main regression at the firm-product-destination level or add additional control variables suggested by the relevant literature. Additionally, we explore whether Chinese importers' state ownership help promote the use of RMB and find some weak evidence to support that those products with larger Chinese state owned enterprises' import share see slightly bigger increase in the RMB share in South Korea's export to China.

Some discussions about our results are in order. First, we observe that the impact of swap lines is not conspicuous in exports to other than China or Japan. We posit that a necessary condition for a swap line to be effective is that there is sufficient destination market size so that exporters have incentives to align with local competitors' currency choices (e.g., Goldberg and Tille (2016) and Amiti et al. (2022)). South Korea's other swap line partners, such as Switzerland, Australia and Indonesia, do not have a market size

that is comparable to that of China or Japan so that it is plausible that currency swap lines alone cannot have a meaningful impact on the export invoicing pattern. Second, we examine the importance of the trade settlement support programs in promoting the use of RMB (related to the trade credit channel emphasized by Bahaj and Reis (2020)) established by the Bank of Korea. However, we find the use of the trade settlement programs to support Korean trade was fairly limited, especially in the first few years when RMB use started to rise. This could be because the interest rate specified in the trade settlement support program by Korea was higher than the alternative borrowing cost in the offshore RMB market. In addition, we examine the role of import-export nexus in the currency choice as highlighted by Bahaj and Reis (2020). We find that even for exporters who do not import from China (Japan) still show significant increase (decrease) in the RMB (Japanese Yen) share after the signing (expiration) of the swap line with China (Japan). Moreover, South Korea's swap line with Japan was purely for liquidity support, and thus we find the role of financial safety net as the most plausible reason in the change of currency invoicing pattern. Finally, we note that we do not downplay the role of trade settlement support program or the trade credit channel; rather, we note that the currency swap can impact currency invoicing pattern additionally via banks' currency risk management under the financial safety net channel.

As for the mechanism, we hypothesize that central bank local currency swap lines reduce banks' perceived risk of doing business in partner countries' currency due to the unforeseen currency-specific liquidity shocks. Therefore, South Korea's banks have more incentives to engage in RMB borrowing and lending businesses after the Bank of Korea signed the swap line with China and less incentives to engage in JPY borrowing and lending businesses after the expiration of the swap line with Japan. These incentives can be reflected in many possible aspects. We provide a set of evidence to support this hypothesis. Firstly, we document that Korean banks provided greater deposit interest to RMB as consistent with our hypothesis. We further explore bank heterogeneity to confirm the mechanism we aim to highlight. Since Korean banks' RMB lending is mainly performed by their subsidiaries in China, we differentiate Korean banks by their pre-swap line branches/offices (normalized by the export value to China of exporters that they serve as main banks), i.e., financial infrastructure in China. We find that banks with more initial exposure indeed see significantly more increase in the RMB share and more decrease in the USD share of those Korean exporters' export to China that they serve as main banks.

Finally, we provide a novel theoretical framework to analyze the effects of central bank local currency swap lines on firms' currency choice in trade. The model embeds

banks' endogenous interest rates for depositors in response to swap lines. With Korean banks' liquidity risk of conducting borrowing and lending business in a certain foreign currency, e.g., RMB, the availability of a local currency swap line with China reduces the expected cost from a RMB specific liquidity shock. Thus Korean banks are more willing to expand their RMB business and increase the interest rate that they are willing to provide for depositors. Higher interest rate in RMB attracts more Korean exporters to invoice in RMB rather than the dominant alternative, USD.

Related Literature Our paper is related to the bulk literature on endogenous currency invoicing in trade. Engel (2006) derives theoretically that exporters choose the invoicing currency to make their prices, which are sticky and unresponsive to shocks, closer to the optimal level. The literature proposes various factors that can influence the currency choice including transaction cost , destination market size, demand elasticity and import-export complementarities (Friberg (1998), Goldberg and Tille (2008),Goldberg and Tille (2016), Chung (2016), Mukhin (2022)). Amiti et al. (2022) provide a more general framework to analyze invoicing currency choice and the exchange rate pass-through, and use Belgian data to test theory predictions. Our paper suggests a new channel that the deposit interest rates in different currencies can also affect firms' currency choice in trade.

This paper is also related to the impact of global financial safety nets including both traditional foreign reserves and the emerging central bank swap lines. Kaminsky and Reinhart (1999), Aizenman and Lee (2008), Obstfeld et al. (2009), and Jeanne (2016), among many others, examine the role of foreign reserves in reducing the incidence of crises. Tong and Wei (2021) find that foreign reserves reduce macroeconomic uncertainty. Recent literature has studied the effects of central bank swap lines, in particular, the US dollar swap lines. Bahaj and Reis (2021), Goldberg and Ravazzolo (2022) and highlight the role of dollar swap lines on stabilizing the dollar funding market, partly rendered by reduced deviations from the covered interest parity. While these papers focus on post-crises response to US dollar swap lines, our paper emphasizes the role of local currency swap lines that changes banks' ex-ante incentives to engage in foreign currency businesses, which ultimately impact firms' currency choice in trade.

Closer to the theme of our paper is Bahaj and Reis (2020). They use bilateral country-level currency invoicing information to gauge how swap lines between China and other countries jumpstarted the internationalization of RMB. Our paper instead explores Korean firm-level dataset that contains currency invoicing information. While their proposed mechanism relies on the trade credit and firm-level natural hedging arguments, our theory emphasizes banks' currency risk management. Using our firm-level dataset, we document that firms without much scope to do natural hedging in RMB (exporters

that do not import from China) see the rise in the use of RMB in their exports to China, consistent with our theory's prediction. We also include bank-level empirics to support the bank risk management mechanism.

2 Institutional Background

2.1 China's RMB Swap Lines

China, as an emerging economic power, has started in recent years to promote the RMB as an international currency. The People's Bank of China, its central bank, actively promoted bilateral currency swap lines with other central banks. As of July, 2017, China had 36 local currency swap lines with total outstanding value 3343 billion RMB (about 500 billion USD).[2] Its first central bank local currency swap line was signed with South Korea. Announced on December 12, 2008, the Won-Yuan arrangement was "designed to help improve short-term liquidity conditions in the financial systems of the two fundamentally sound and well managed economies and to promote the bilateral trade." as the press release by the Bank of Korea stated.

We discuss several characteristics of the Chinese swap lines. First, China's local currency swap lines are standing swap lines, which usually last for 3 years before renewals. This is unlike the US Federal Reserve's swap lines with other countries. In specific, while the US also has standing swap lines with Canada, UK, Japan, Eurozone and Switzerland since April 2009 and North American Framework Agreement Swap Lines with Mexico and Canada since 1994, it only provided short-term dollar liquidity to other central banks including Australia, Brazil, Denmark, Korea, New Zealand, Norway, Singapore and Sweden during the global financial crisis and COVID-19 crisis.[3] For the latter group, it is perhaps fair to say that these countries did not expect dollar liquidity with certainty before each crisis. Second, China's swap lines sometimes came with a trade settlement support scheme that directly facilitated the use of RMB in cross-border transactions. The complete list of countries that had a trade settlement support scheme is difficult to trace, but news reports for countries including South Korea, Malaysia, Thailand etc. suggest that the swap lines are intended to facilitate trade settlement in local currencies in addition to support financial stability. In contrast, the stated purpose of US swap lines is only liquidity support and there is not a trade settlement support scheme.

[2] http://www.pbc.gov.cn/huobizhengceersi/214481/214511/214541/3353326/2017082115054924438.pdf

[3] US also provided short-term dollar liquidity to Canada, UK, Japan, Eurozone and Switzerland during the global financial crisis.

2.2 South Korea Local Currency Swap Lines

South Korea policy makers pay special attention to financial stability, partly due to its dire experience during the Asian Financial Crisis and the Global Financial Crisis. The objective of the Bank of Korea, its central bank, centers around not only price and output stability, but also financial stability.[4] Globally, central bank swap lines are increasingly used by central banks to enhance financial stability (Gopinath (2017), Denbee et al. (2016)). South Korea actively participates in both multilateral and bilateral swap line arrangements in the past two decades.

We label the central bank swap lines that involve the swap of both sides' own currencies as local currency swap lines. Most of South Korea's swap lines belong to this type. The second type involves the swap of Korean won and the US dollar under the Chiang Mai Initiative in Asia. The size of the second type is usually small (relative to the use of US dollars in cross-border trade). This paper will examine the impact of those of the first type that are precautionary in nature (established or expired in normal time), so the crisis-triggered Korea-US swap lines are not the focus. After all, as the US dollar is the dominant currency in Korea's trade to all destinations, the US dollar financial safety nets will likely affect the use of it to all destinations, rendering a clean identification difficult.

We describe South Korea's central bank currency swap lines, chronologically until the end of 2019, which is the last year of our trade data. The US dollar swap lines under the Chiang Mai Initiative are presented in the Appendix A.

Local Currency Swap Lines between Korea and Japan South Korea's first local currency swap was signed with Japan and took effect on May 27th, 2005. The maximum amount of the swap arrangement between the Japanese yen and the Korean won was equivalent to 3 billion US dollars. As stated, the goal was is "in pursuit of stabilizing regional financial markets through supplying short-term liquidity." [5] It was scheduled to expire on July 3rd, 2007 but extended for another 3 years. On December 12, 2008, the Bank of Korea reached an agreement with the Bank of Japan to raise the maximum amount to 20 billion US dollars equivalent. This increase will be effective until the end of April, 2009. On March 31st, 2009, the two central banks extended the above expiration date to Oct 30, 2009. On October 16, 2009, they extended the expiration date to Feb, 1st, 2010. On January 19, 2010, they further extended the expiration date to April 30, 2010 and the above-mentioned temporary increase expired as scheduled. On June 22, 2010, they

[4] See more details on the Bank of Korea's role in maintaining financial stability on their website https://www.bok.or.kr/eng/main/contents.do?menuNo=400037. In addition, in 2009 the Bank of Korea joined the Financial Stability Board (FSB), the successor to the Financial Stability Forum (FSF) that was founded in 1999 in a bid to seek international cooperation on finding ways to prevent a financial crisis.

[5] https://www.boj.or.jp/en/intl_finance/cooperate/index.htm/

Table 1: Korea-Japan Central Bank Local Currency Swap Lines

Effective Date	Amount	Duration	Note
2005.05.27	3 Billion USD	expire 2007.07.03	swap line
2007.07.03	3 Billion USD	expire 2010.07.03	extension of swap line
2008.12.12	20 Billion USD	expire 2009.04.30	increase of swap line
2009.03.31	20 Billion USD	expire 2009.10.30	extension of the increase
2009.10.16	20 Billion USD	expire 2010.02.01	extension of the increase
2010.01.19	20 Billion USD	expire 2010.04.30	extension of the increase
2010.06.22	3 Billion USD	expire 2013.07.03	another extension of swap line
2011.10.10	30 Billion USD	expire 2012.10.31	second increase of swap line

Notes: This table summarizes the local currency swap lines between South Korea and Japan.

agreed on another 3-year extension for the 3 billion US dollars yen-won swap until July 3, 2013. On October 10, 2011, there was a temporary increase again in the yen-won swap line to 30 billion US dollar equivalent which was expected to expire on October 31, 2012 and the second temporary increase expired as scheduled.

The relationship between the two countries deteriorated in August 2012 when South Korea's president visited disputed islands that both countries claim sovereignty over. Korea and Japan let currency swap lapse amid the political conflict. Therefore, after July 3rd, 2013, yen-won swap lines no long existed. The two central banks did not officially give specific reasons for not extending the won-yen swap agreement. The media reported that "Analysts said the swap end has more to do with political reasons rather than economic. Japan has recently been increasing its rhetoric, with its politicians including Prime Minister Shinzo Abe making insensitive historical comments regarding its imperial rule over the Korean Peninsula." [6] Interestingly, the political fights did not seem to cause immediate decline in Korean export value to Japan (see Figure H.1) in the Appendix. Table 1 summarizes the Korea-Japan central bank local currency swap lines.

Local Currency Swap Lines between Korea and China The amount of the first Korea-China swap line was 180 billion RMB/ 38 Trillion KRW (roughly 25 billion USD equivalent) and the effective period of the facility was 3 years, and could be extended by agreement between the two sides. On November 26th, 2011, both sides agreed to renew the agreement and doubled the size of the swap line. They continued to renew the agreement twice in Octobers of 2014 and 2017. Table 2 summarizes the Korea-China central

[6] For details, see https://www.koreaherald.com/view.php?ud=20130624000990&mod=skb

Table 2: Korea-China Central Bank Local Currency Swap Lines

Effective Date	Amount	Duration	Note
2008.12.12	180 Billion RMB/38 Trillion KRW	3 years	
2011.10.26	360 Billion RMB/64 Trillion KRW	3 years	renewal
2014.10.11	360 Billion RMB/64 Trillion KRW	3 years	renewal
2017.10.11	360 Billion RMB/64 Trillion KRW	3 years	renewal

Notes: This table summarizes the local currency swap lines between South Korea and China.

bank local currency swap lines.

The Korea-China local currency swap line functions had two aspects: a trade settlement support program (TSSP) and RMB liquidity support (RLS).[7] As the name suggests, the objective of TSSP is for the Bank of Korea to provide short term RMB loan to Korean importers (via commercial banks) to facilitate RMB-invoicing in importing. The interest rate of the TSSP loan was Shanghai Interbank Offered Rate (SHIBOR) plus a spread determined by the bank and the loan has to be initiated by a firm. Commercial banks pay the Bank of Korea at the SHIBOR and need to post collateral that is worth 110% value of the loan. Perhaps due to the fact that SHIBOR is usually higher than the Hong Kong Internbank Offered Rate (HIBOR) for RMB before 2016 (see online Appendix Figure H.2 for the historical SHIBOR and HIBOR rates) and Korean banks need to post additional collateral to use the TSSP, the actual usage of the TSSP program did not appear to be considerable relative to the Korea-China trade before 2016. For instance, Woori Bank, the Korean bank with the most transactions with China and claimed to be the largest user of the TSSP among Korean commercial banks, only made 1.3 million US dollar equivalent TSSP loans in RMB up to May of 2016. This figure is minuscule relative to the use of RMB invoicing in Korea-China trade, which already exceeded 4 billion USD in 2015.

On the other hand, the RLS role (the lender of last resort of RMB) allows Bank of Korea to provide emergency RMB loan if Korean commercial banks face RMB liquidity shortage in a systemic crisis. Historically, no liquidity support in foreign currency other than USD was actually used, but the potential for Bank of Korea to provide RMB liquidity loan provides reassurance to Korean banks when dealing with RMB business.

Local Currency Swap Lines between Korea and the United States US dollar is the

[7] The Bank of Korea formally introduced the Liquidity Supply Program (LSP) on July 1st of 2015 to make the procedures of emergency loans clear. But the swap line enables Bank of Korea to access the RMB, which implies that the Korean central bank is ready to act as the lender of last resort for the RMB since the signing of the local currency swap line agreement with China.

Table 3: Korea-US Central Bank Swap Lines

Effective Date	Amount	Duration	Note
2008.10.30	30 Billion USD	6 month	
2009.02.04	30 Billion USD	expire 2009.10.30	extension
2009.06.26	30 Billion USD	expire 2010.02.01 (as scheduled)	second extension

Notes: This table summarizes the local currency swap lines between South Korea and the US.

dominant currency in both global financial and trade systems. To safeguard the financial stability in the United States and other countries, the US Federal Reserve signed multiple currency swap lines with foreign central banks (including Bank of Korea) during the global financial crisis. [8] Table 3 summarizes the details of the Korea-US swap lines. On October 30th, 2008, the US and South Korea agreed on a liquidity swap line worth 30 billion USD, which was extended subsequently in February of 2009 and June of 2009 and expired on February 1st, 2010. Bank of Korea indeed used the dollar swap line to provide USD liquidity to Korean commercial banks via auctions.

Local Currency Swap Lines between Korea and Other Countries South Korea also established local currency central bank swap lines with Switzerland, UAE, Canada, Australia, Malaysia, and Indonesia. The enhanced ability of liquidity support by the Bank of Korea followed immediately after these swap lines since the Bank of Korea is able to draw credit limits in these countries' currencies specified in the swap lines. In addition, the swap lines with Malaysia and Indonesia also include trade settlement programs, which, as mentioned earlier, facilitate the use of partner's currency when Korean importers import from these countries. Table 4 summarizes South Korea's local currency swap lines with these countries.

3 Data Description

Our micro-level trade data are accessed from the Korea Trade Statistics Promotion Institute (KTSPI) under the approval of the Korean Customs with disclosure restrictions. They consist of randomly sampled exporters identified in the KISValue (Korean Information Service) dataset, which compiles firm-level financial information. We extract a list

[8] For a brief history of the Federal Reserve's currency swap lines with foreign central banks, please see: https://www.federalreserve.gov/monetarypolicy/bst_liquidityswaps.htm

Table 4: Other Bilateral Central Bank Local Currency Swap Lines of Korea

Partner	Effective Date	Amount	Duration	Note
Switzerland	2018.02.19	10B CHF/11.2T KRW	3 years	
Canada	2017.11.15	unlimited	standing	
Australia	2014.02.23	5B AUD/5T KRW	3 years	
	2017.02.28	10B AUD/9T KRW	3 years	amount increase
UAE	2013.10.13	20B AED/5.8T KRW	3 years	
	2019.04.13	20B AED/6.1T KRW	3 years	
Indonesia	2014.03.06	115T INR/10.7T KRW	3 years	
	2017.03.06	115T INR/10.7T KRW	3 years	renewal
Malaysia	2013.10.20	15B MYR/5T KRW	3 years	
	2017.01.25	15B MYR/5T KRW	3 years	renewal

Notes: This table summarizes the local currency swap lines between South Korea and other countries (except China, US and Japan).

of exporters' business identifiers from the KIS. The KTSPI returned us information of a random sample from the list with anonymized firm ID. The data identify an observation by the trading firm, trade direction (export or import), destination or origin, product category (Harmonized System 4-digit), and the invoicing currency. Our sample has approximately 4,000 exporters from 2006 to 2019. The data also report the USD value of each trade flow after applying the relevant exchange rate. The data provide us the US dollar values at the firm-trade type (export or import)- destination - product (the Harmonized System 4-digit level) - currency level, which enables us to calculate different currencies' share for each firm-trade type-destination-product.

Our firm-level information is obtained from the KISValue (Korean Information Service) dataset which is compiled and maintained by the NICE Information Service Co., Ltd. Any firm with total assets over 12 billion KRW is required to report its financial statements every year to the Financial Services Commission in Korea. Firms that do not meet these criteria can also voluntarily report their financial statements. The KIS data reports firms' financial information including total sales, asset, debt, sales, and it also contains firms' main bank information. The main bank of a firm is usually the largest lender to the firm and deals with most of the firm's transactions.

Table 5: Summary Statistics

Panel A: Firm-Country Level						
Variable	Obs	Mean	Std. Dev.	Min	Max	Median
export value in LC	525,504	1.82×10^6	5.83×10^7	0	8.50×10^9	0
export value in KRW	525,504	9.67×10^4	3.83×10^6	0	7.44×10^8	0
export value in USD	525,504	6.66×10^6	1.54×10^8	0	3.65×10^{10}	59857.5
export value	525,504	7.82×10^6	1.60×10^8	1	3.75×10^{10}	110664.5

Panel B: Firm-Product-Country Level						
Variable	Obs	Mean	Std. Dev.	Min	Max	Median
export value in LC	1,687,615	5.68×10^5	2.61×10^7	0	7.49×10^9	0
export value in KRW	1,687,615	3.01×10^4	1.56×10^6	0	4.95×10^8	0
export value in USD	1,687,615	2.07×10^6	6.93×10^7	0	3.39×10^{10}	8, 680
export value	1,687,615	2.43×10^6	7.10×10^7	1	3.43×10^{10}	18,005

Notes: This table shows the summary statistics of our sample Korean exporters' export values by different currencies.

3.1 Summary Statistics

We document relevant summary statistics of our sample firms. Panel A of Table 5 reports firm-country level yearly export values by currencies. The sample size at the firm-country-year level is large with half million observations. The mean of export values in US dollar is much larger than that in local currency. The mean of export values in Korean Won is in a smaller order. The medians of export values in local currency and Korean Won are 0 while that in US dollar is positive. These indicate the dollar dominance in Korean export settlement. There are also large dispersions of export values, which illustrate the large heterogeneity of our sample firms. The firm-product-country level statistics in Panel B share similar patterns with Panel A.

3.2 Data Representativeness

We verify that our data on Korean exporters are representative of the aggregate trade pattern in Korea. The aggregate trade data is obtained from the UN Comtrade. Roughly speaking, our sample micro-level trade data obtained from Customs account for about 50% of Korean aggregate exports. Figure B.1 Panel (a) compares the total export dynamics of our sample data with that of the Korean aggregate trade data. It is clear that the two lines evolve at a similar pace over time. As we restrict our firm sample to be exporting firms identified by the KIS data, firms that only engage in importing may be

under-represented in our data. Yet, the comparison of the total import dynamics of our sample data with that of the Korean official data in Figure B.1 Panel (b) still features a highly comparable (albeit less synchronized) trend.

We also demonstrate the representativeness of the Customs data by showing the trade shares with top export/import partners and product level export/import volume. Figure B.2 and B.3 show Korea's top importing and exporting countries' (US, China and Japan) trade shares, respectively. Both figures demonstrate that our Customs data not only capture the levels of the trade shares of the top destinations, but also represent the dynamic evolution of the official aggregate data very well. For instance, both figures show that export to China accounted for approximately 25% of total Korean export and that its share had been increasing between 2006 and 2010. Both figures also aptly show the declining Japanese trade shares in both import and export transactions. In Figures B.4 and B.5, we use both customs sample data and the official aggregate data to plot South Korea's HS 4-digit level log-import and export trade volume, respectively. Both figures indicate that our customs sample data represent product-level trade volumes fairly well across the years.

3.3 Invoicing Currency Shares in Korean Exports

A key aspect of our data that we demonstrate its representative is the use of major currencies in Korea's exports. We thus compare the share of major currencies in Korea's export calculated with our customs sample data with that reported by Bank of Korea.

Figure 1 shows the currency shares of Korean export to the world. Panel (a) uses the official aggregate data from the BOK and panel (b) uses the Customs sample data. In both figures, the left and right axes are for the USD and other currencies' shares, respectively. Both panels show that US dollar is a dominant currency and occupied approximately 85% of Korean export. Euros and JPY were also frequently used but both of them experienced a declining trend. The Euro share declined significantly during the global financial crisis, where as the decline of JPY started after 2012. Both RMB and KRW's invoicing share increased over time to be on par with that of JPY by 2019.

Whether the above currency shares' dynamics merely reflect a compositional effect of the adjustment in Korean export shares to different destinations or not requires the knowledge of invoicing currency shares to different destinations, in particular to its top trading partners.

In Figure 1, the dynamics of the currency shares may be driven by the evolution of trade shares with major trading partners or/and the evolution of the currency invoicing

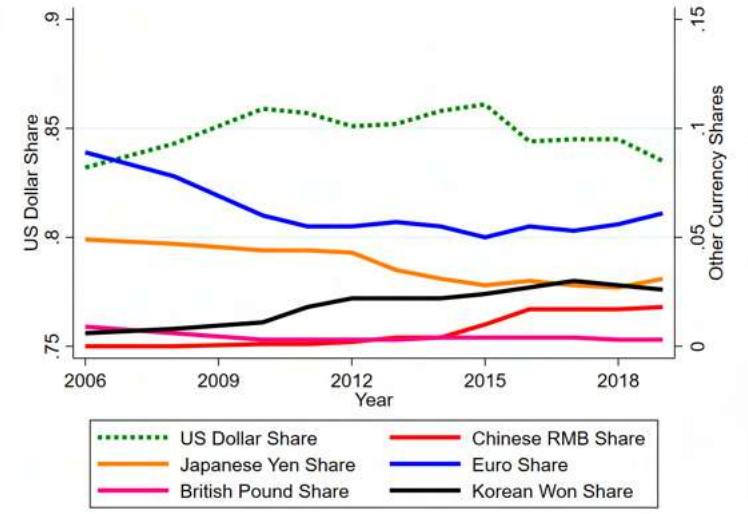
pattern within trade with each partner. Thus, in Figure 2, we illustrate the currency shares of Korean export to China. Panel (a) uses the official aggregate data and panel (b) uses the Customs sample data. Note that the USD share started with an overwhelming share of 98% before the global financial crisis, but was around 90% in 2019 after a steep decline. Nevertheless, it enters a declining trajectory after the global financial crisis and only accounts for about 90% in 2019. In contrast, the RMB share, starting from almost none in 2006, increased sharply since 2009 and stayed at around 6% in 2019. In the meantime, KRW share increased slowly over time from almost none to 2%. The shares of JPY and Euro also dropped slightly during the period but their impact is negligible to the overall pattern. Overall, we observe an invoicing pattern in Korea's export to China that RMB (and KRW to some extent) was diminishing the close-to-monopoly role played by the USD.

Figure 3 shows the currency shares of Korean export to the US, where panel (a) uses the official aggregate data and panel (b) uses the customs data. In almost all years, US dollar share is higher than 98%, rendering changes in other currencies' shares economically meaningless.

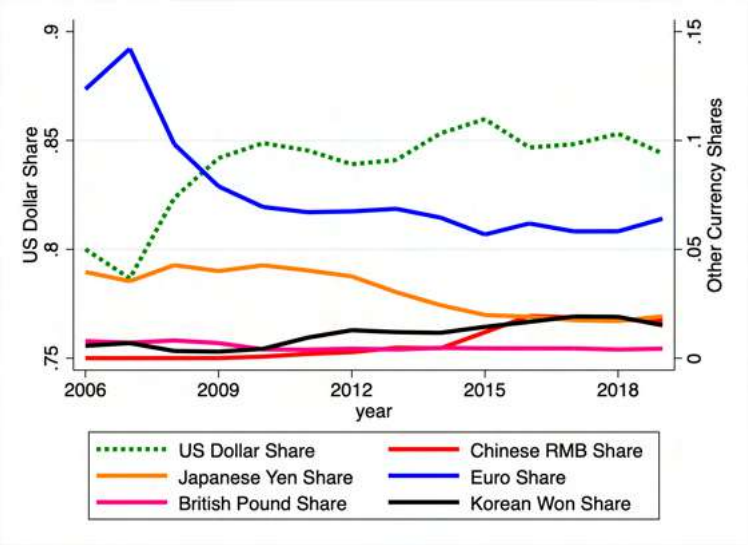
Figure 4 shows the currency shares of Korean export to Japan, whose second largest economy status was replaced by China in 2010. Panel (a) uses the official aggregate data and panel (b) uses the customs data. Except US dollar, Japanese Yen and Korean Won, all other currencies account for virtually none. We also find that Japanese Yen and US dollar shares took dominant positions. The global financial crisis was accompanied with a decline in US dollar and a rise in Japanese Yen. In 2010, Japanese Yen share is even larger than US dollar share. However, the rise in Japanese Yen was reversed after 2011. Similar to the export of Korea to China, there is also mild increase in the Korean Won share in Korean export to Japan.

We also report the currency shares of Korean exports to other destinations, in particular those with local currency swap lines with Korea in Online Appendix C. A general takeaway from the figures is that the shares of USD and local currencies had been fluctuating over time while the share of KRW exhibits an upward trend.

Figure 1: Currency Shares in Korean Export to World: Official vs. Our Sample Data



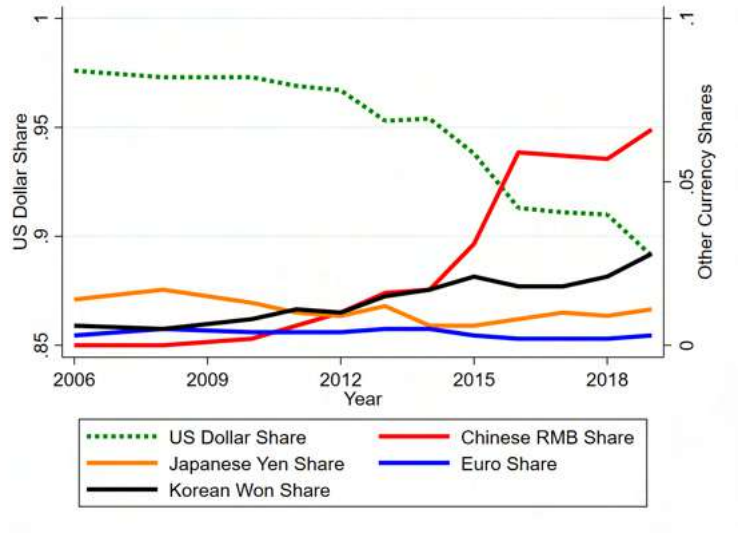
(a) Official Data



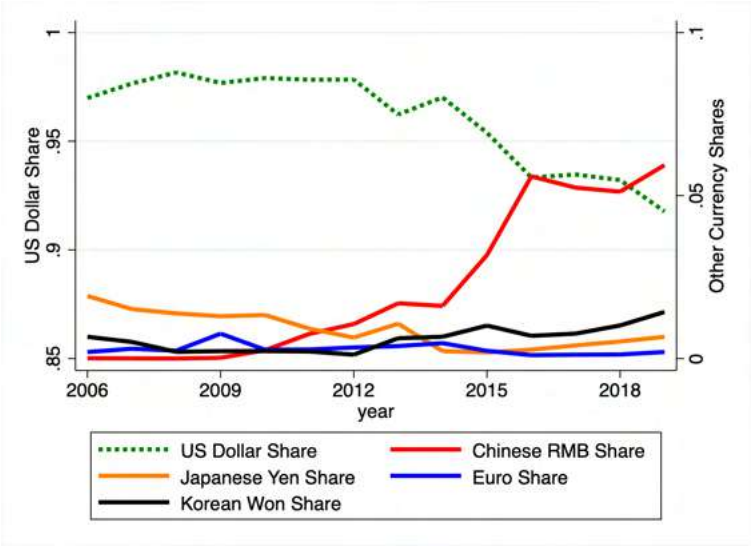
(b) Customs Sample Data

Notes: This figure shows the currency shares in Korean export to the world. Panel (a) uses official data from the Bank of Korea. Panel (b) uses our firm sample data.

Figure 2: Currency Shares in Korean Export to China: Official vs. Our Sample Data



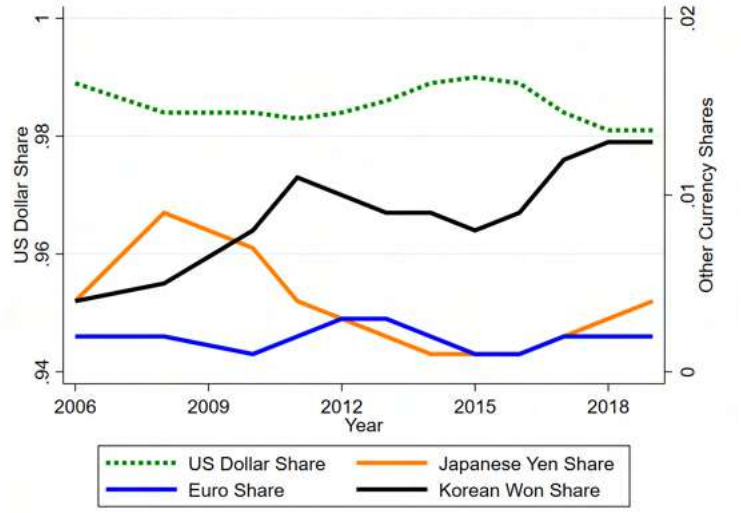
(a) Official Data



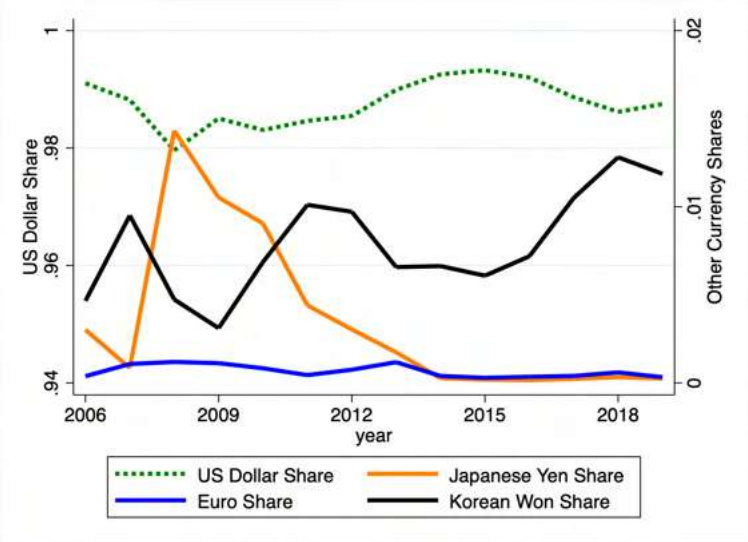
(b) Customs Sample Data

Notes: This figure shows the currency shares in Korean export to China. Panel (a) uses official data from the Bank of Korea. Panel (b) uses our firm sample data.

Figure 3: Currency Shares in Korean Export to US: Official vs. Customs Sample Data



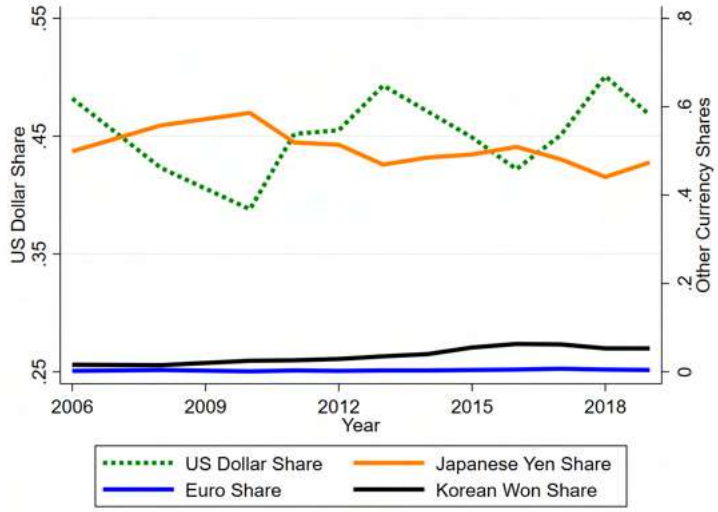
(a) Official Data



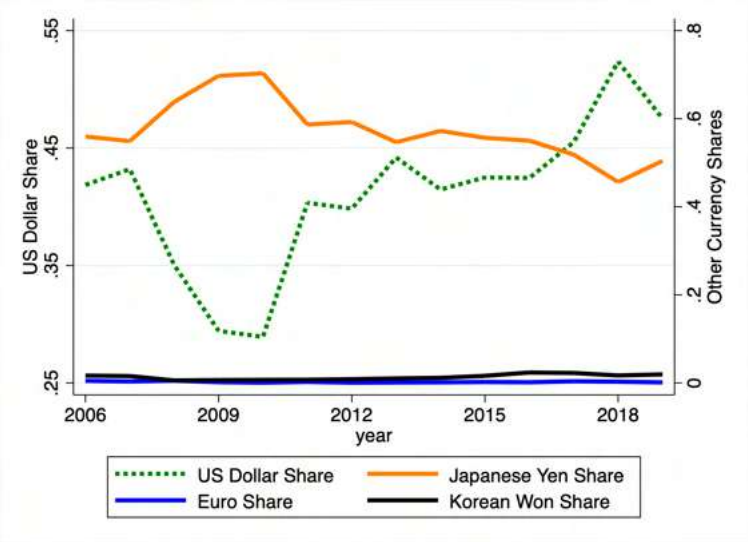
(b) Customs Sample Data

Notes: This figure shows the currency shares in Korean export to US. Panel (a) uses official data from the Bank of Korea. Panel (b) uses our firm sample data.

Figure 4: Currency Shares in Korean Export to Japan: Official vs. Our Sample Data



(a) Official Data



(b) Customs Sample Data

Notes: This figure shows the currency shares in Korean export to Japan. Panel (a) uses official data from the Bank of Korea. Panel (b) uses our firm sample data.

Additional figures in Online Appendix D displays the patterns of Korean import invoicing currency shares from major trading partners. While we observe similar patterns to those found in the export invoicing (except that Korean import from the US increasingly uses Korean Won), we note that our customs sample does not include Korean pure importers, which may lead to a sample bias problem.

Figure 5 shows the major currencies' use (top 4 as illustrated in Figure 1) in Korean trade with countries that are not issuers of the corresponding currencies. We produce the figure with our sample data. Panel (a) is the USD shares in Korean export to or import from non-US destinations. The dominance of US dollars is as expected and there are in general increases in US dollar shares in both exports and imports. Panel (b) is the Euro shares in Korean export to or import from non-Eurozone destinations. In Korean export to non-Eurozone destinations, the Euro share started from about 5% and declined to 2% after 2015. Euros were rarely used in Korean import from non-Eurozone countries. Panel (c) is the Japanese Yen shares in Korean export to or import from non-Japan destinations. We find that the use of Japanese Yen is minuscule and is declining. Finally, panel (d) is the Chinese Yuan shares in Korean export to or import from non-China destinations. It demonstrates that Chinese Yuan was barely used in Korean trade with countries other than China.

4 The Effects of Central Bank Swap Lines

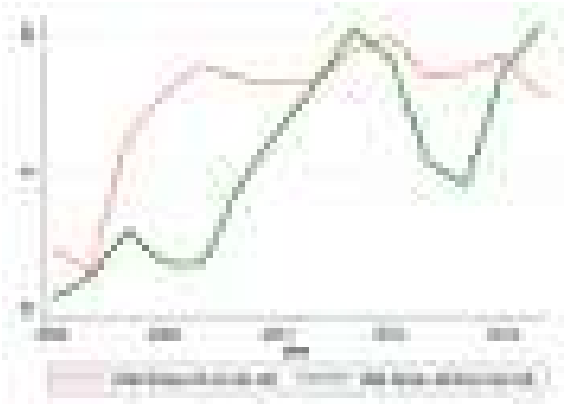
So far we presented patterns of Korean export invoicing currency shares at the destination country level. Our detailed customs data with invoicing currency information provides us an advantage of analyzing the dynamics of currency invoicing choice at the finer level that can account for various compositional effects. We start with firm-country level analysis that uses invoicing currency shares in destination currencies (LCP), US dollar (DCP), Korean Won (PCP) and all others. We connect the local currency swap line events with the dynamics of invoicing currency shares. It will be too early to assign a causal interpretation in this section's analyses, but they reveal data patterns that we will explore potential explanations in depth in the next section.

4.1 Firm-Country Level Analysis

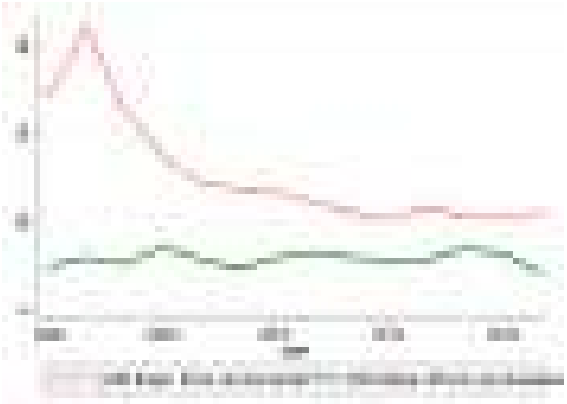
Our first empirical setting is

$$exsh^{o}_{fjt} = \alpha^{o}_{fj} + \delta^{o}_{t} + \sum_{j,\tau \neq 0} \beta^{o}_{j\tau} I(swapline\_event_{jt} = \tau) + \epsilon^{o}_{fjt} \tag{1}$$

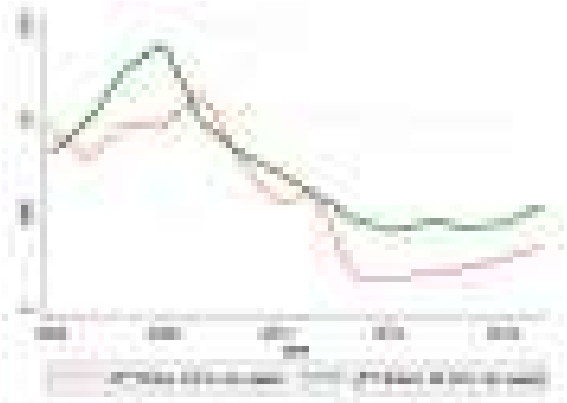
Figure 5: Major Currencies' Use in Korean Trade



(a) USD Share in Korean Trade with Non-US Destinations



(b) EUR Share in Korean Trade with Non-Eurozone Destinations



(c) JPY Share in Korean Trade with Non-Japan Destinations

(d) RMB Share in Korean Trade with Non-China Destinations

Notes: This figure shows major currencies' use in Korean export to and import from partners that issue the currencies and other partners.

where $exsh^o_{fjt}$ denotes the share of firm f export to destination j invoiced in currency o,

$$exsh^o_{fjt} = \frac{exvalue^o_{fjt}}{exvalue_{fjt}}. \tag{2}$$

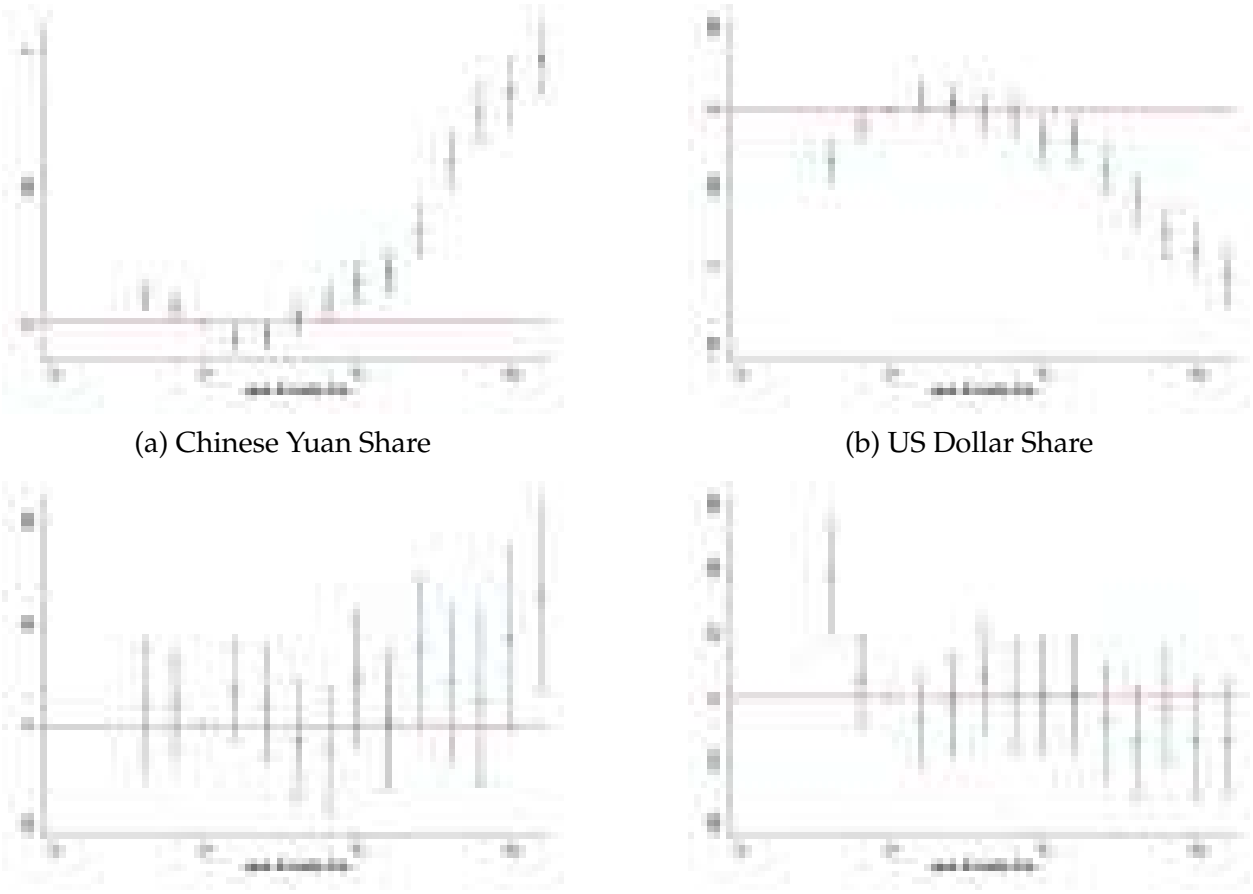
Here $exvalue_{fjt}$ is the US dollar value of firm f export to destination j and $exvalue^o_{fjt}$ is the US dollar value of firm f export to destination j invoiced in currency o. α_{fj} is firm-destination fixed effect and δ_t is year fixed effect. $I(swapline\_event_{jt} = \tau)$ is an indicator function that equals 1 if time t's distance to the "swap line event" of country j is τ and equals 0 otherwise. The swap line event indicates the year that country j and South Korea signed a local currency swap line except that for Japan. For Japan, it indicates the discontinuation of the yen-won swap line with South Korea. Since our customs data is annual, we specify the event year as T if the swap line is signed in the second half of year T (e.g., the swap line with China was signed in December of 2008, the event year is 2008) and $T-1$ if the swap line is signed in the first half of T (e.g., the swap line with Australia was signed in February of 2014, the event year is 2013). Korea and Japan reduced the amount of their swap line significantly (since the increase in the swap line expired) in October of 2012 and completely discontinued their swap line in early July of 2013. Thus, we choose 2012 as the event year for Japan.

Currency o can be destination country's currency, US dollar, Korean won or other currencies. The coefficients of interest are $\hat{\beta}^o_{j\tau}$, which represents each year's average currency o shares relative to that in the "swap line event" year. The treatment groups will include destinations that did not have any local currency swap line event with Korea. We will present the estimated $\hat{\beta}^o_{j\tau}$ series in graphs with 95% confidence intervals.

Figure 6 shows the estimated coefficients for China, $\hat{\beta}^o_{China,\tau}$. Panel (a) corresponds to Chinese Yuan share (o=local currency). We find that while before time 0 (year 2008), there was slight decrease in firm-level Chinese RMB share, the mild trend was reversed after 2009, soon after the Korea-China local currency swap line. The Chinese RMB shares in 2019 is on average 10% above those in 2007. The patterns on the firm-level US dollar share (o=US dollar) in panel (b) mirrors those in panel (a). After the global financial crisis, there was significant decline of the US dollar shares. The Korean Won share in panel (c) (o=producer currency) shows that its significant rise did not realize until 10 years after the first Won-Yuan swap line. Finally, all other currencies' shares do not show economically significant trend after 2008. In sum, Chinese Yuan substitutes US dollars in Korean export to China after 2008.

Figure 7 shows the estimated coefficients for Japan, $\hat{\beta}^o_{Japan,\tau}$. Panel (a) corresponds to Japanese Yen share (o=local currency). Before time 0 (year 2012), there was no significant

Figure 6: Firm Level Currency Shares in Korean Export to China: No Controls



(a) Chinese Yuan Share

(b) US Dollar Share

(c) Korean Won Share

(d) Other Currencies' Share

Notes: This figure shows the dynamics of firm-level currency shares of Korean export to China. Year 0 denotes 2008 when China and Korea signed the local currency swap line.

changes in the firm-level Yen share. But it started to decline after 2012 when the two countries entered into political conflict over the sovereignty issues of an island and started to curb the amount of the swap line, and finally let the remaining 3 billion dollars equivalent Won-Yen swap line expire one year after. The Japanese Yen shares in 2019 is on average more than 6% below those in 2011. The patterns on the firm-level US dollar share (o=US dollar) in panel (b) forms an opposite image to those in panel (a) as well. After the global financial crisis, there was significant increase in the US dollar shares. The Korean Won share in panel (c) (o=producer currency) does not exhibit significant changes. Finally, all other currencies' shares do not show economically significant trend after 2012, either. In sum, US dollar substitutes Japanese Yen in Korean export to Japan after 2012.

We also examine the firm-level export invoicing currency shares for other countries that signed swap lines with Korea. Figure 8 shows the estimated coefficients for Australia, $\hat{\beta}^{o}_{Australia,\tau}$. Interestingly, we do not find that there are significant changes for the four currency shares after the Korea-Australia swap lines. In general, the results of no significant changes after swap lines also hold for other destinations: Switzerland, Canada, UAE, Malaysia and Indonesia. These patterns can be found in the Online Appendix E.

4.2 The Role of Import-Export Nexus in Currency Choice

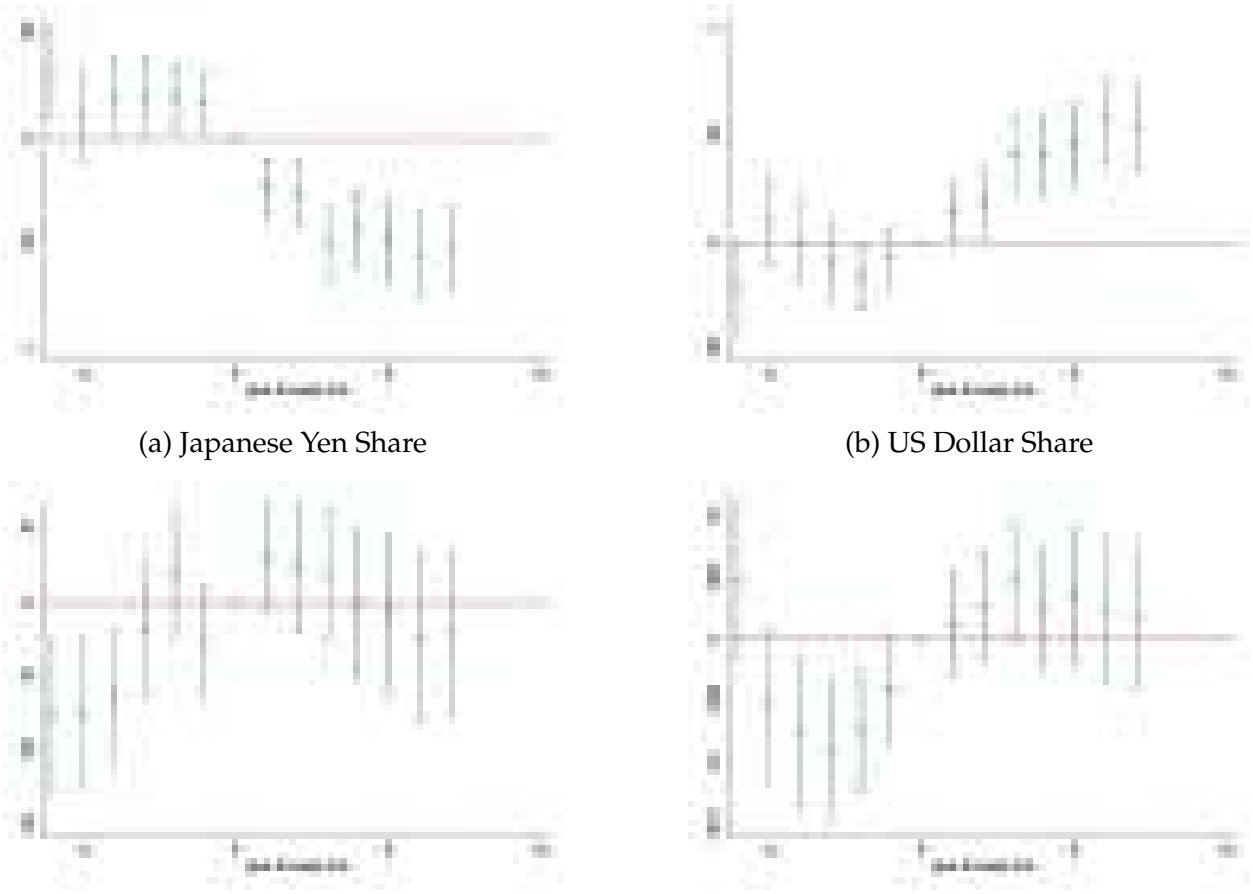
We then take into account the import-export nexus as highlighted by Bahaj and Reis (2020). They propose that the reason that exporters start to use RMB invoicing in exports after swap lines is that they are more likely to import using RMB when low interest rate RMB loans become available. This hypothesis on exporters' currency choice relies on the exporters being importers and using RMB in import. We are able to evaluate the importance of this import-export nexus with the firm-level data.

We define import dummies for exporters as ie_{fjt} which take a value of 1 if firm f import from country j in year t and 0 otherwise. Then we interact this dummy with swap line dummy in the regression setting

$$exsh^{o}_{fjt} = \alpha^{o}_{fj} + \delta^{o}_{t} + \sum_{j,\tau \neq 0} \beta^{o}_{j\tau} I(swapline\_event_{jt} = \tau) + \sum_{j,\tau \neq 0} \zeta^{o}_{j\tau} I(swapline\_event_{jt} = \tau) * ie_{fjt} + \epsilon^{o}_{fjt}. \tag{3}$$

The coefficient $\zeta^{o}_{j\tau}$ captures the differences in exporters' currency choice for destination j after the swap line event with country j between importers and non-importers from j. The coefficient $\beta^{o}_{j\tau}$ denotes the change in exporters' currency choice for destination j after the swap line event with country j for non-importers from j. The theoretical framework in Bahaj and Reis (2020) do not have explicit predictions on $\beta^{o}_{j\tau}$.

Figure 7: Firm Level Currency Shares in Korean Export to Japan: No Controls



(a) Japanese Yen Share

(b) US Dollar Share

(c) Korean Won Share

(d) Other Currencies' Share

Notes: This figure shows the dynamics of firm-level currency shares of Korean export to Japan. Year 0 denotes 2012 when Japan and Korea started to let their local currency swap lines expire.

Figure 8: Firm Level Currency Shares in Korean Export to Australia: No Controls

(a) Australian Dollar Share

(b) US Dollar Share

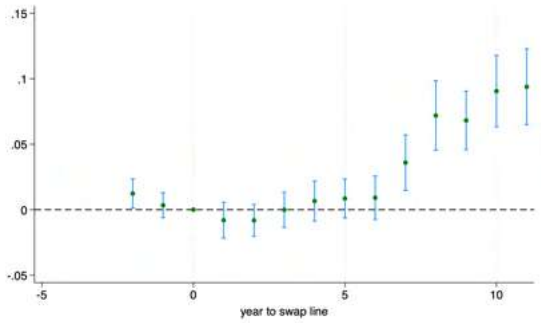
(c) Korean Won Share

(d) Other Currencies' Share

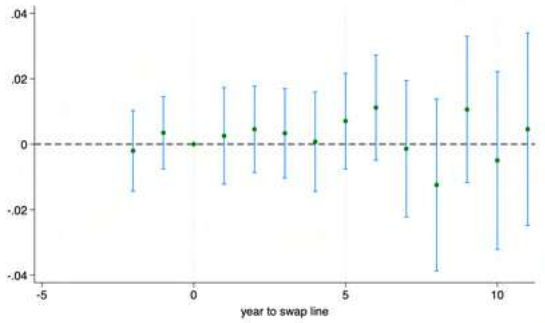
Notes: This figure shows the dynamics of firm-level currency shares of Korean export to Australia. Year 0 denotes 2014 when Australia and Korea signed the local currency swap line.

We report the estimation results on $\beta^o_{j\tau}$ and $\zeta^o_{j\tau}$ for j =China, Japan when o denotes the local currency in Figure 9. We find that in terms of exporters' use of RMB (Japanese Yen) in exporting to China (Japan), there are no statistically significant differences between importers and non-importers from China (Japan). Even for non-importers from China (Japan), there is a significant increase (decrease) in the use of RMB (Japanese Yen) when they export to China (Japan) after the signing (expiration) of the swap lines.

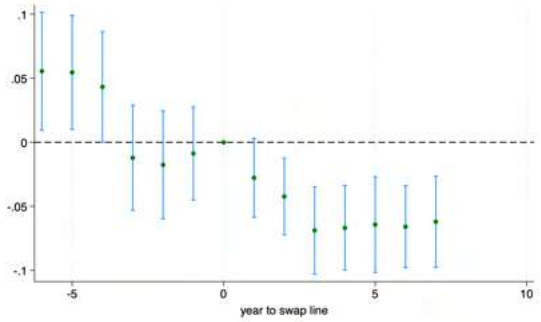
Figure 9: Import-Export Nexus in Currency Choice for Exporters



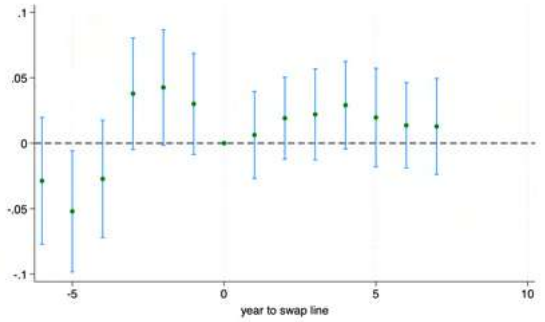
(a) RMB Share for Non-importers from China



(b) Difference in RMB Share for Importers and Non-importers from China



(c) Japanese Yen Share for Non-importers from Japan



(d) Difference in Japanese Yen Share between Importers and Non-importers from Japan

Notes: This figure shows the role of import-export nexus in exporters' currency choice.

4.3 The Extensive Margins of Export Invoicing

Figure 10 illustrates the export invoicing currency use in the extensive margin. We compute the fraction of firms in each year that use certain currencies (as long as non-zero use) when they export to China or Japan, respectively. So the sum of the fractions in each panel is larger than 1. They show almost the same message as before. In Korean export to

China, Chinese Yuan substitutes US dollar after the swap line. In Korean export to Japan, US dollar substitutes Japanese Yen after the expiration of the swap line. Moreover, both panels show fractions of firms using Korean Won significantly rise. This is not contradictory to 6 or 7 because when Korean exporters start to use Korean Won, they only invoice a small fraction of their export in Korean Won.

We can also directly perform an empirical analysis with the extensive margins of export currency invoicing information by substituting the dependent variable in equation (1) by a dummy variable denoting whether a firm uses currency o or not. Formally,

$$exdummy^o_{fjt} = \alpha^o_{fj} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline\_event_{jt} = \tau) + \epsilon^o_{fjt} \tag{4}$$

where $exdummy^o_{fjt} = 1$ denotes that firm f uses currency o in its export to country j at time t, where as $exdummy^o_{fjt} = 0$ denotes that it does not use currency o at all.

Figure 11, 12 and 13 graphically show the regression results for China, Japan and Australia. In Figure 11, we find that on the extensive margin, there is a large increase in the fraction of firms starting to use RMB after South Korea's swap line with China, but the decline in the fraction of firms stops using USD was mild. There were also more Korean exporters starting to use KRW significantly. Figure 12 shows that the expiration of Korea-Japan swap line is associated with a smaller fraction of Korean exporters using JPY, and a moderate increase (decrease) in the fraction of firms using USD (KRW). Finally, there are not significant changes in the fraction of firms using Australian Dollars, US Dollar or the Korean Won after the Korea-Australia swap line takes effect as shown in Figure 13.

4.4 Firm-Product-Country Level Analysis

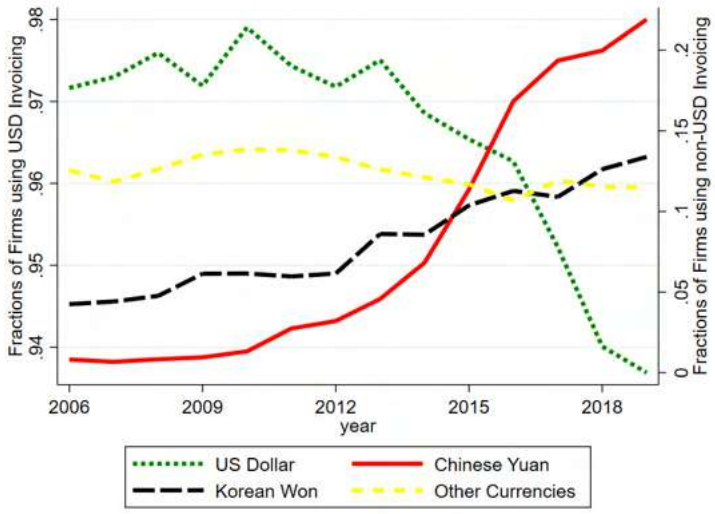
Most firms are multiple-product firms. To account for the compositional effect within a firm-destination, we compute the export invoicing currency shares at the firm-product-country level. Our empirical setting is

$$exsh^o_{fjpt} = \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline\_event_{jt} = \tau) + \epsilon^o_{fjpt} \tag{5}$$

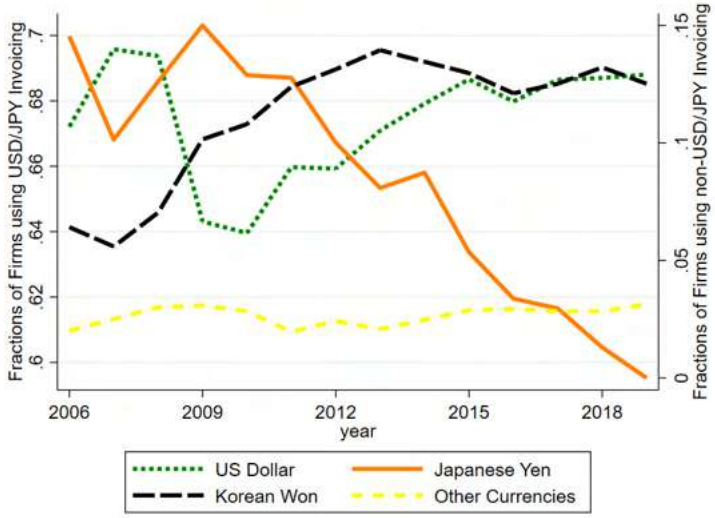
where $exsh^o_{fjpt}$ denotes the share of firm f export to destination j of product p settled in currency o,

$$exsh^o_{fjpt} = \frac{exvalue^o_{fjpt}}{exvalue_{fjpt}}. \tag{6}$$

Figure 10: Fractions of Firms Using Different Currencies in Korean Export to China and Japan



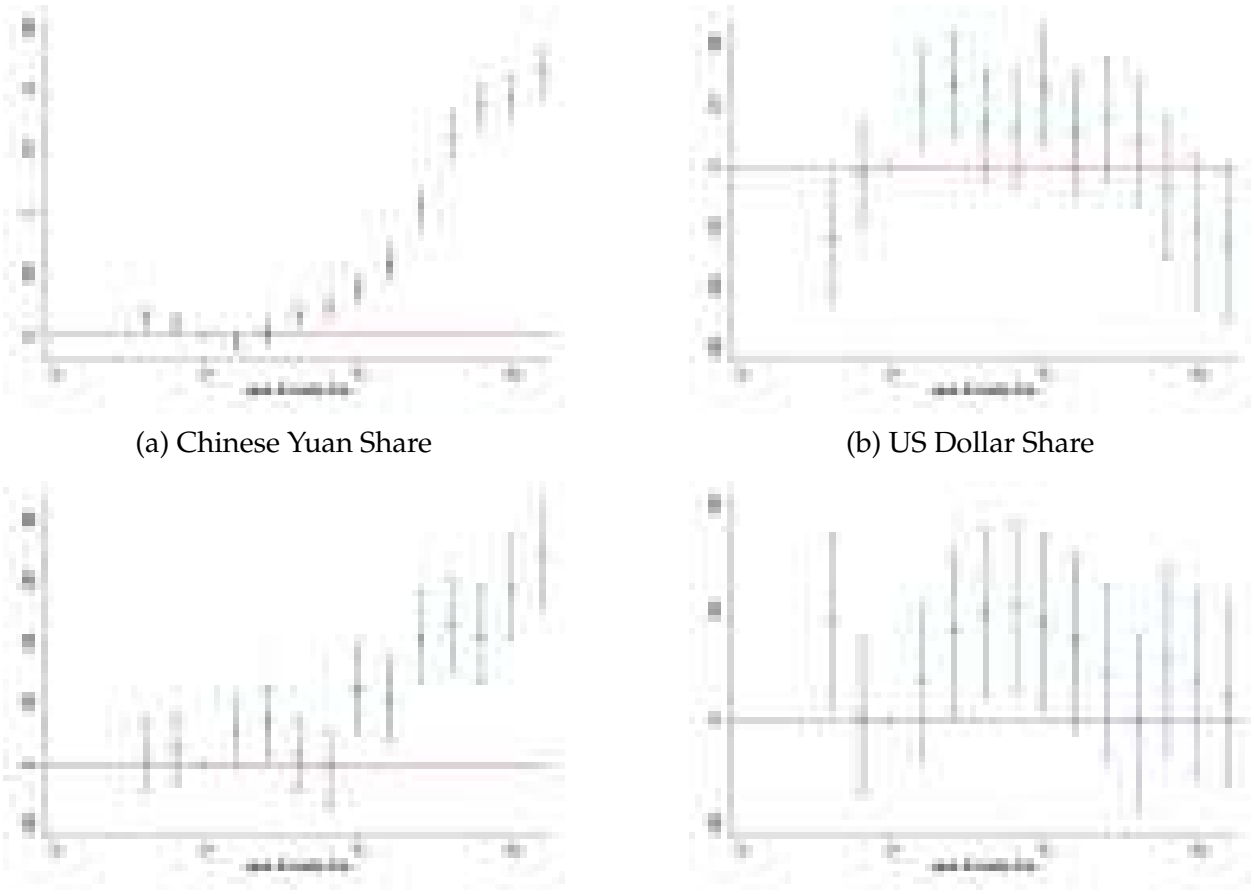
(a) Currency Use in Export to China



(b) Currency Use in Export to Japan

Notes: This figure shows the fraction of Korean exporters that use positive amount of different currencies in their exports to China and Japan.

Figure 11: The Extensive Margin of Currency Shares in Korean Export to China: No Controls



(a) Chinese Yuan Share

(b) US Dollar Share

(c) Korean Won Share

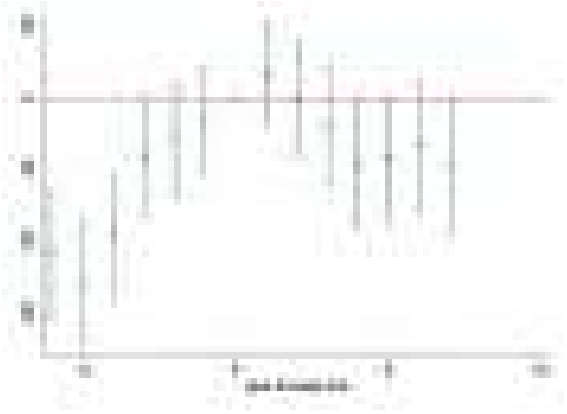
(d) Other Currencies' Share

Notes: This figure shows the dynamics of firm-level extensive margin of currency use of Korean export to China. Year 0 denotes 2008 when China and Korea signed the local currency swap line.

Figure 12: The Extensive Margin of Currency Shares in Korean Export to Japan: No Controls

(a) Japanese Yen Share

(b) US Dollar Share



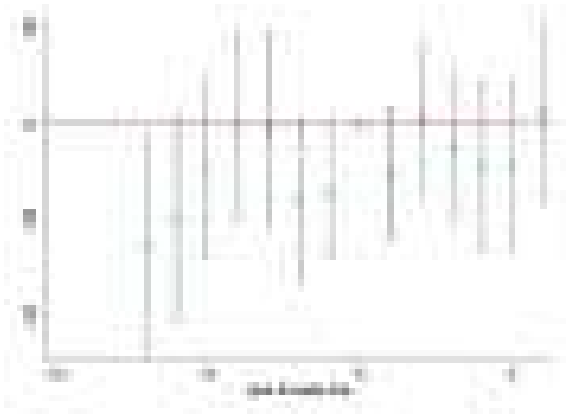
(c) Korean Won Share

(d) Other Currencies' Share

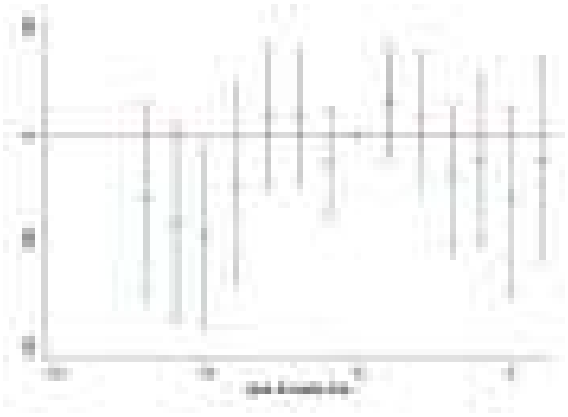
Notes: This figure shows the dynamics of firm-level extensive margin of currency use of Korean export to Japan. Year 0 denotes 2012 when Japan and Korea started to let their local currency swap lines expire.

Figure 13: The Extensive Margin of Currency Shares in Korean Export to Australia: No Controls

(a) Australian Dollar Share



(b) US Dollar Share



(c) Korean Won Share

(d) Other Currencies' Share

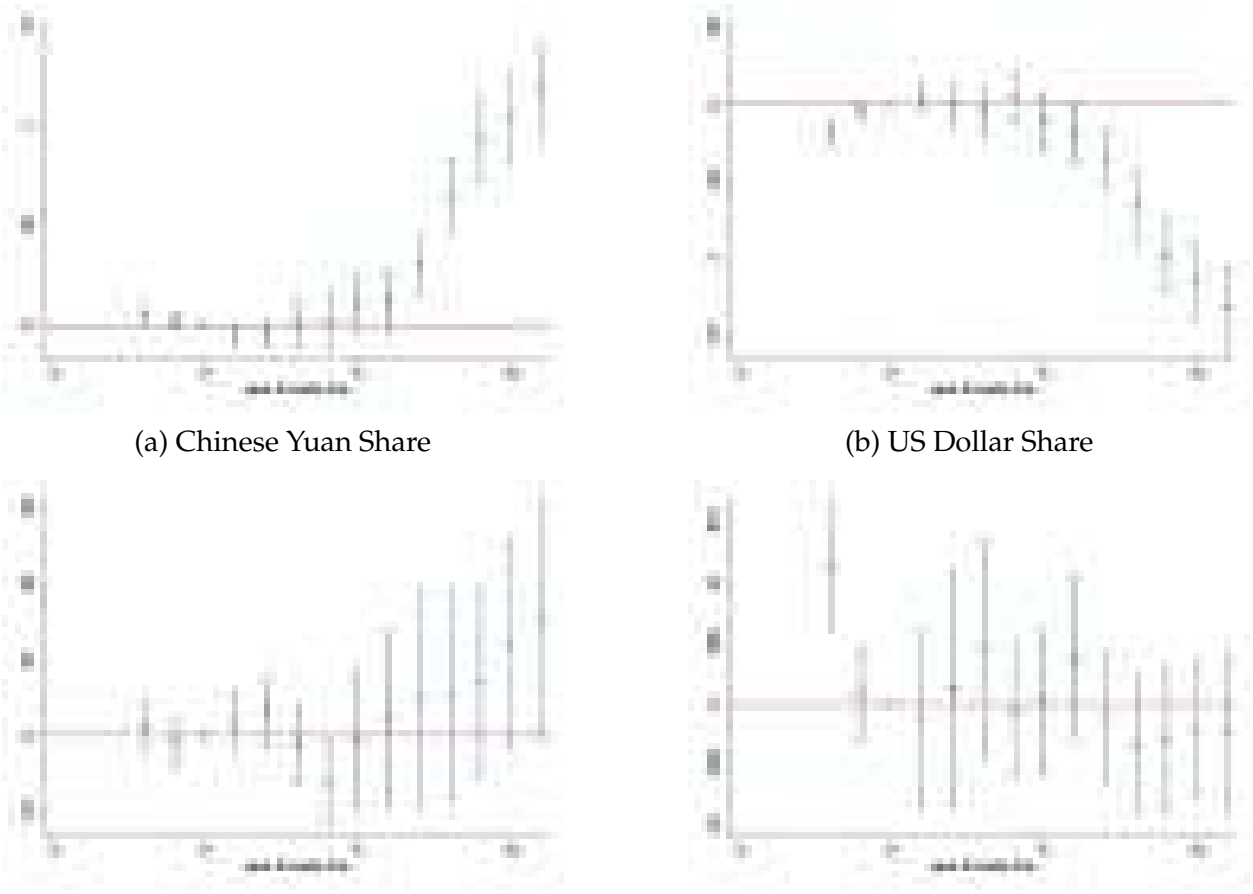
Notes: This figure shows the dynamics of firm-level extensive margin of currency use of Korean export to Australia. Year 0 denotes 2013. Note Australia and Korea signed the local currency swap line in 2014 February.

Here $exvalue_{fjpt}$ is the US dollar value of firm f export to destination j of product p and $exvalue^o_{fjpt}$ is the US dollar value of firm f export to destination j of product p settled in currency o. α_{fjp} is firm-product-country fixed effect and δ_t is year fixed effect. The coefficients of interest are $\beta^o_{j\tau}$, which represents the each year's average currency o shares relative to that in the "swap line event" year.

Figure 14 shows the estimated coefficients for the local currency swap line with China. In panel (a), the estimated β^o shows an increasing trend after the first local currency swap line with China. On the contrary, panel (b) shows that US dollar is crowded out. However, Korean won and other currencies are barely affected, as illustrated in panels (c) and (d). Overall, Chinese yuan substitutes US dollar since the swap line.

Figure 15 shows the estimated coefficients for the local currency swap line with China. In panel (a), the estimated β^o shows an increasing trend after the first local currency swap line with China. On the contrary, panel (b) shows that US dollar is crowded out. However, Korean won and other currencies are barely affected, as illustrated in panels (c) and (d). Overall, Chinese RMB substitutes US dollar after the signing of the swap line.

Figure 14: Firm-Product Level Currency Shares in Korean Export to China: No Controls



(a) Chinese Yuan Share

(b) US Dollar Share

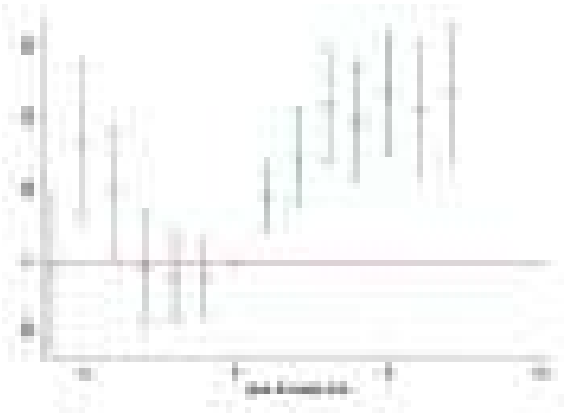
(c) Korean Won Share

(d) Other Currencies' Share

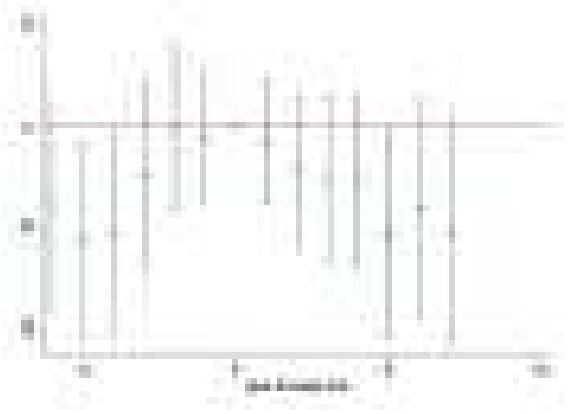
Notes: This figure shows the dynamics of firm-product level currency shares of Korean export to China. Year 0 denotes 2008 when China and Korea signed the local currency swap line.

Figure 15: Firm-Product Level Currency Shares in Korean Export to Japan: No Controls

(a) Japanese Yen Share



(b) US Dollar Share



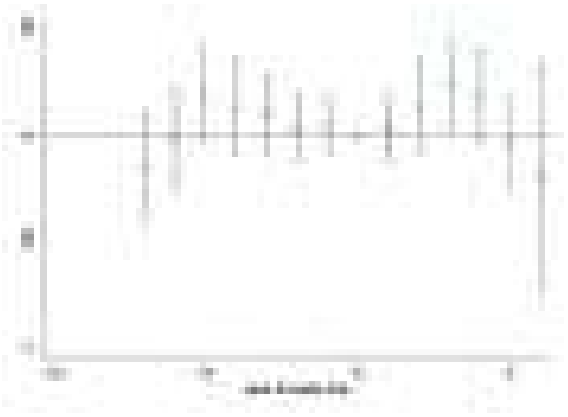
(c) Korean Won Share

(d) Other Currencies' Share

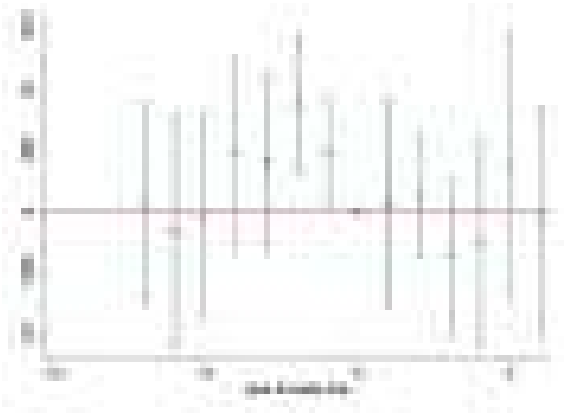
Notes: This figure shows the dynamics of firm-product level currency shares of Korean export to Japan. Year 0 denotes 2012 when Japan and Korea started to let their local currency swap lines expire.

Figure 16: Firm-Product Level Currency Shares in Korean Export to Australia: No Controls

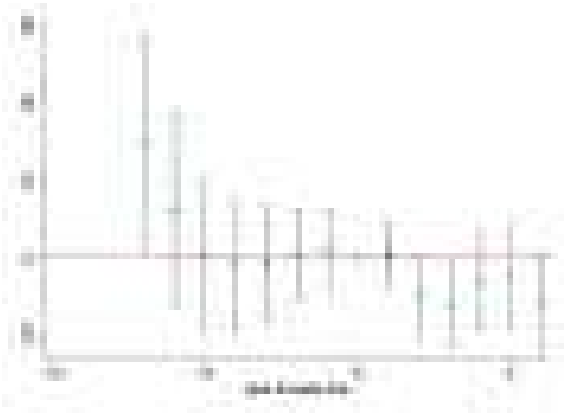
(a) Australian Dollar Share



(b) US Dollar Share



(c) Korean Won Share



(d) Other Currencies' Share

Notes: This figure shows the dynamics of firm-product level currency shares of Korean export to Australia. Year 0 denotes 2013. Note Australia and Korea signed the local currency swap line in 2014 February.

4.5 The Role of Chinese State Owned Importers

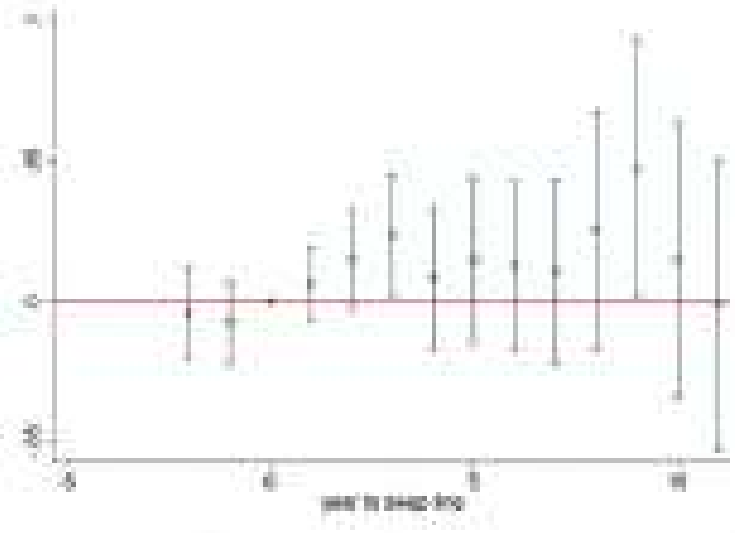
Existing literature suggests that state owned firms are important to help countries achieve their global aspirations. Horn et al. (2021) find that China's international lending is mainly through its state owned firms' commercial loans. We try to examine the role of Chinese state owned firms in promoting the use of RMB in trade. While we cannot identify Chinese importing firms, we are able to classify products by the intensity of imports by state owned firms in China. We use China's customs transaction-level data in 2006 and calculate for each HS 4 product p the fraction of import values by state owned firms and label this fraction as "chnsoe_share$_p$". The empirical setting is

$$\begin{aligned} exsh^o_{fjpt} =& \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline\_event_{jt} = \tau) \\ &+ \sum_{\tau\neq 0} \gamma^o_{China,\tau} I(swapline\_event_{China,t} = \tau) * chnsoe\_share_p + \epsilon^o_{fjpt} \end{aligned} \tag{7}$$

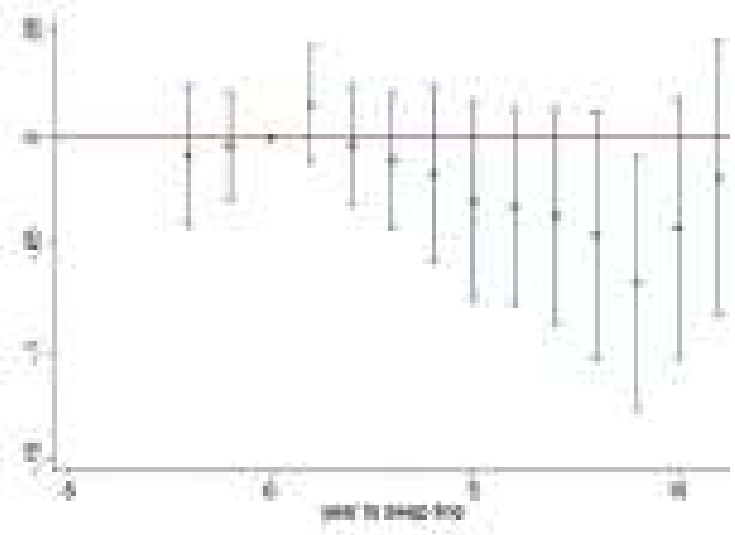
where we interact the state owned share with the distance to the swap line event with China.

We are interested in the estimated $\hat{\gamma}^o_{China,\tau}$, which are shown in Figure 17 for firms' local currency invoicing share and USD share. We find that qualitatively, products with larger China state owned shares show greater increase in the RMB share and corresponding drop in the USD share. However, the difference is not always statistically significant and the economic significance is also limited.

Figure 17: The Role of Chinese State Owned Importers



(a) $\hat{\gamma}^{RMB}_{China,\tau}$



(b) $\hat{\gamma}^{USD}_{China,\tau}$

Table 6: Additional Controls

	(1)	(2)	(3)	(4)
Dependent Variable:	LC share	USD share	KRW share	Other share
market share	0.047***	-0.067*	0.010	0.008
	(0.007)	(0.036)	(0.011)	(0.028)
log(employment)	0.002	-0.002	0.000	0.000
	(0.002)	(0.002)	(0.001)	(0.000)
import LC dummy	0.025***	-0.022***	-0.002	-0.000
	(0.003)	(0.003)	(0.001)	(0.001)
import LC share	0.052***	-0.045***	-0.003	-0.002*
	(0.006)	(0.006)	(0.002)	(0.001)
Year FE	Y	Y	Y	Y
Firm-Product-Destination FE	Y	Y	Y	Y
Observations	795045	795045	795045	795045
R^2	0.889	0.810	0.660	0.792

4.6 Additional Controls

We include additional control variables in our baseline regressions and report the point estimates for these controls in Table 6. We first follow Amiti et al. (2022) to construct a market share measure for Korean exporter f's export to market j in year t

$$s_{fjt} = \frac{exvalue_{fjt}}{\sum_h exvalue_{hjt}}.$$

This variable is intended to capture its relative size. We also include firm employment (its natural logarithm) as a control. Moreover, we construct "import LC dummy" to denote whether the exporter uses destination country's currency in their import and "import LC share" to denote the fraction of the exporter's destination country's currency use in their total import. Note that we run a panel regression that utilizes time-varying control variables while Amiti et al. (2022) focus primarily on the cross-sectional setting to discuss the currency choice in trade. But we consistently find that a larger market share is associated with more LC use and less USD use. There is also evidence on the import-export currency hedging. Nevertheless, adding these controls does not change our swap line dummies' estimates in a material way.

5 Exploring the Mechanism: The Role of Banks

5.1 Bank Heterogeneity and Export Currency Invoicing

Banks' initial branches in China are important for them to expand lending business in RMB once the perceived risks is reduced. We note that Korean banks' RMB lending business is likely to be conducted mainly by their subsidiaries in China. For example, we find that almost all of Woori Bank's RMB lending is reported in the annual report of Woori Bank China (Woori Bank's subsidiary in China). We thus calculate a new variable that measures the initial infrastructures of bank j to conduct business in Chinese RMB as

$$branch\_initial_b = \frac{\text{number of cities bank b has branches before 2008}}{\text{export values of exporters with main bank b in 2006 (million US \$)}}$$

The denominator is intended to have some normalization to the number of branches. We drop government owned banks, foreign banks and focus on private banks.

Firms rely on banks to deal with international transactions and we utilize the self-reported main bank information provided by the KIS data. The main bank of a firm is usually the largest lender of the firm and deals with most of the firm's transactions, including cross-border transactions. Amiti and Weinstein (2011) discuss a similar context in the case of Japan. We further show that the RMB deposits of Chinese banks' branches in Korea is only a small fraction of those of Korean commercial banks.[9] Therefore, it is natural to consider the important role of Korean commercial banks in the rise of RMB. Our empirical setting is

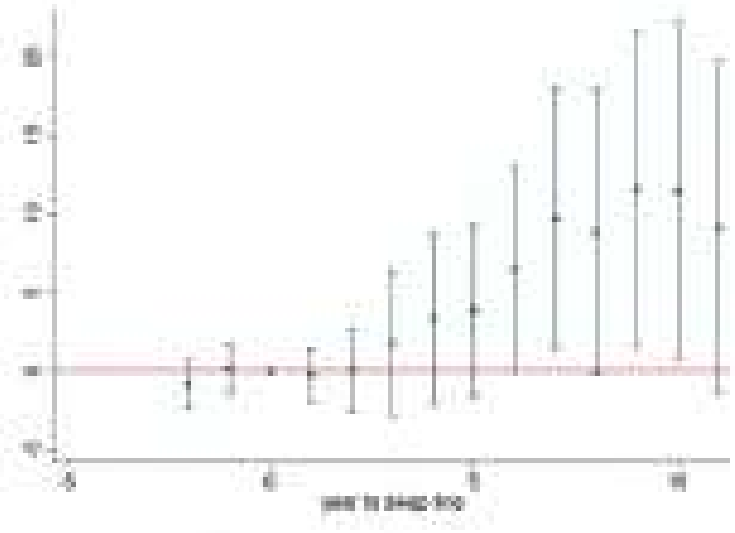
$$\begin{aligned} exsh^o_{fjpt} =& \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline\_event_{jt} = \tau) \\ &+ \sum_{\tau\neq 0} \xi^o_{China,\tau} I(swapline\_event_{China,t} = \tau) * branch\_initial_b + \epsilon^o_{fjpt}, \end{aligned} \tag{8}$$

in which firm f's main bank is bank b. The coefficient $\xi^o_{China,\tau}$ for the interaction term captures the differential responses of firms' currency choice when their main banks have more branch exposure to China.

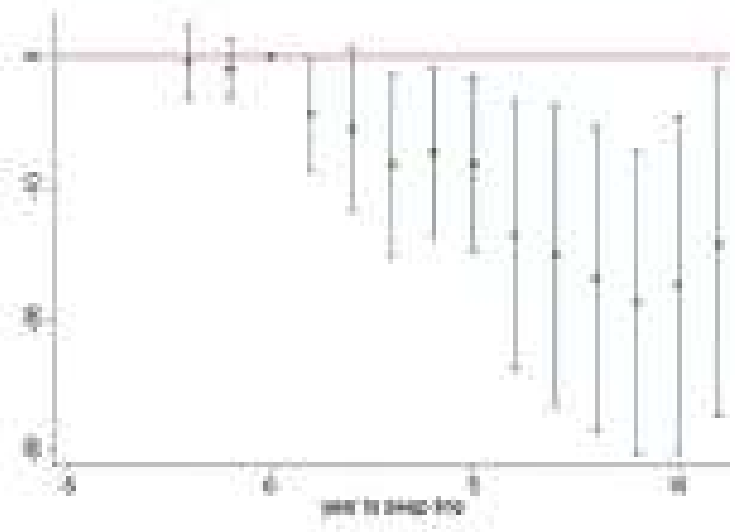
Figure 18 shows the estimated $\xi^o_{China,\tau}$ where o denotes RMB or USD. There is indeed evidence that banks with more initial branches in China (normalized) also see their firms use more RMB and less USD after the Korea-China swap line. This is consistent with our financial safety net hypothesis.

[9] The RMB deposits of two major branches of Chinese banks (Bank of China and Industrial and Commercial Bank of China) are less than 3% of those of Korean commercial banks in 2018.

Figure 18: The Role of Initial Korean Bank Branches in China



(a) $\hat{\xi}^{RMB}_{China,\tau}$



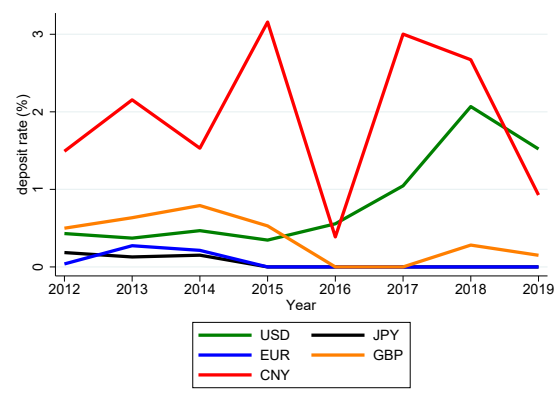
(b) $\hat{\xi}^{USD}_{China,\tau}$

5.2 Korean Banks' Deposit Rates by Currency

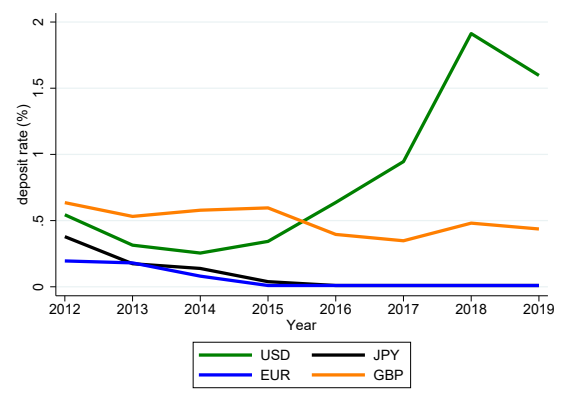
We hand-collect the deposit rates data by currency of different Korean banks from their websites. Not all Korean banks' historical deposit rates are available. We manage to obtain some data from big Korean banks including Woori Bank, Industrial Bank of Korea (IBK), Shinhan Bank and Korean Exchange Bank (KEB). Our baseline deposit rate is 3-month term deposit rate. When the 3-month term deposit rate is not available, we report term deposit rate of another maturity or the ordinary deposit rate.

Figure 19 shows deposit rates in different major currencies of Korean commercial banks. In panel (a), Woori Bank's data is only available after 2012. We find its 3-month Japanese Yen term deposit rate decreases after 2012, when Korea and Japan discontinued their bilateral swap line. The Industrial Bank of Korea in panel (b) exhibits a similar pattern on the 3-month Japanese Yen term deposit rate. Panel (c) of Shinhan Bank not only shows a decline in the 12-month Japanese Yen term deposit rate after 2012, but also an increase in the rate after 2005 since the establishment of Korea-Japan swap line. It is also evident that RMB deposit rate after 2016 is higher than that in 2004-2006. (There are missing values between 2007 and 2015.) Panel (d) on the ordinary deposit rates of Korean Exchange Bank (KEB) is consistent with panel (c). The post-swap line periods have a higher RMB deposit rate than that in the pre-swap line periods. Moreover, the expiration of the Korea-Japan swap line is associated with a decline in JPY deposit rate.

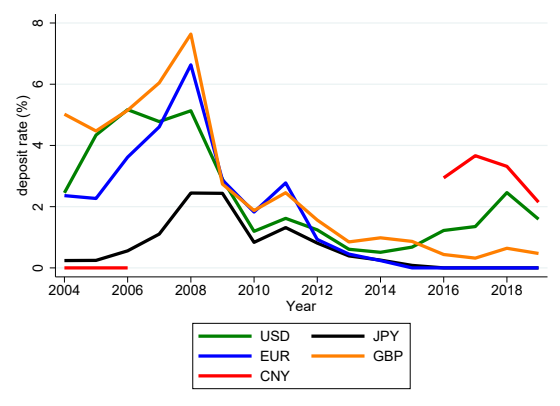
Figure 19: Korean Banks' Deposit Rates on Foreign Currencies



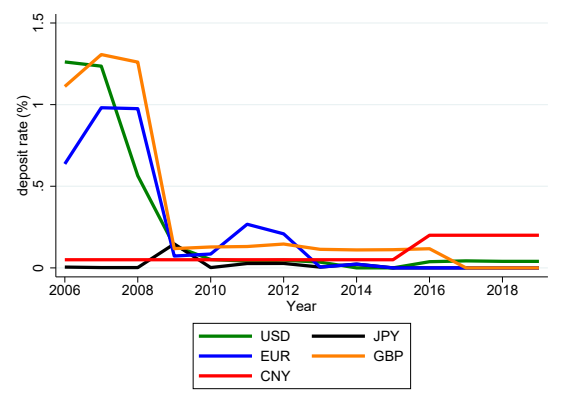
(a) Woori Bank 3-month Term Deposit Rate



(b) Industrial Bank of Korea (IBK) 3-month Term Deposit Rate



(c) Shinhan Bank 12-month Term Deposit Rate



(d) Korean Exchange Bank (KEB) Ordinary Deposit Rate

Notes: This figure shows Korean banks' deposit rates in different currencies upon data availability.

Table 7: Deposit Response to Central Bank Swap Line

	(1)
Dependent Variable:	LC deposit ratio
Swap Line Dummy	0.173**
	(0.051)
Year FE	Y
Bank-Destination FE	Y
Observations	224
R^2	0.872

Notes: This table shows the regression that Korean banks' Japanese Yen deposits (normalized by firms' export volume) significantly declined after Japan and Korea let their local currency swap lines expire.

5.3 Currency Denomination of Korean Banks' Deposits

We hand-collect banks' balance sheet data of major Korean banks denominated in different currencies, including Euros, British Pound, Japanese Yen and Chinese Yuan. We take banks' deposits information. South Korea has/had swap lines with Japan and China, but not with the Eurozone and UK.

For each bank b, we know the group of firms that it serves as a main bank from the Korean Information Service data. We label these firms as bank b firms. We investigate whether bank b's currency j deposits as a fraction of bank b firms' total export to country j (labeled as local currency deposit ratio, abbreviated as "$lc\_deposit\_ratio$") is correlated with the SwapLineDummy, i.e., we test

$$lc\_deposit\_ratio_{bjt} = \alpha_{bj} + \beta * SwapLineDummy_{jt} + \delta_t + \epsilon_{bjt}.$$

To reduce the impact of outliers, we winsorize $lc\_deposit\_ratio$ at the 2.5% level of both tails. Since the available Korean banks' RMB balance sheets are only available after 2008, and the Eurozone and UK did not sign local currency swap lines with Korea, the SwapLineDummy variable essentially captures the variation in the status of Korea's swap line with Japan.

We report the regression results in Table 7. It shows that the discontinuation of swap line between Korea and Japan is associated with a decline in deposit in Japanese Yen (normalized by the export value to Japan of firms with a given main bank) at the bank level.

6 Model

We present a simple model with exporting firms and banks to demonstrate how currency swap impacts the equilibrium currency use by firms. The timing of events are as follows. At the beginning of the first period, Korean banks announce the interest rates for currency l deposit. We consider $l \in \{j, v\}$, where j and v are the local currency in country j (RMB) and the vehicle currency (USD), respectively. Observing this, firms choose an invoicing currency l. Subsequently, the exchange rate shocks $\{\xi_l, \xi_j\}$ are realized, production and consumption take place and the firms deposit the sales revenue in a bank for interest. The bank immediately lends out the money with a long-term contract (two periods) to make profit. In the second period, we suppose that there is an exogenous probability π_j that firms that adopted currency j for invoicing (that we refer to as j firms) need to withdraw the deposit from the bank. Since the bank does not have cash reserve readily available, it has to borrow externally with a higher interest rate $\bar{i}$ or from the central bank with a lower interest rate $\underline{i}$ if a currency swap is in place. In the third, also the final, period, the bank pays back the principal and the two-period interest to j firms with probability $(1 - \pi_j)$ and to v firms.

6.1 Firms

We consider a continuum of Korean monopoly firms exporting to China (denoted as j). The production function of each firm can be expressed as

$$y = A\alpha^{-1}h^{\alpha}, \tag{9}$$

where y denotes output, A denotes the productivity level, which is assumed to be parameter common to all firms, α is a scale parameter $(\alpha < 1)$, and h is the amount of labor used for production. We specify each firm's demand function to be

$$y_l = C_j \left(\frac{\xi_l p_l \tau_l}{\xi_j P_j} \right)^{-\lambda} \quad \text{for } l \in \{j, v\}, \tag{10}$$

where y_l denotes the level of demand if the firm adopts currency l for invoicing. We consider two types of currencies in our model: j for the local currency in country j (RMB) and v for the vehicle currency (USD). C_j and P_j are the consumption and price levels in country j, respectively, and ξ_l is the exchange rate between KRW and currency l defined in a way that a unit of currency l can exchange for ξ_l unt of KRW. p_l is the firm's price in currency l, τ_l is the transaction cost associated with using currency l and λ (> 1) is the

demand elasticity.

For a given level of exchange rate shock (ξ_l, ξ_j), the firm's profit can be expressed as

$$\begin{aligned} \Pi_j &= \xi_j p_j y_j \left[\pi_j + (1-\pi_j)(1+i_j)^2\right] - wh_j \\ \Pi_v &= \xi_v p_v y_v (1+i_v)^2 - wh_v. \end{aligned} \tag{11}$$

We suppose that a firm i chooses currency l such that

$$\max_{l \in \{j,v\}} \mathbb{E}(\Pi_l) \cdot \epsilon_{il}^{-1},$$

where ϵ_{il} is a random variable from Fréchet distribution with parameters (T_l, θ), where T_l and θ are respectively location and shape parameters. The share of firm that uses currency l invoicing can be expressed as

$$s_l = 1 - \frac{T_l \mathbb{E}(\Pi_l)^{-\theta}}{\sum_{l'} T_{l'} \mathbb{E}(\Pi_{l'})^{-\theta}}. \tag{12}$$

Equation (12) suggests that the share of firms that use currency l for invoicing increases with the expected profit in currency l (relative to the profit in the other currency).

6.2 Banks

So far we solved the model given the interest rates that banks provide for firms. Now we solve for the bank's problem to obtain the equilibrium interest rates. The bank's profit maximization problem can be expressed as

$$\begin{aligned} \max_{i_j, i_v} \Pi_B = \left\{\mathbb{E}(g_j(D_j)) - (1-\pi_j)(1+i_j)^2 \mathbb{E}(D_j) - \pi_j((1-\omega)\bar{i} + \omega \underline{i})\mathbb{E}(D_j)\right\} s_j \\ + \left\{\mathbb{E}(g_v(D_v)) - (1+i_v)^2 \mathbb{E}(D_v)\right\} s_v, \end{aligned} \tag{13}$$

where $\mathbb{E}(g_l(D_l))$ is the expected return on banks' loan to other sectors in the economy. We assume that the $g_l(D_l)$ is a homogeneous function of degree 1 to ease the aggregation of firms' deposit D_j. Since the bank does not know the realization of exchange rate ξ at the time of decision, it chooses the optimal level of interest rates based on the expected value of the firm's deposit D_l, which amounts to each firm's export revenue. We summarize the comparative statics of the bank's optimal interest rates with respect to the signing of the currency swap agreement in the following proposition.

Proposition 1. *The bank's optimal interest rate in currency j increases (currency v decreases) if a currency swap agreement is signed.*

Proof.
Let function f denote the first-order derivative with respect to Π_B. The FOC with respect to i_j suggests:

$$f(i_j, i_v, \omega) \equiv \frac{\partial \{\cdot\}_j}{\partial i_j} s_j + \{\cdot\}_j \frac{\partial s_j}{\partial i_j} + \{\cdot\}_v \frac{\partial s_v}{\partial i_j} = 0,$$

where $\{\cdot\}_j \equiv \{\mathbb{E}(g_j(D_j)) - (1-\pi_j)(1+i_j)^2\mathbb{E}(D_j) - \pi_j((1-\omega)\bar{r} + \omega\underline{r})\mathbb{E}(D_j)\}$ and $\{\cdot\}_v \equiv \{\mathbb{E}(g_v(D_v)) - (1+i_v)^2\mathbb{E}(D_v)\}$. It is easy to establish that[10]

$$\frac{\partial D_j}{\partial \omega} = 0, \quad \frac{\partial D_j}{\partial i_j} > 0 \quad \text{and} \quad \frac{\partial D_v}{\partial i_j} = 0$$

$$\frac{\partial s_j}{\partial \omega} = 0, \quad \frac{\partial s_j}{\partial i_j} > 0 \quad \text{and} \quad \frac{\partial s_v}{\partial i_j} < 0.$$

Assuming that the second order condition is satisfied around the i_j^* that maximizes the bank's profit, we have $\frac{\partial f}{\partial i_j} < 0$. Note that $\frac{\partial f}{\partial \omega} = \frac{\partial^2 \{\cdot\}_j}{\partial i_j \partial \omega} s_j + \frac{\partial \{\cdot\}_j}{\partial \omega} \frac{\partial s_j}{\partial i_j} > 0$. According to the implicit function theorem, we immediately show $\frac{\partial i_j^*}{\partial \omega} > 0$. Similarly, we can show $\frac{\partial i_v^*}{\partial \omega} < 0$. □

The intuition for this proposition is clear. The signing of a currency swap ($\omega = 1$) affects the optimal interest rate for i_j through two channels. First, holding constant the market share of j firms, a currency swap agreement lowers the bank's financing cost for each bank should firms withdraw the deposit with a chance of π_j. Second, a currency swap lowers the financing cost of the bank such that it lowers the cost associated with expanding the market share of j firms. These two channels ensure that the signing of a currency swap agreement increases the bank's optimal interest i_j in currency j. However, the optimal interest i_v in the vehicle currency is impacted by the agreement only by a single channel in the opposite way. Namely, the signing of a currency swap agreement makes the erosion of firm j share by an increase in i_v more costly.

6.3 A Numerical Example

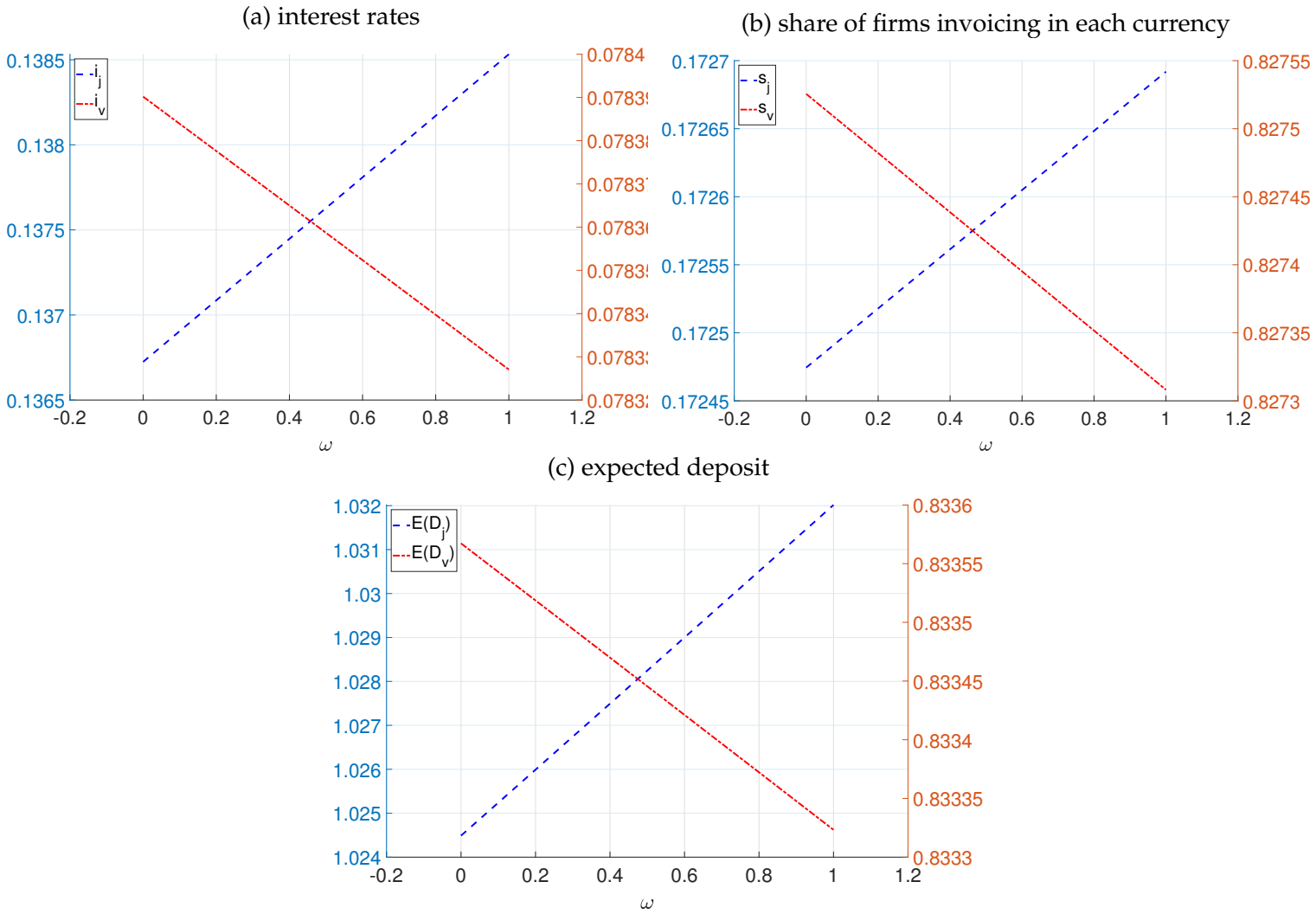
We have shown in Proposition 1 that the bank's optimal interest rate in currency j increases after the currency swap agreement is signed. This is consistent with the key empirical patterns that we document in this paper. In this subsection, we use a numerical

[10] See Appendix G for details.

example to confirm Proposition 1 and observe the comparative statics of other equilibrium variables with respect to the signing of the currency swap agreement.

In Figure 20, we plot the changes in interest rates, shares of firms that adopt two different invoicing currencies and the expected deposit from each type of firms. As predicted by Proposition 1, panel (a) shows that the interest rate i_j increases after a swap agreement is signed, whereas i_v decreases. This is consistent with the results in panel (c) that the share of j (v) firms increases (decreases) and panel (c) that the expected deposit from j (v) firms increases (decreases) as the swap agreement is signed. Intuitively, a higher interest rate i_j increases the share of j firms, and a higher interest rate, which is isomorphic to an ad-valorem subsidy in our model, allows the firms to set lower prices and increase the expected revenue deposited in the bank.

Figure 20: Model Comparative Statics



Notes: These figures show the comparative statics of interest rates, shares of firms invoicing in each currency and the expected amount of deposit (firm revenue) with respect to the signing of the currency swap agreement (ω changes from 0 to 1). Model parameters are as follows: $\pi_j = 0.1$, $\lambda = 3$, $\alpha = 0.9$, $T_j = 1$, $T_v = 0.2$, $\theta = 0.2$, $g_j = 3.3\sqrt{(\cdot)}$, $g_v = 3\sqrt{(\cdot)}$, $\bar{i} = 0.2$, $\underline{i} = 0.1$. C_j, τ_j, τ_v, P_j, w and A are normalized to 1.

7 Conclusion

In this paper, we consider the role of a rising instrument of global financial safety - central bank swap lines - in promoting currency internalization in trade transactions. In particular, we use detailed customs data from South Korea that record currency use. We find that after South Korea's local currency swap line with China, its exporters increase their RMB share in their trade with China significantly. Conversely, after the discontinuation of South Korea's local currency swap line with Japan, Korean exporters' JPY shares in their trade with Japan see significant declines.

We propose a risk reduction explanation on our findings of the connection between local currency swap lines and currency choice in trade. When Korean commercial banks learn that their central bank can be the lender of last resort of RMB with the standing swap line with China, they are more willing to take risks in expanding RMB business. As a result, they will spend efforts to attract more deposits and lend loans denominated in RMB. To strengthen the empirical identification, we utilize information of main banks for Korean exporters where a main bank is usually the largest lender of a firm and processes the firm's cross-border transactions. Under the risk reduction mechanism, those banks with more pre-swap line infrastructure presence such as bank branches or offices in China should respond more to the swap line as it is less costly for them to expand their RMB lending business. Indeed, we find that Korean exporting firms whose main banks had more pre-swap line branch exposure (relative to the cross-border transaction volume) see larger increases in their RMB share. Consistent with the proposed mechanism, the few Korean banks whose historical deposit rates are available show increases in RMB interest rates after the signing of Korea-China swap line and declines in JPY interest rates after the expiration of Korea-Japan swap line.

Finally, we provide a novel firm currency choice model with explicitly modeled banks. Banks are subject to liquidity mismatch and value central banks' lender of last resort. When the central bank acts as a lender of last resort of a foreign currency, it will incentivize these banks to expand borrowing and lending business in the foreign currency. Banks can provide more attractive terms to exporters to attract their deposits in the foreign currency. This transmits to exporting firms' leaning towards more use of that currency.

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Online Appendix

(Not For Publication)

A The Chiang Mai Initiative

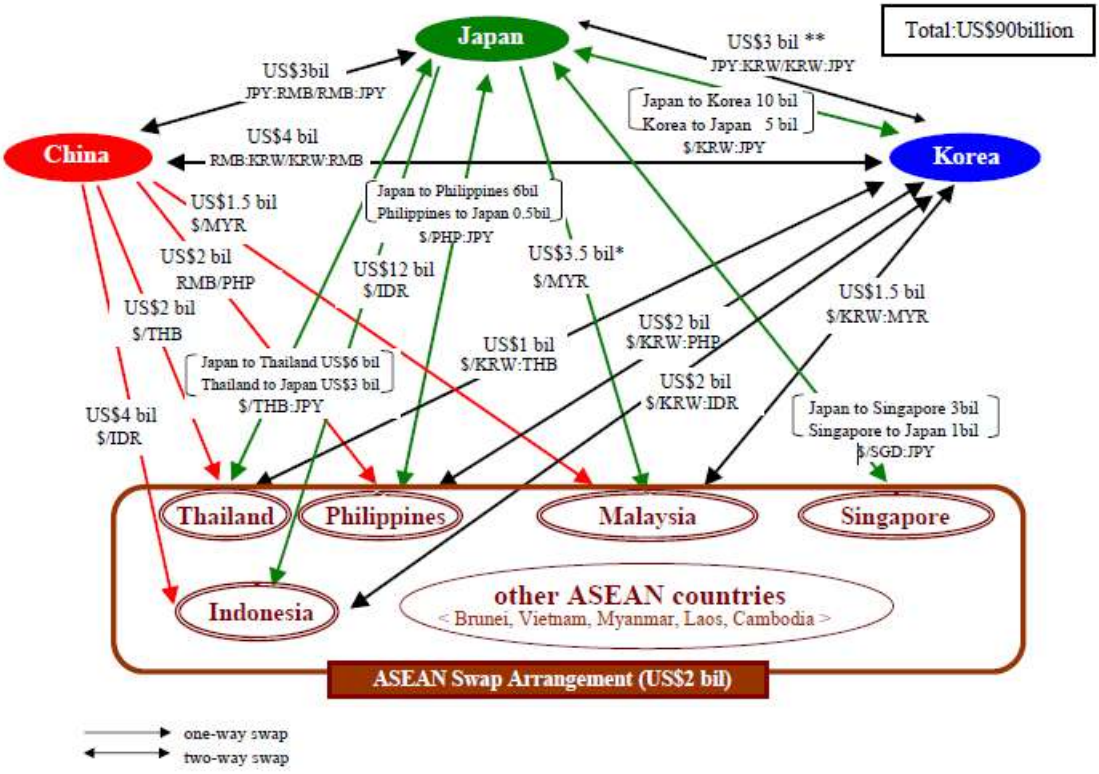
The Chiang Mai Initiative (CMI) is a multilateral currency swap agreement among the ten members of the Association of Southeast Asian Nations (ASEAN), China (including Hong Kong SAR), Japan, and South Korea (the so called "ASEAN plus Three" countries). The CMI started as a set of bilateral swap arrangements after a meeting of the Board of Governors of the Asian Development Bank (ADB) on May 6th, 2000 in Chiang Mai, Thailand. It is a response to the Asian Financial Crises and supposed to manage short-term liquidity problems in the region using a network of currency swap lines. These bilateral swap lines are facilities designed to provide short-term liquidity in the form of swaps of US dollars with the domestic currencies of participating countries. Participating countries can draw on the US dollars for 90 days. The interest rate of the drawing is usually the LIBOR plus a premium. South Korea first signed a US dollar swap line with Japan on July 4th, 2001, in which South Korea contributed 2 billion US dollars and Japan contributed 5 billion US dollars. Either country can swap their own currency for the US dollars the other side contributes. The US dollar swap line agreement was renewed until the size was increased to 10 billion US dollars from the Japanese contribution, and 5 billion from the Korean contribution. It finally expired on February 23rd, 2015.

South Korea signed US dollar swap line with China on June 24th, 2002 with 2 billion US dollars from each side. The size was doubled in May of 2005. The bilateral Korea-China US dollar swap line was extended until the Chiang Mai Initiative Multilateralization (CMIM) was established.

South Korea also signed US dollar swap lines with Indonesia, Malaysia, Philippines and Thailand under the Chiang Mai Initiative. Figure A.1, A.2 and A.3 show the evolution of the Chiang Mai Initiative.

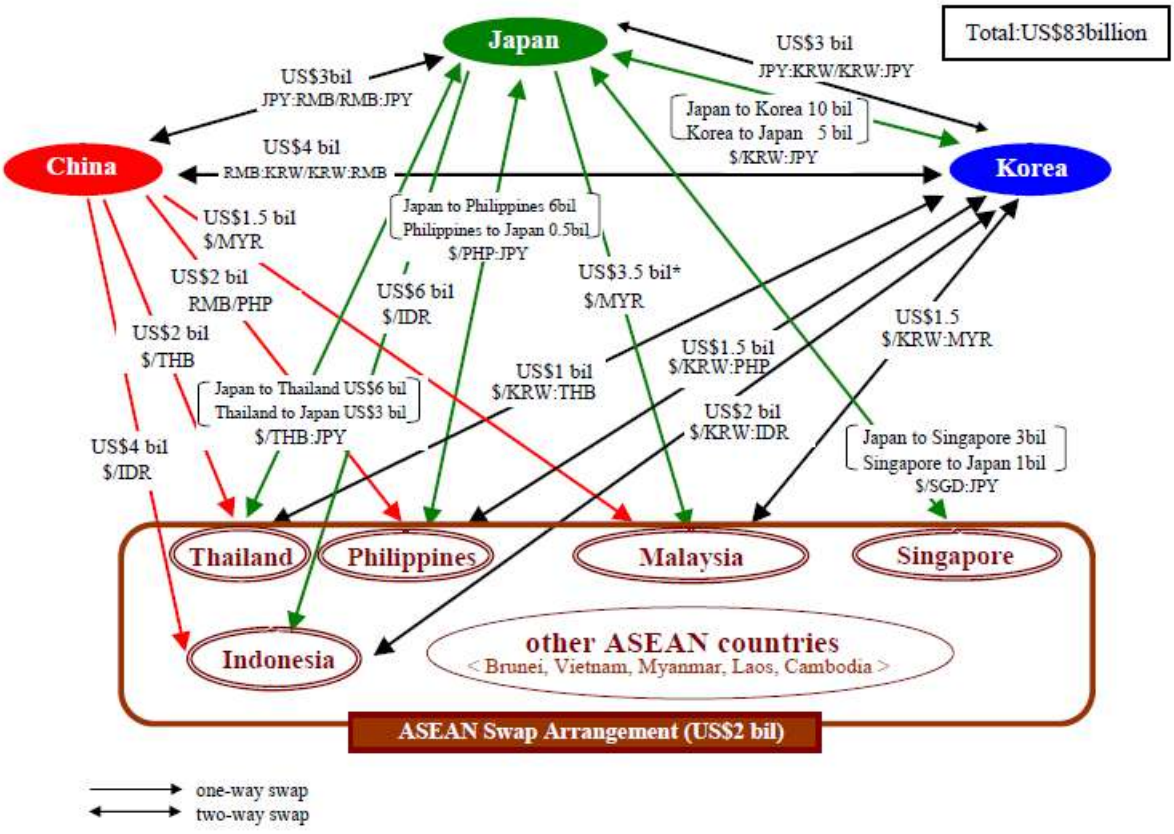
The Chiang Mai Initiative Multilateralization (CMIM) formally turns to the multilateral reserve pool in May of 2009. The reserve pool is 120 billion US dollars in which South Korea contributed 16% and is able to draw US dollars with an upper bound 19.2 billion US dollars, the same as South Korea contributed. The size of the reserve pool doubled in July of 2014. Table A.1 summarizes the details of the CMIM contributions and borrowing multipliers by each country/region.

Figure A.1: The Agreement on the Swap Arrangement under the Chiang Mai Initiative (as of August 31, 2005)



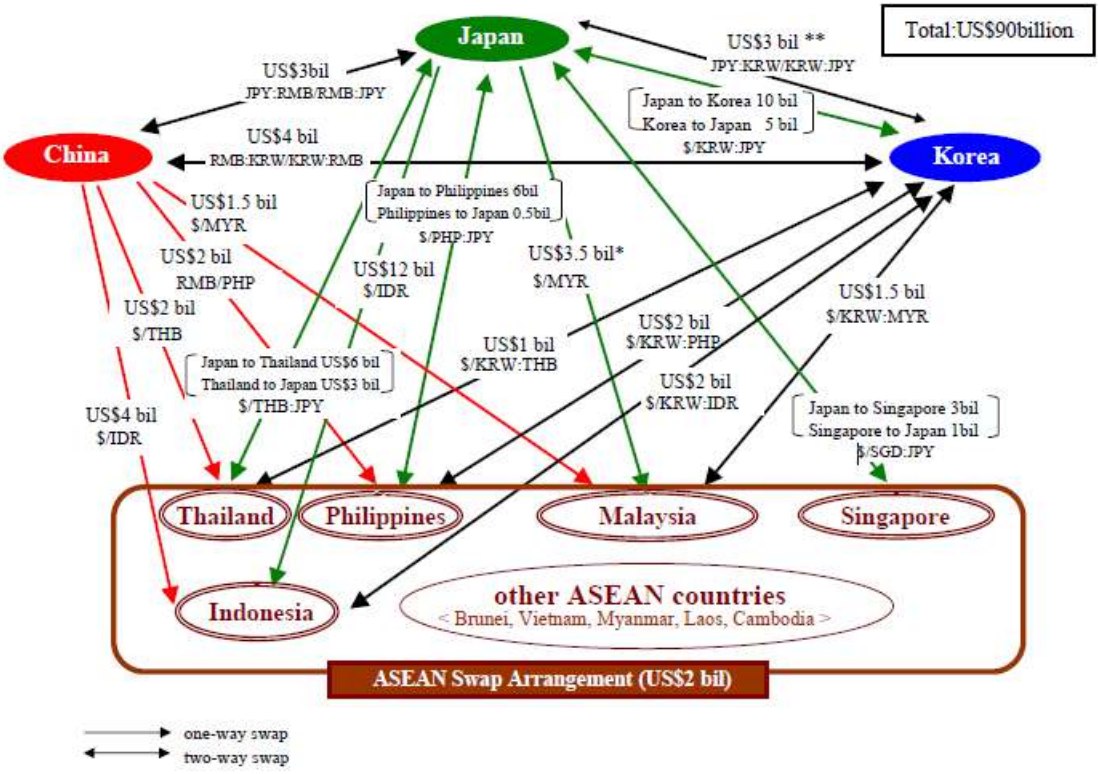
Source: Bank of Japan

Figure A.2: The Agreement on the Swap Arrangement under the Chiang Mai Initiative (as of July 10, 2007)



Source: Bank of Japan

Figure A.3: The Agreement on the Swap Arrangement under the Chiang Mai Initiative (as of April 6, 2009)



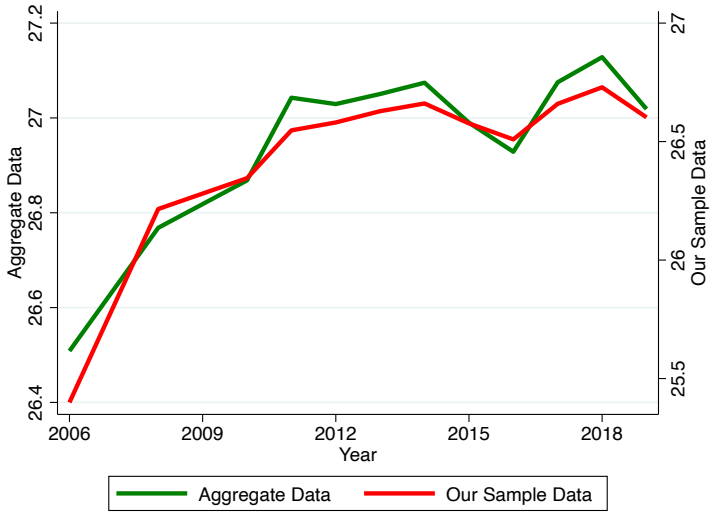
Source: Bank of Japan

Table A.1: CMIM Contributions and Borrowing Multipliers

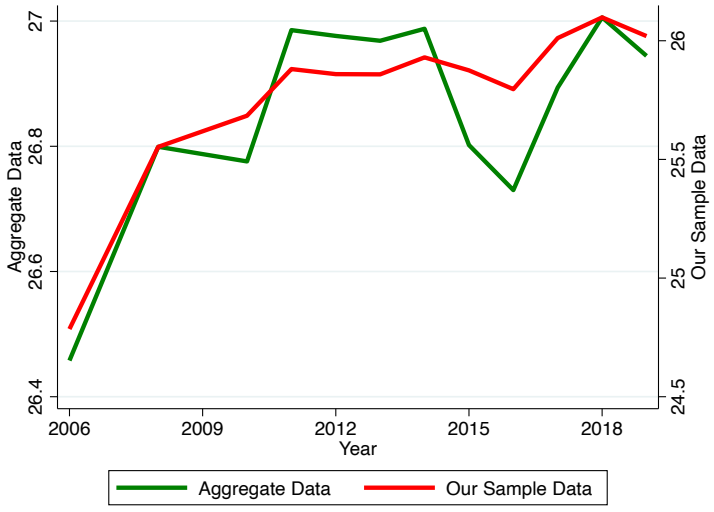
Country/Region	Contributions (US $ Billion)	Borrowing Multipliers
Brunei	0.01	5
Cambodia	0.12	5
PRC, Excluding Hong Kong	34.2	0.5
Hong Kong, China	4.2	2.5
Indonesia	4.77	2.5
Japan	38.40	0.5
Korea	19.20	1
Lao PDR	0.03	5
Malaysia	4.77	2.5
Myanmar	0.06	5
Philippines	3.68	2.5
Singapore	4.77	2.5
Thailand	4.77	2.5
Vietnam	1.00	5

B Sample Representativeness

Figure B.1: Export and Import Dynamics: Official Data vs. Customs Sample Data

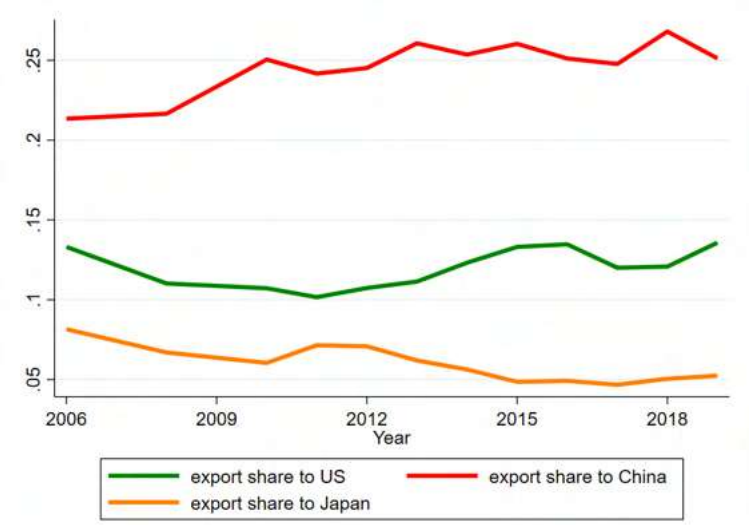


(a) Export Dynamics

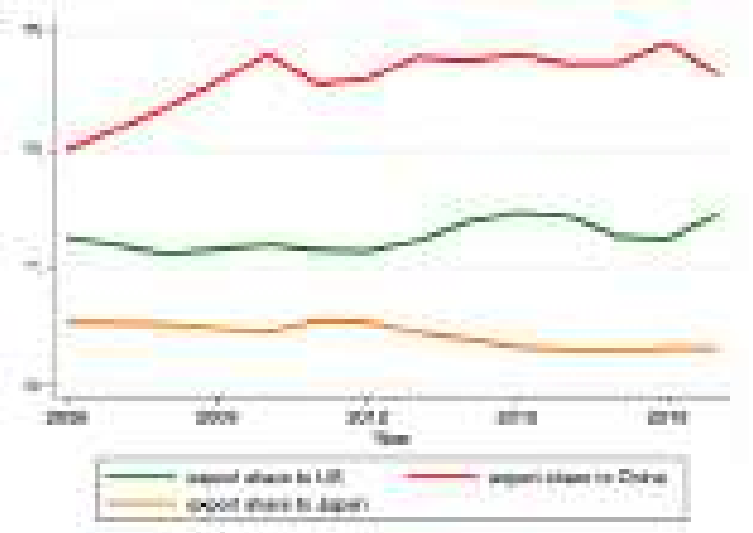


(b) Import Dynamics

Figure B.2: Export Shares by Top Destinations: Official vs. Our Sample

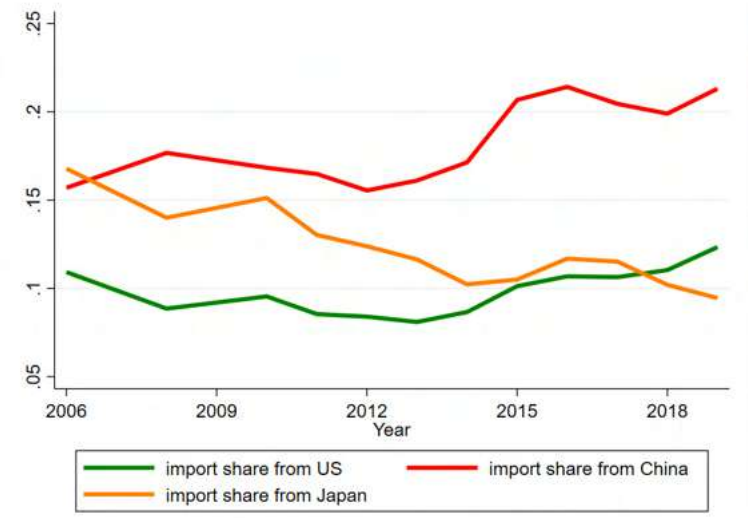


(a) Official Data

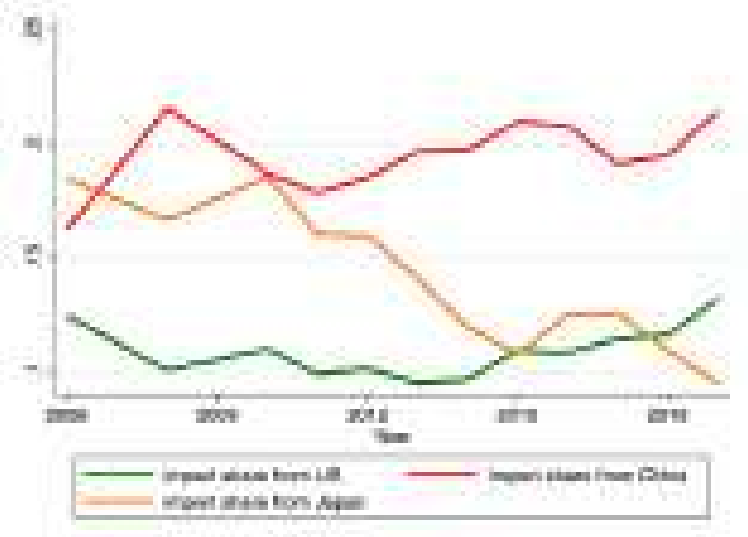


(b) Customs Sample Data

Figure B.3: Import Shares by Top Destinations: Official Data vs. Customs Sample Data

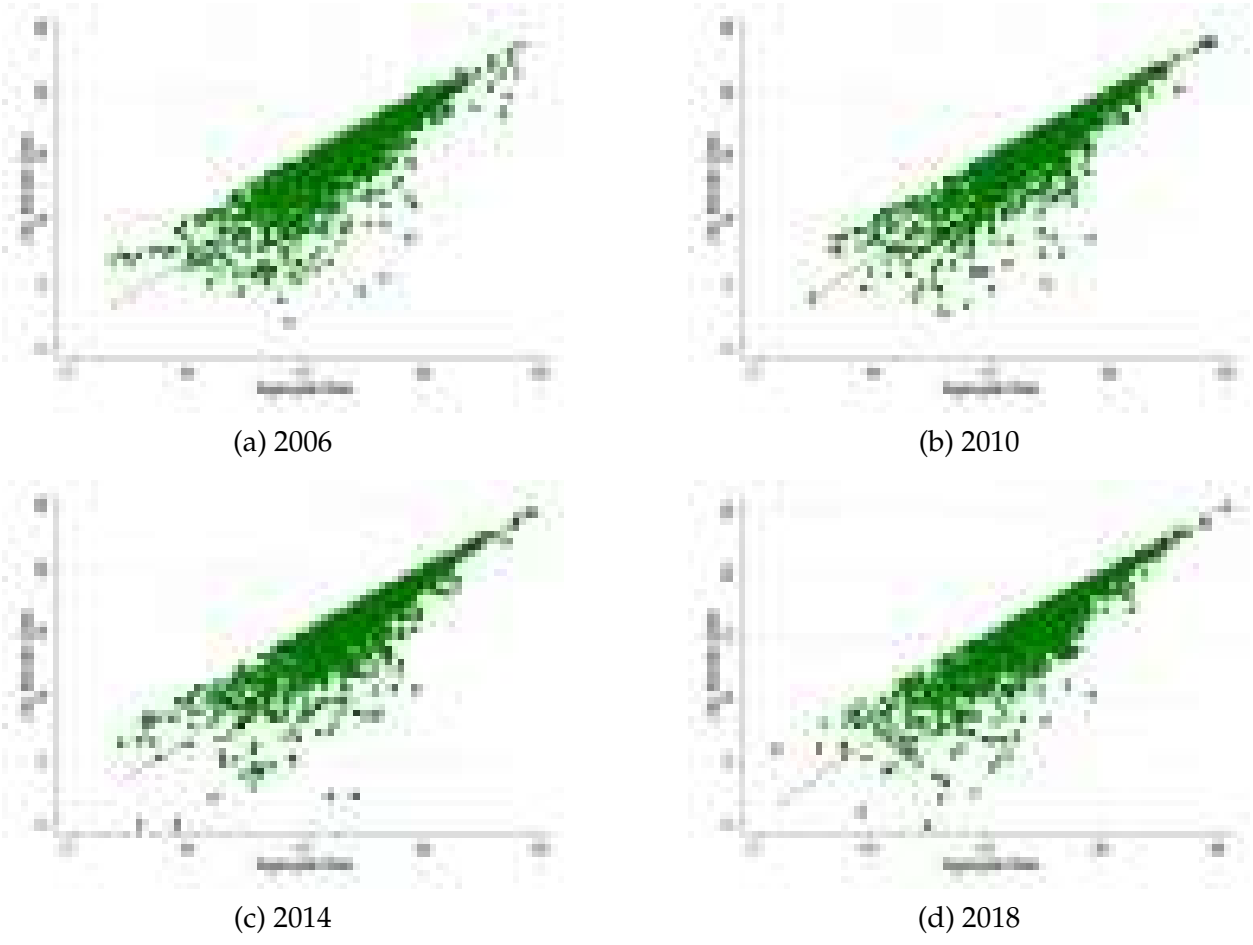


(a) Official Data



(b) Customs Sample Data

Figure B.4: Korean Export Product Level Comparison by Year: Official vs Our Sample



(a) 2006

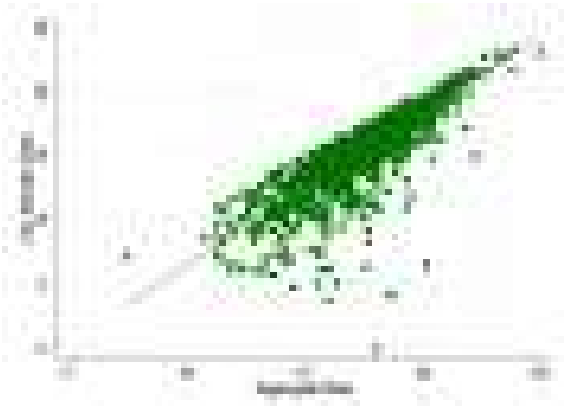
(b) 2010

(c) 2014

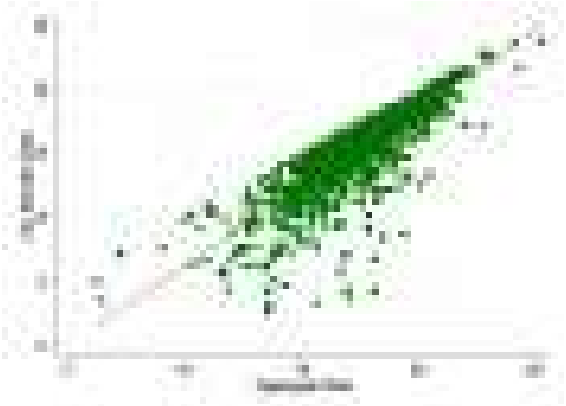
(d) 2018

Figure B.5: Korean Import Product Level Comparison by Year: Official vs Our Sample

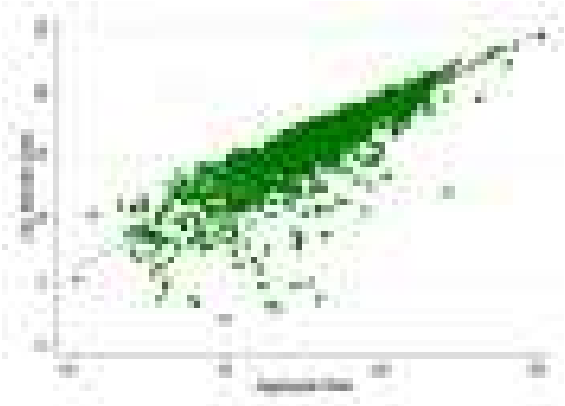
(a) 2006



(b) 2010



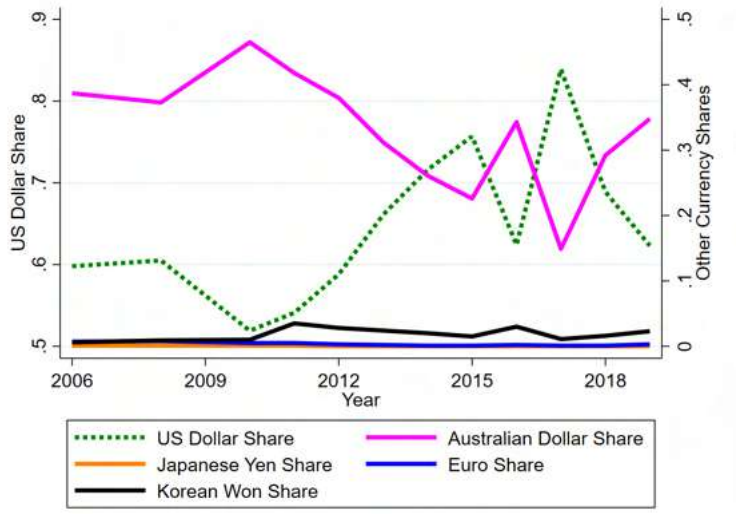
(c) 2014



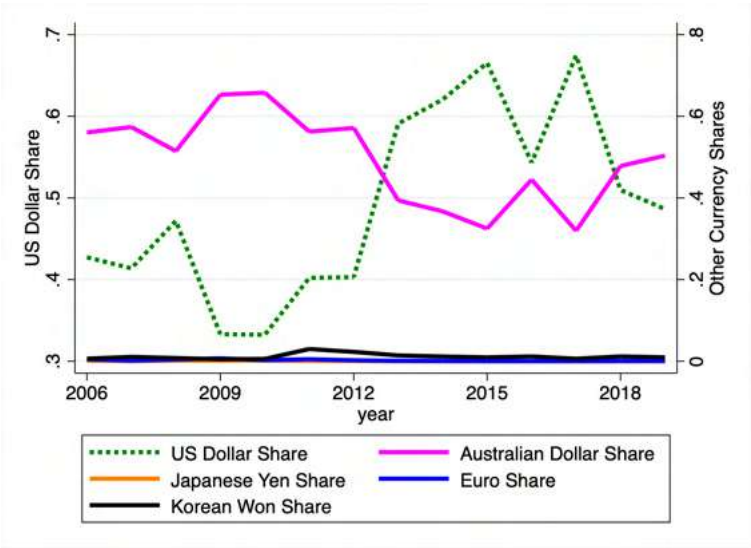
(d) 2018

C More on Patterns of Korean Export Currency Shares

Figure C.1: Currency Shares in Korean Export to Australia: Official vs. Our Sample Data

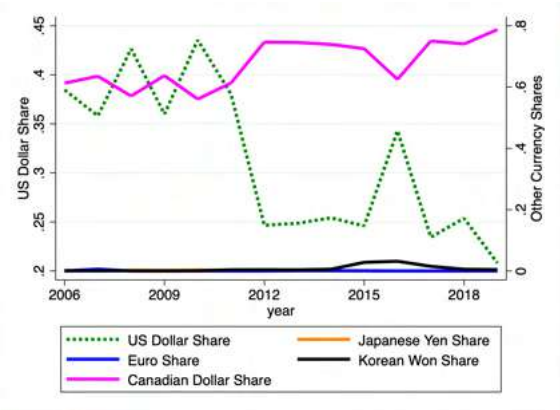


(a) Official Data

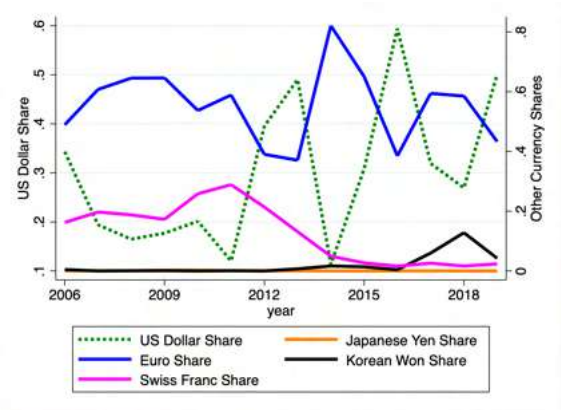


(b) Customs Sample Data

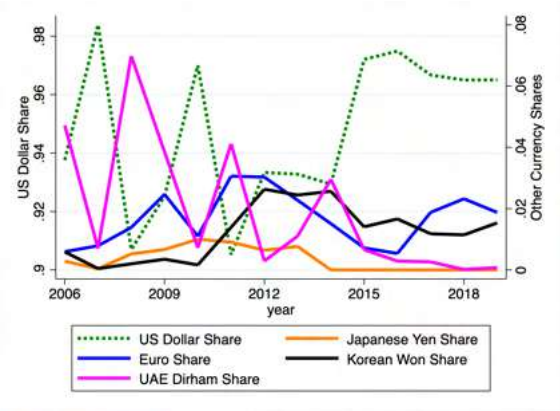
Figure C.2: Currency Shares in Korean Export to Other Destinations with Swap Lines: Customs Sample Data



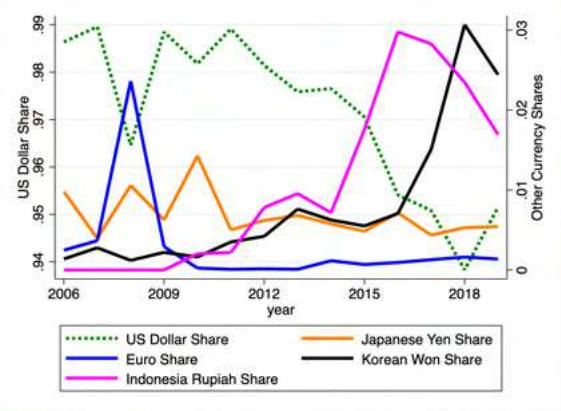
(a) Export to Canada



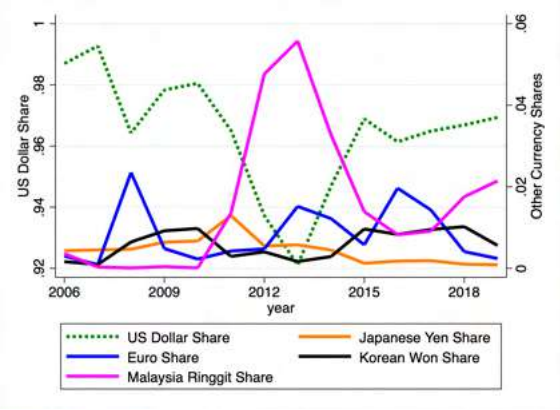
(b) Export to Switzerland



(c) Export to UAE



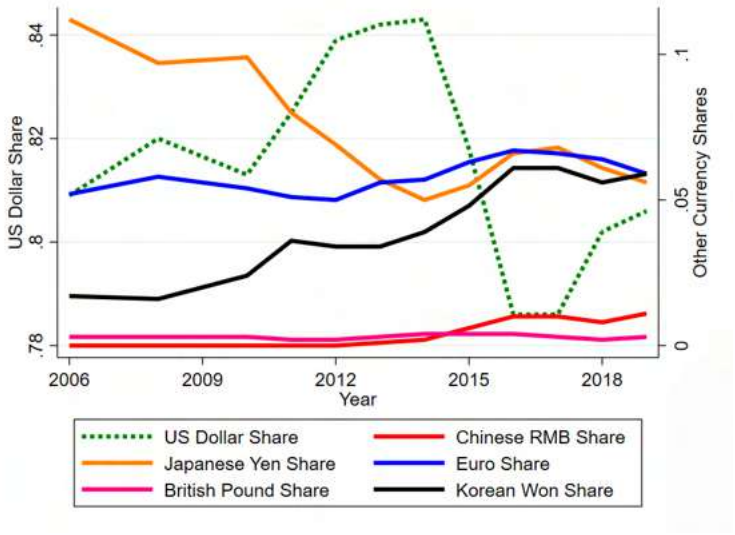
(d) Export to Indonesia



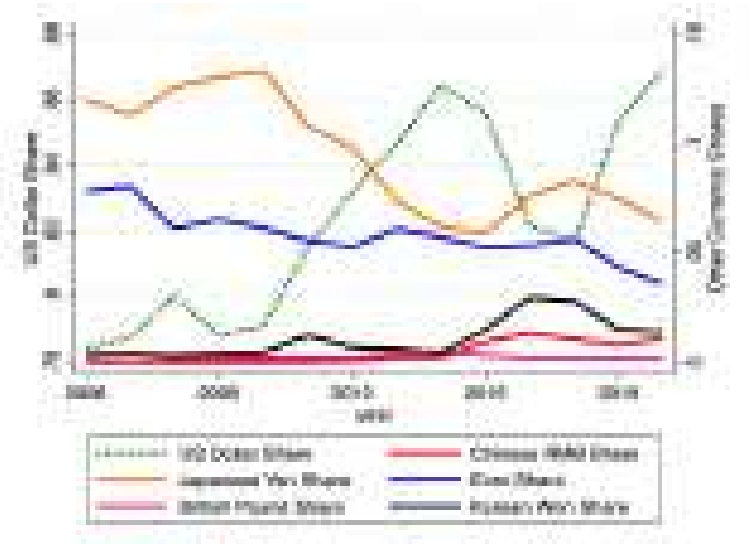
(e) Export to Malaysia

D Patterns of Korean Import Invoicing Currency Shares

Figure D.1: Currency Shares in Korean Import from World: Official vs. Our Sample Data

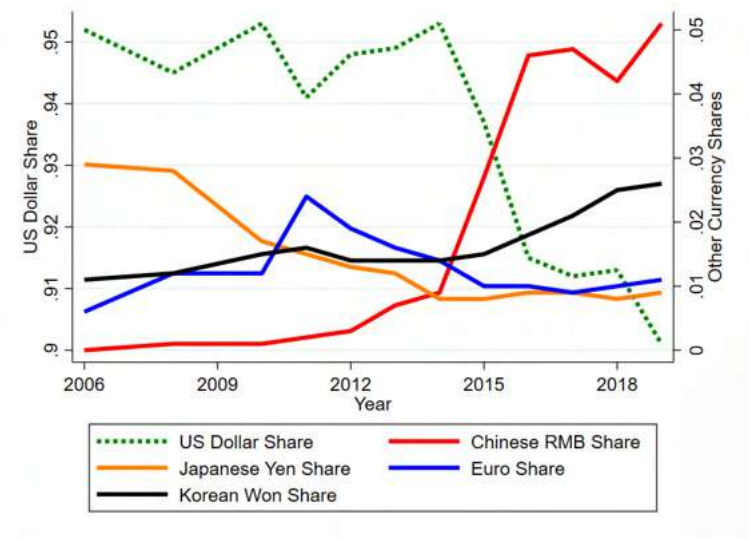


(a) Official Data

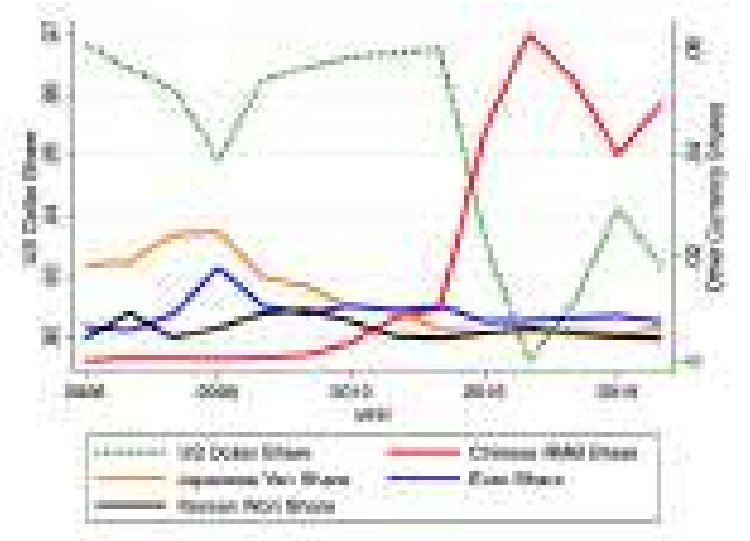


(b) Customs Sample Data

Figure D.2: Currency Shares in Korean Import to China: Official vs. Our Sample Data

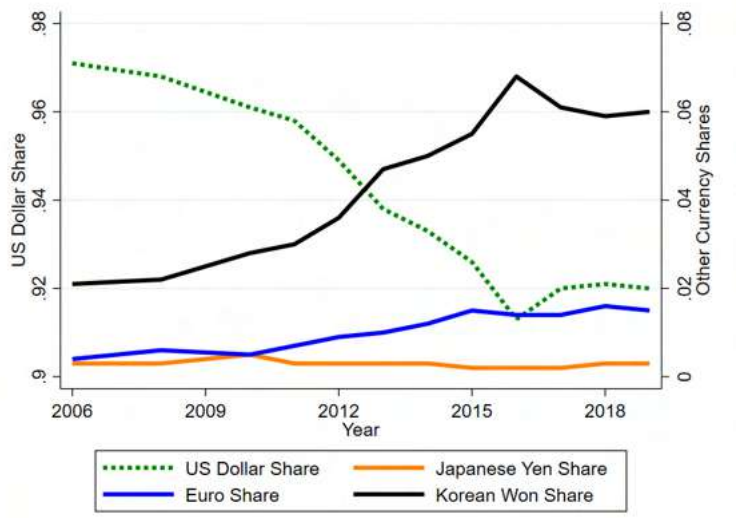


(a) Official Data

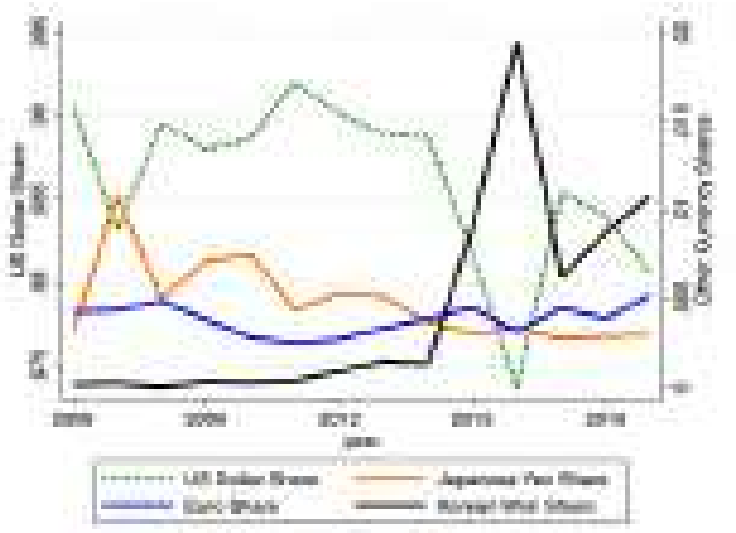


(b) Customs Sample Data

Figure D.3: Currency Shares in Korean Import from US: Official vs. Our Sample Data

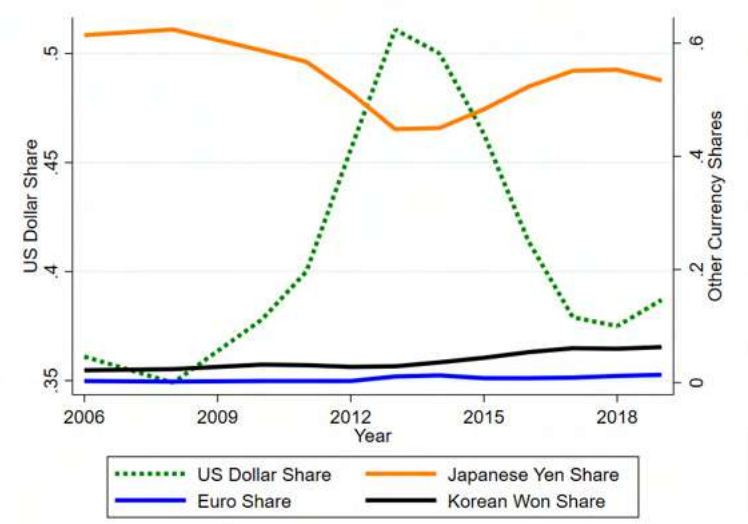


(a) Official Data

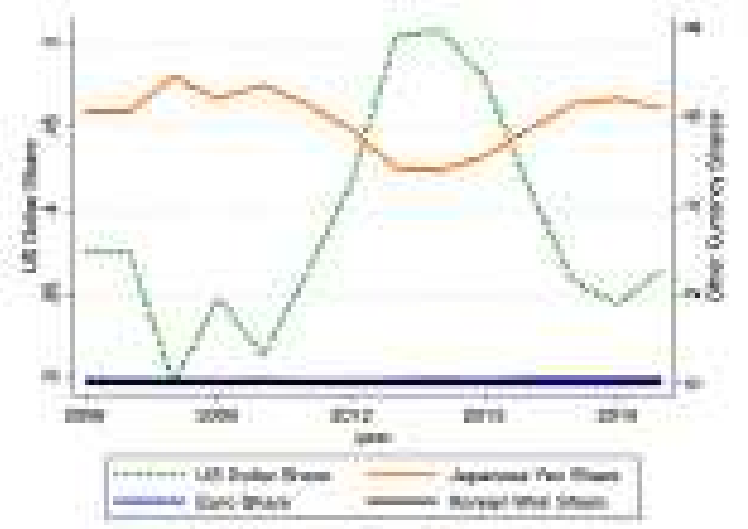


(b) Customs Sample Data

Figure D.4: Currency Shares in Korean Import from Japan: Official vs. Our Sample Data

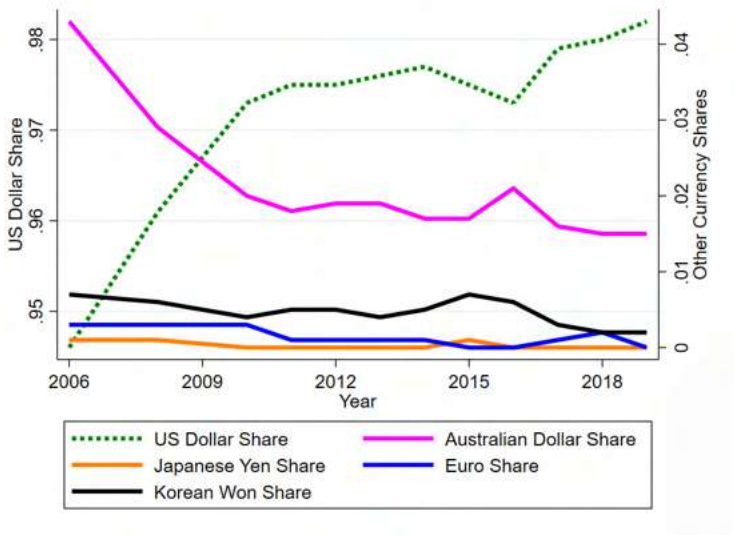


(a) Official Data

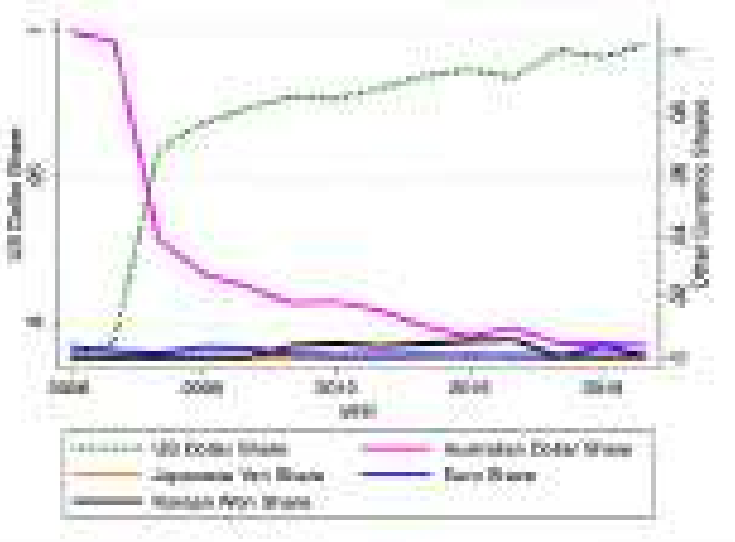


(b) Customs Sample Data

Figure D.5: Currency Shares in Korean Import from Australia: Official vs. Our Sample Data



(a) Official Data



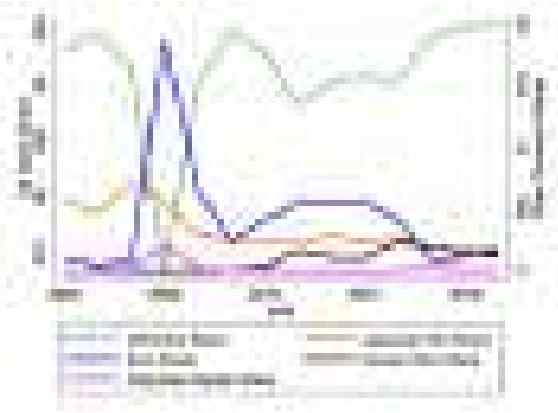
(b) Customs Sample Data

Figure D.6: Currency Shares in Korean Import from Other Destinations with Swap Lines: Customs Sample Data

(a) Import from Canada

(b) Import from Switzerland

(c) Import from UAE



(d) Import from Indonesia

(e) Import from Malaysia

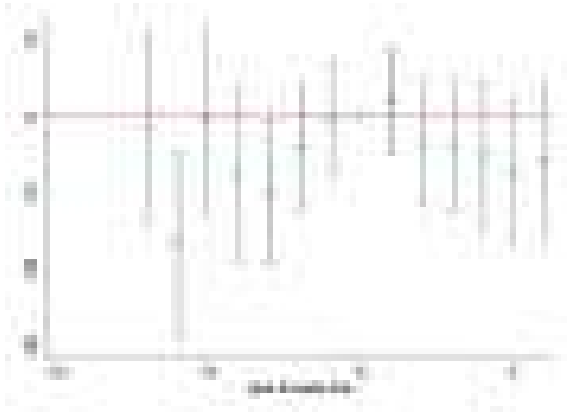
E Export Currency Invoicing and Central Bank Swap Lines for Other Destinations

Figure E.1: Firm Level Currency Shares in Korean Export to Malaysia: No Controls

(a) Malaysia Ringgit Share

(b) US Dollar Share

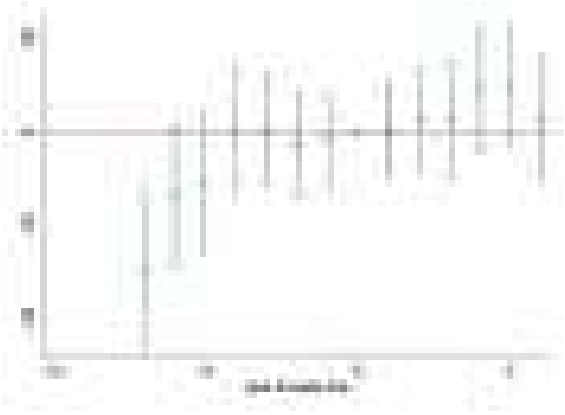
(c) Korean Won Share



(d) Other Currencies' Share

Figure E.2: Firm Level Currency Shares in Korean Export to Indonesia: No Controls

(a) Indonesia Rupiah Share

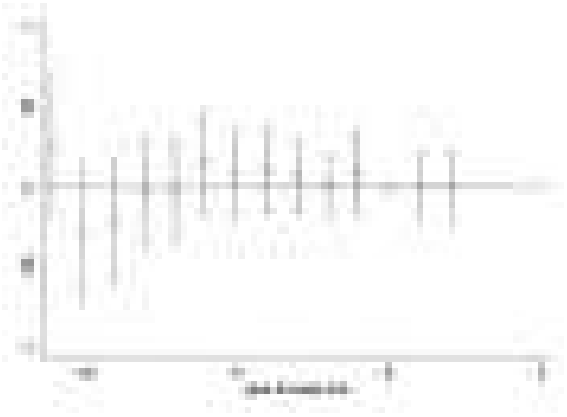


(b) US Dollar Share

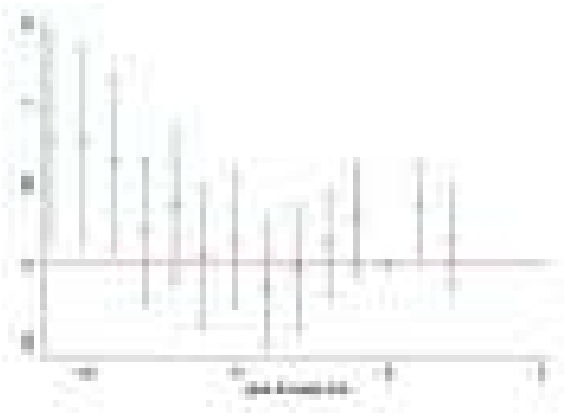
(c) Korean Won Share

(d) Other Currencies' Share

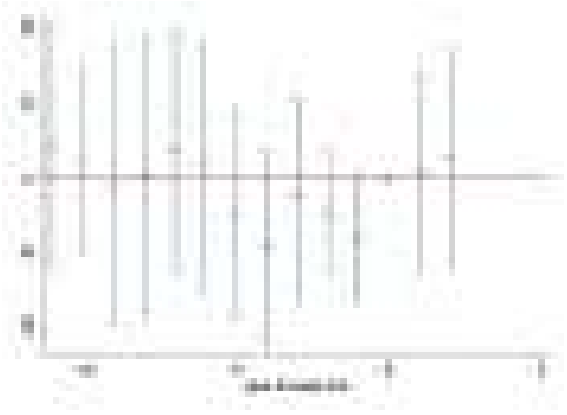
Figure E.3: Firm Level Currency Shares in Korean Export to Switzerland: No Controls



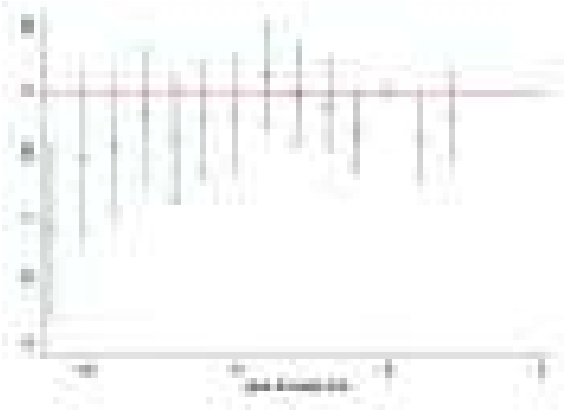
(a) Swiss Franc Share



(b) US Dollar Share

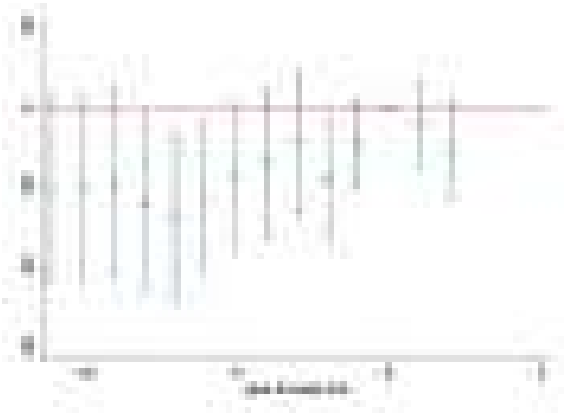


(c) Korean Won Share



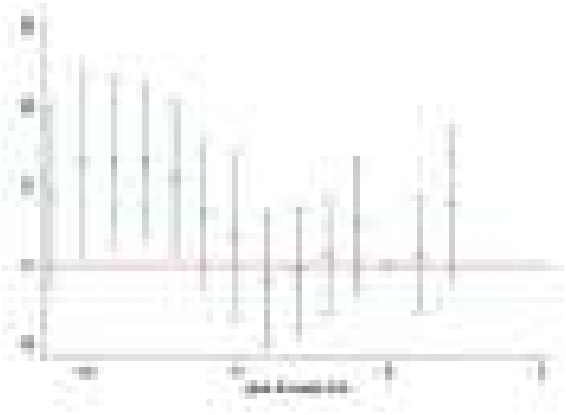
(d) Other Currencies' Share

Figure E.4: Firm Level Currency Shares in Korean Export to Canada: No Controls



(a) Canadian Dollar Share

(b) US Dollar Share



(c) Korean Won Share

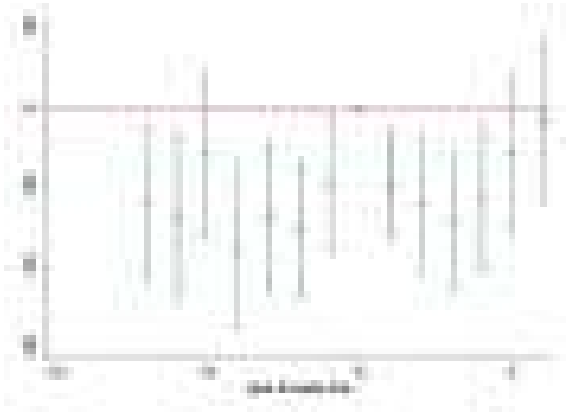
(d) Other Currencies' Share

Figure E.5: Firm Level Currency Shares in Korean Export to UAE: No Controls

(a) Emirati Dirham Share

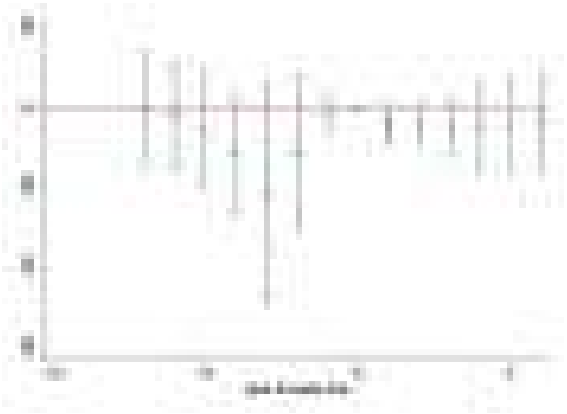
(b) US Dollar Share

(c) Korean Won Share



(d) Other Currencies' Share

Figure E.6: Firm-Product Level Currency Shares in Korean Export to Malaysia: No Controls



(a) Malaysia Ringgit Share

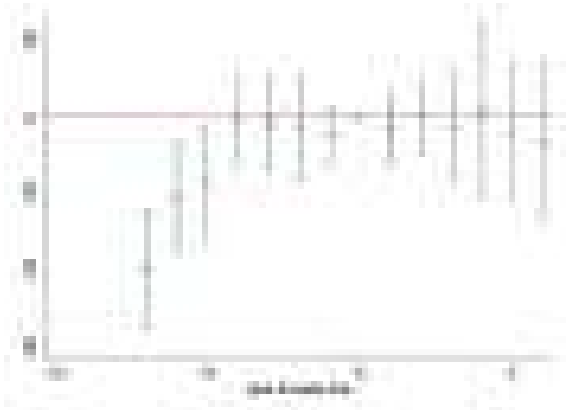
(b) US Dollar Share

(c) Korean Won Share

(d) Other Currencies' Share

Figure E.7: Firm-Product Level Currency Shares in Korean Export to Indonesia: No Controls

(a) Indonesia Rupiah Share



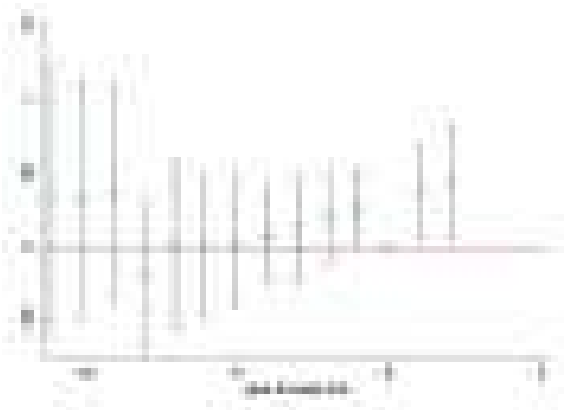
(b) US Dollar Share

(c) Korean Won Share

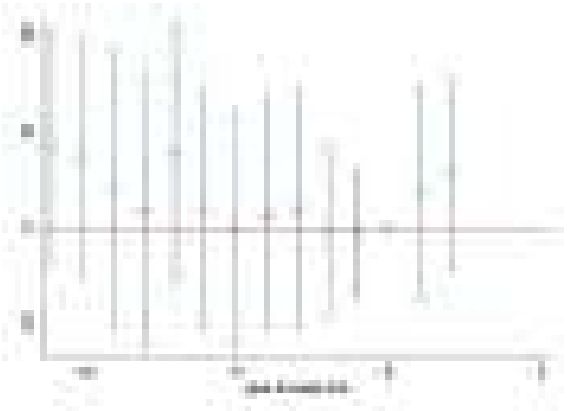
(d) Other Currencies' Share

Figure E.8: Firm-Product Level Currency Shares in Korean Export to Switzerland: No Controls

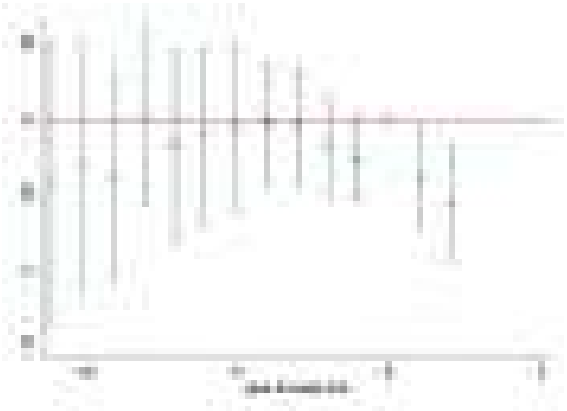
(a) Swiss Franc Share



(b) US Dollar Share

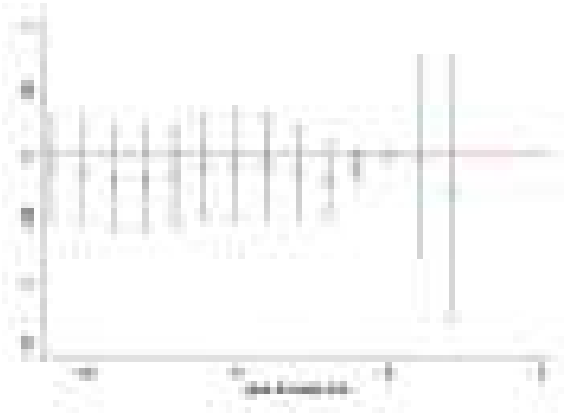


(c) Korean Won Share

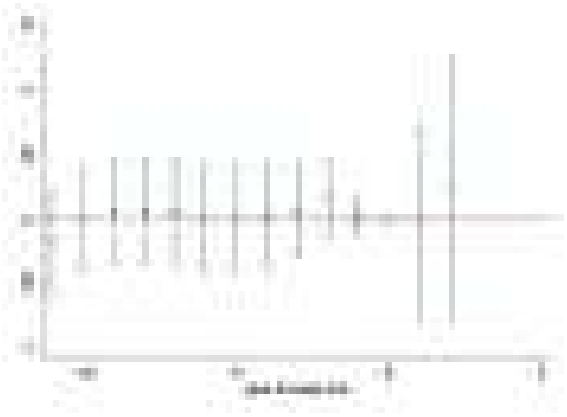


(d) Other Currencies' Share

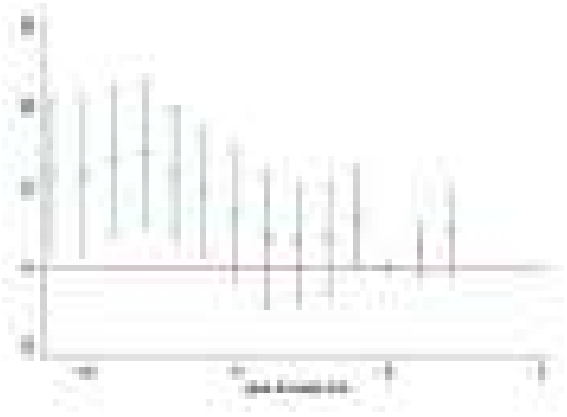
Figure E.9: Firm-Product Level Currency Shares in Korean Export to Canada: No Controls



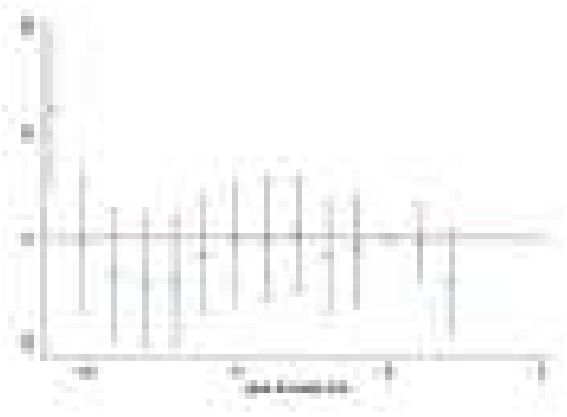
(a) Canadian Dollar Share



(b) US Dollar Share



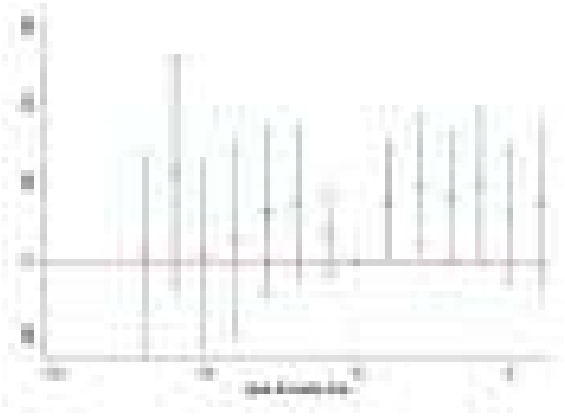
(c) Korean Won Share



(d) Other Currencies' Share

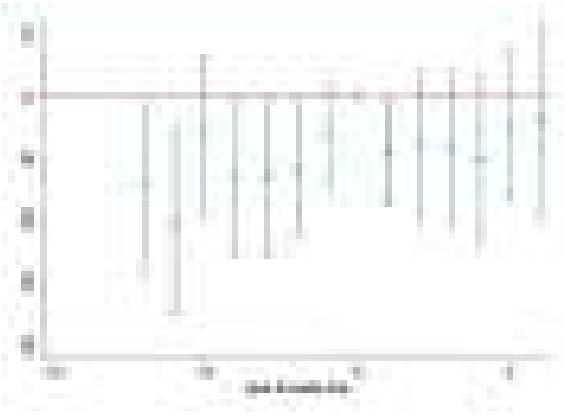
Figure E.10: Firm-Product Level Currency Shares in Korean Export to UAE: No Controls

(a) Emirati Dirham Share



(b) US Dollar Share

(c) Korean Won Share

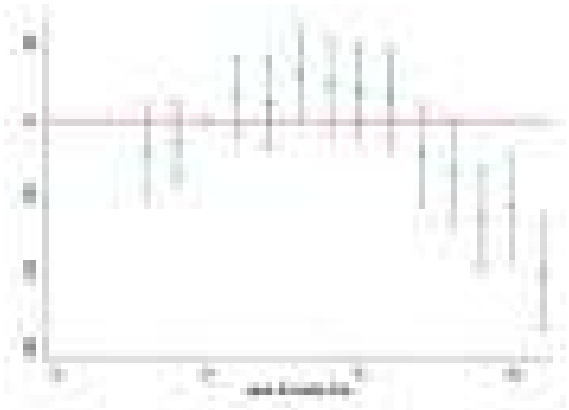


(d) Other Currencies' Share

F Import Invoicing Currency and Central Bank Swap Lines

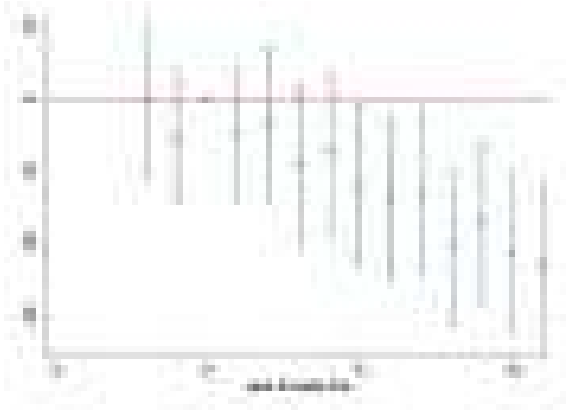
Figure F.1: Firm Level Currency Shares in Korean Import from China: No Controls

(a) Chinese Yuan Share



(b) US Dollar Share

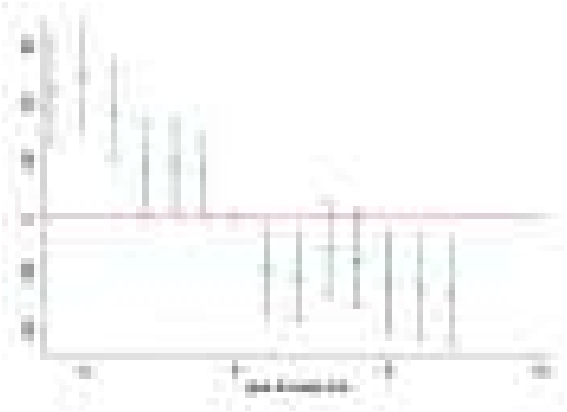
(c) Korean Won Share



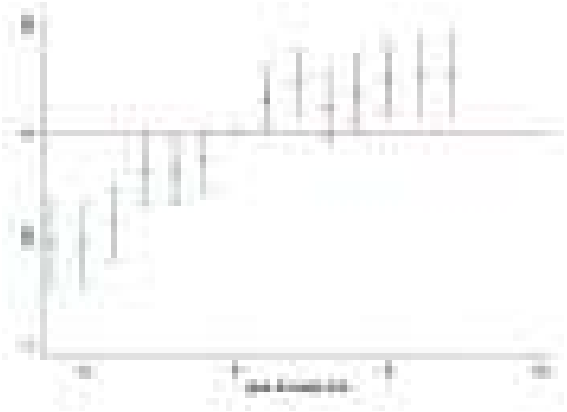
(d) Other Currencies' Share

Notes:

Figure F.2: Firm Level Currency Shares in Korean Import from Japan: No Controls



(a) Japanese Yen Share



(b) US Dollar Share

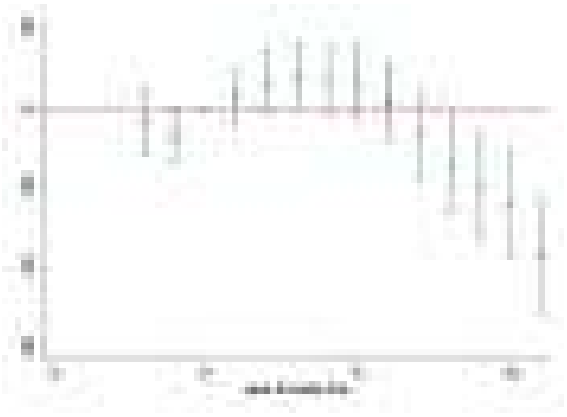
(c) Korean Won Share

(d) Other Currencies' Share

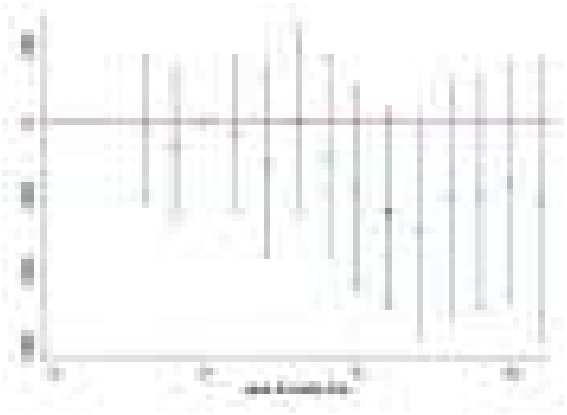
Notes:

Figure F.3: Firm-Product Level Currency Shares in Korean Import from China: No Controls

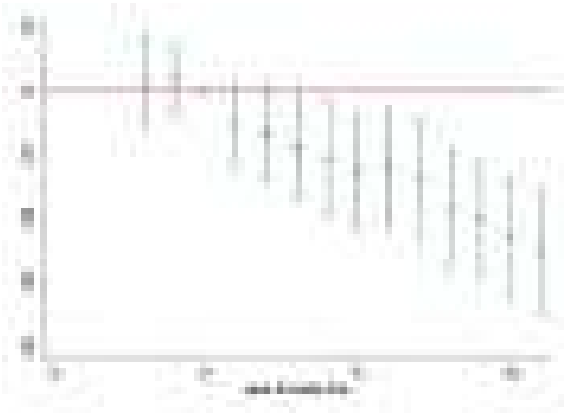
(a) Chinese Yuan Share



(b) US Dollar Share



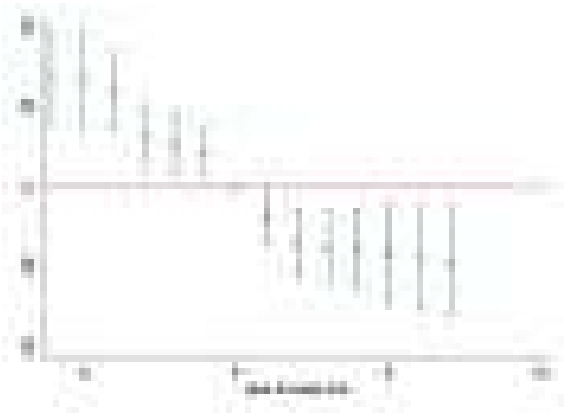
(c) Korean Won Share



(d) Other Currencies' Share

Notes:

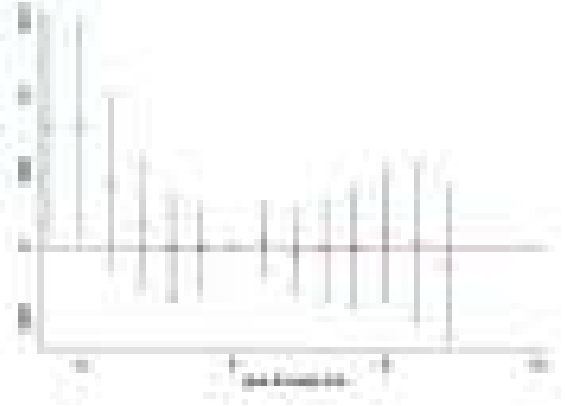
Figure F.4: Firm-Product Level Currency Shares in Korean Import from Japan: No Controls



(a) Japanese Yen Share

(b) US Dollar Share

(c) Korean Won Share



(d) Other Currencies' Share

G Firm's Profit Maximization

Using equations (9) and (10), we can express the firm profit using currency l as

$$\Pi_l = \xi_l [\cdot]_l C_j \left(\frac{\xi_l \tau_l}{\xi_j P_j}\right)^{-\lambda} p_l^{1-\lambda} - w \left[\frac{\alpha}{A} C_j \left(\frac{\xi_l \tau_l}{\xi_j P_j}\right)^{-\lambda}\right]^{1/\alpha} p_l^{-\lambda/\alpha},$$

where

$$[\cdot]_l = \begin{cases} \pi_j + (1-\pi_j)(1+i_j)^2 & \text{if } l = j \\ (1+_{i_v})^2 & \text{if } l = v \end{cases} \tag{G.1}$$

After consolidating the parameters, consider a simple problem

$$\max_p \kappa_1 p^{1-\lambda} - \kappa_2 p^{-\frac{\lambda}{\alpha}}$$

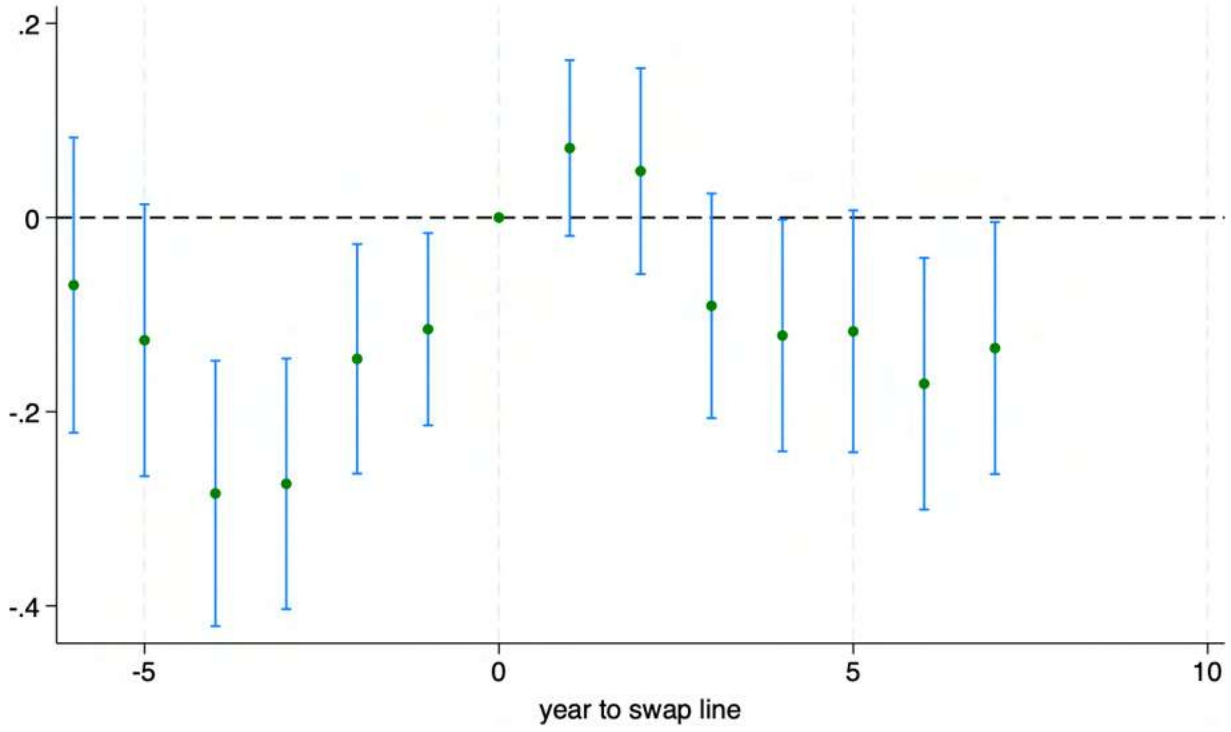
The solution to this problem is

$$\begin{cases} p^* = \left(\frac{\lambda\kappa_2}{(\lambda-1)\alpha\kappa_1}\right)^{\frac{\alpha}{\alpha+\lambda(1-\alpha)}} \\ \kappa_1 p^{*1-\lambda} = \kappa_1^{\frac{\lambda}{\alpha+\lambda(1-\alpha)}} \left(\frac{\lambda\kappa_2}{\alpha(\lambda-1)}\right)^{\frac{\alpha(1-\lambda)}{\alpha+\lambda(1-\alpha)}} \\ \kappa_1 p^{*1-\lambda} - \kappa_2 p^{*-\frac{\lambda}{\alpha}} = \kappa_1^{\frac{\lambda}{\alpha+\lambda(1-\alpha)}} \left(\frac{\lambda\kappa_2}{\alpha(\lambda-1)}\right)^{\frac{\alpha(1-\lambda)}{\alpha+\lambda(1-\alpha)}} \left(\frac{\lambda-\alpha(\lambda-1)}{\lambda}\right) \end{cases} \tag{G.2}$$

An increase in the interest rates i_l increases the κ_1. The comparative statics for the price, revenue and profit follow naturally.

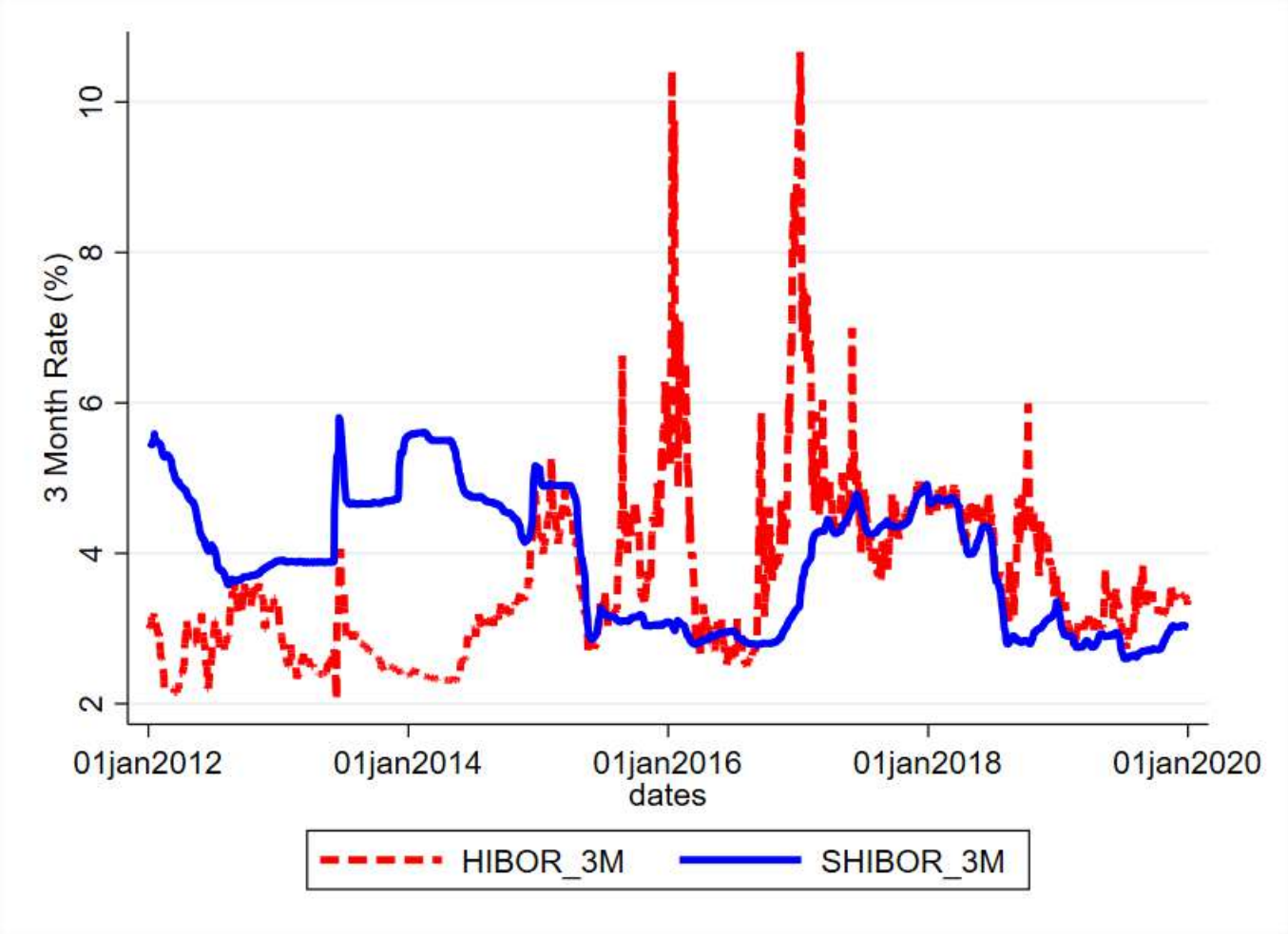
H Additional Figures and Tables

Figure H.1: Dynamics of Korean Firm-level Export Value to Japan



Notes: This figure shows the dynamics of Korean export value to Japan at the firm level. We control for log(employment), market share and destination GDP.

Figure H.2: 3-Month Shanghai Interbank Offered Rate (SHIBOR) and Hong Kong Interbank Offered Rate (HIBOR) for RMB



Source: https://www.chinamoney.com.cn/ and WIND Terminal