Central Bank Swap Lines and Currency Choices in Trade: the Bank Risk Management Channel *

Yang Jiao† Ohyun Kwon ‡ Saiah Lee§ Shang-Jin Wei¶

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Abstract

This paper proposes and investigates the role of bank risk management channel in how central bank local currency swap lines facilitate the international use of local currencies in trade invoicing. We exploit disaggregated data at the Korean exporter-trading partner-year level on currency invoicing during 2006-2019. We find that the signing of swap lines between Korea and China has likely contributed to a rise of the RMB in invoicing shares among Korean exporters. Conversely, the expiration of a swap line between Korea and Japan has likely led to a decline in the Japanese yen (JPY) invoicing share. Importantly, Korean banks raised interest rates on RMB deposits but lowered them on JPY deposits. Furthermore, those Korean exporting firms whose main banks had more ex-ante exposure to China exhibit a greater increase in RMB invoicing. We rationalize this in a model in which the swap line on a foreign currency improves banks' risk management with respect to that currency, which incentivizes them to offer higher deposit interest rates on that currency, leading to its greater use in trade invoicing.

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†Singapore Management University. Email: yangjiao@smu.edu.sg.

‡Drexel University. Email: ok85@drexel.edu.

§Corresponding author. Ulsan National Institute of Science and Technology. Email: saiahlee@unist.ac.kr.

¶Columbia University and NBER. Email: sw2446@gsb.columbia.edu.

1 Introduction

Greater international use of a national currency confers many benefits to the currency issuing country including more seigniorage revenue, lower cross-border transaction costs, lower borrowing costs for its governments and firms, and reduced incidence of foreign exchange crises, and potentially more macroeconomic flexibility.[1] In the event of geopolitical tensions, the international role of a national currency may also offer the issuing country some advantage in countering financial sanctions imposed by adversaries. This paper studies role of central bank swap lines in promoting the internationalization of a national currency (say, China's RMB). The existing literature (Bahaj and Reis, 2020) posits that a swap line (e.g., one involving Chinese RMB) encourages more trade invoicing using that currency by making import trade finance in that currency more accessible to firms doing both imports and exports, thereby enabling them to align their export invoicing currency with the currency used for working capital. This paper, instead, proposes a bank risk management channel that will also lead to more trade invoicing in the currency that is facilitated by a currency swap agreement between the relevant central banks. For example, a swap agreement between Korea and China allows Korean banks to better manage risks associated with taking RMB-denominated deposits or making RMB denominated loans to Korean firms. As a consequence, those Korean importing and exporting firms find it more attractive to denote their trade in RMB. Using evidence from disaggregated Korean trade data, we show that the bank risk management channel is likely to be an important mechanism.

The internationalization of the RMB has attracted the attention of both the international media and policy makers, as it is the first currency from a non-rich country that appears to have made some significant inroads in its international usage. According to SWIFT statistics, the RMB has also exhibited a visible improvement in its relative share in global payments, from only 35th in 2010 to 4th 2021. In March 2023, the RMB surpassed the US dollar to become the most used currency in China's own cross-border payments (including financial and trade transactions) for the first time.[2] It is of great interest in understanding how a country can jump start the use of its currency in international trade.

Having a currency swap line with another central bank (say with the US Federal Reserve or People's Bank of China) can help a central bank (say that of Korea) to manage better its exchange rate risk or foreign currency liquidity risk, supplementing its foreign

[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).

[2] See https://www.bbc.com/zhongwen/simp/business-65423899.

exchange reserve.[3] The direct function of a swap line is to allow either a central bank to borrow funds from its counterpart at a pre-set interest rate to stabilize financial markets. South Korea, a country that experienced acute financial stress during the Asian Financial Crisis of 1997-1998, has actively participated in signing central bank swap lines. A majority of South Korea's swap agreements were in local currencies rather than US dollars (USD). This means borrowing from a foreign country is generally in the partner country's currency. By 2019, South Korea had signed currency swap agreements with major economies such as China and the US (which was only temporary in response to the global financial crisis), but not with the United Kingdom or the Eurozone. Interestingly, Korea signed a swap agreement with Japan in 2005 but let it expire in 2013 for political reasons. It is noteworthy that South Korea was the first country with which China has had a local currency swap agreement partner, a rising economic power actively pursuing bilateral currency swaps to reduce reliance on the US dollar. These plausibly exogenous variations in South Korea's swap lines serve as a quasi-experiment to study their impacts.

Leveraging South Korean customs' trade data on currency invoicing from 2006 to 2019, we study whether and how local currency swap lines affect currency choices in international trade.[4] Consistent with Gopinath (2015) and Gopinath et al. (2020), we find that the USD is overwhelmingly used to invoice trade with nearly all partners. This includes trade with countries other than the United States. For example, both Korean exports to or imports from Thailand or Mexico use the US dollar and rarely use either Thai baht or Mexican peso as an invoicing currency. Indeed, third country currencies in general are also rarely used. However, we also observe some important exceptions, notably changing shares of the Chinese RMB and the Japanese yen as an invoicing currency for Korea's external trade.

We begin with regressions at the level of exporting firm, destination country, and invoicing currency. Specifically, we calculate four types of currency shares for each South Korean exporting firm to each export destination: (i) the export destination's currency (i.e., local currency), (ii) the dominant currency (USD), (iii) the Korean won, and (iv) all others. Our analysis is in the spirit of an event study that utilizes the dates of start or expiration of swap lines involving South Korea. We find that South Korean exporters significantly increased their RMB invoicing share, at the expense of the US dollar share, after the Korea-China swap line was signed. This pattern became more pronounced following an increase in the swap line's value. On the other hand, after the expiration of the

[3] See Gopinath (2017), Denbee et al. (2016).

[4] A comparison with official aggregate data confirms that our customs sample effectively captures South Korea's overall trade and currency-invoicing patterns.

swap line with Japan, the share of JPY invoicing in Korean exports to Japan significantly declined, while the share of the dollar rose correspondingly. In comparison, currency invoicing patterns in Korean exports to other countries were unaffected by the changes in these swap lines.

These findings are robust both when we extend the analysis from the intensive margin to the extensive margin (i.e., how many Korean firms use the RMB or the yen invoicing), and when we perform regressions at a more granular firm-product-destination level. Note that the approach has accounted for potential compositional shifts in South Korea's export bundle. Adding additional control variables, as suggested by the literature, does not affect our baseline results. We also investigate whether the Chinese state owned firms are effective in promoting the RMB use but find no significant supportive evidence for such a mechanism.

Several discussions of our results are in order. First, we observe that the impact of swap lines is not significant in exports to countries other than China or Japan. We argue that for a swap line to be effective, it must be paired with a sufficiently large destination market in which exporters have stronger incentives to match the invoicing currency choices of local competitors (see e.g., Goldberg and Tille (2016); Amiti et al. (2022)). South Korea's other swap line partners, such as Switzerland, Australia, and Indonesia, lack market sizes comparable to China or Japan, making it plausible that currency swap lines alone do not significantly affect export invoicing patterns in these cases. Second, we examine the role of trade settlement support programs (i.e., direct trade finance support channels) established by the Bank of Korea to promote RMB use. However, we find that the utilization of these programs for supporting Korean trade was fairly limited, particularly in the initial years when RMB usage began to rise. This could be attributed to the higher interest rates specified by Korea's trade settlement program compared to alternative borrowing costs in the offshore RMB market. Third, we explore the role of the import-export nexus in currency choice. We find that even exporters who do not import from China (or Japan) still experienced a significant increase (or decrease) in the RMB (or Japanese yen) share after the signing (or expiration) of the swap line with China (or Japan). Moreover, because South Korea's swap line with Japan served solely as a liquidity backstop, the financial safety net offers a plausible explanation for the observed changes in Korea's currency invoicing patterns. Finally, while we do not rule out the trade settlement support programs or the trade finance channel, we emphasize that currency swap lines can additionally influence currency invoicing patterns through banks' currency risk management under the financial safety net channel. Importantly, our argument is that Korean exporters' RMB (JPY) invoicing will increase (decrease) following the swap line arrangement (expiration),

regardless of whether they import or use RMB (JPY) as their working capital currency.

The mechanism that we propose is that such a local currency swap line reduces commercial banks' perceived risk of conducting business in the foreign currency in the swap agreement by mitigating unforeseen currency-specific liquidity shocks. Consequently, following the Bank of Korea's swap line with China, South Korean banks have stronger incentives to engage in RMB borrowing and lending activities. Similarly, following the expiration of Korea's swap line with Japan, Korean banks find it less attractive to engage in JPY borrowing and lending. These incentives can manifest in various ways. We provide several pieces of evidence to support this hypothesis. First, we document that Korean banks offered higher deposit interest rates for RMB, following the Korea-China swap line agreement. Second, different patterns across different Korean banks further corroborate the mechanism. Since Korean banks primarily conduct RMB lending through their subsidiaries in China, we differentiate Korean banks by their presence in China before the swap-line agreement, measured as the number of branches/offices per million USD of exporter trade value to China of the exporters they serve as main banks, i.e., their financial infrastructure in China. We find, following the Korea-China currency swap agreement, a significant increase in the RMB share of trade invoicing by the Korean exporting firms that are served by those banks with greater initial exposure in China, and a corresponding decrease in the USD share by the Korean exporters.

We propose a novel theoretical framework that places financial institutions (banks) at the center of the analysis to examine the effects of central bank local currency swap lines on firms' trade currency choices. The model incorporates banks' endogenous adjustments to deposit interest rates in response to swap lines. Given Korean banks' liquidity risk associated with borrowing and lending in certain foreign currencies, such as the RMB, the availability of a RMB-Korean won swap line reduces the expected cost of an RMB-specific liquidity shock. As a result, Korean banks are more willing to expand their RMB business and offer higher interest rates on RMB deposits. These higher RMB interest rates, in turn, attract more Korean exporters to invoice in RMB rather than the US dollar, which is the most important alternative invoicing currency.

Related Literature Our paper contributes to the broader literature on endogenous currency invoicing in trade. Engel (2006) theoretically shows that exporters choose the invoicing currency to align their prices, which are sticky and unresponsive to shocks, as closely as possible to the optimal level. The literature identifies various factors influencing currency choice, including transaction costs, destination market size, exchange rate policy, demand elasticity, and import-export complementarities (Friberg (1998) , Goldberg and Tille (2008), Shi and Xu (2010), Goldberg and Tille (2016) , Chung (2016), Mukhin (2022)).

Amiti et al. (2022) provide a more general framework for analyzing invoicing currency choice and exchange rate pass-through, using Belgian data to test their theoretical predictions. Our paper introduces a new channel, suggesting that deposit interest rates in different currencies can also influence firms' currency choices in trade.

This paper also relates to the literature on the impact of global financial safety nets, including both traditional foreign reserves and 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 financial crises. Tong and Wei (2021) find that foreign reserves help lower macroeconomic uncertainty. Recent literature has also explored the effects of central bank swap lines, particularly US dollar swap lines. Bahaj and Reis (2021), Goldberg and Ravazzolo (2022), Aizenman et al. (2022), and Kekre and Lenel (2023) highlight the role of dollar swap lines in stabilizing the dollar funding market, partly by reducing deviations from covered interest parity. While these papers focus on post-crisis responses to US dollar swap lines, our study emphasizes the role of local currency swap lines in altering banks' ex-ante incentives to engage in foreign currency activities, which ultimately influence firms' currency choices in trade.

Closer to the theme of our paper is Bahaj and Reis (2020).[5] We differ from their paper in two significant ways. First, in terms of empirical work, we use more granular currency invoicing data at the Korean firm-product-destination level, as opposed to their country-pair level data. The micro-level data also allow us to distinguish between extensive and intensive margin adjustments at the firm level, and to examine various sources of heterogeneity—such as the potential role of Chinese SOEs in promoting RMB internationalization. Second, in terms of postulated mechanism, we propose a bank risk management channel as opposed to their trade finance channel. We show empirically that even exporting firms with limited capacity for natural hedging in RMB such as those exporters that do not import from China and have little opportunity to invoice imports in RMB (note that in Korean import, the RMB is used almost exclusively for Korean imports from China) increased their use of RMB in exports to China, which is consistent with the predictions of our theory. In fact, a program of the RMB-Won swap agreement to explicitly support trade financing was rarely drawn upon, potentially due to its high cost. We also present bank-level evidence that supports the bank risk management channel. We see our paper as complementary to Bahaj and Reis (2020), with the high cost of RMB trade finance in

[5] Liu et al. (2024) documents a similar pattern in the rise of RMB use in a country's trade after signing a swap line with China. They further divide swap lines with China into two categories: one focused solely on trade initiatives, and the other covering both trade and financial initiatives. They show that the second group exhibits a larger crowding-out effect of RMB on USD.

South Korea offering a good opportunity to highlight our mechanism.

2 Institutional Background

2.1 China's RMB Swap Lines

China has in recent years begun promoting the greater usage of the RMB in international payment. The People's Bank of China, its central bank, has actively pursued bilateral currency swap agreements with other central banks. As of July 2017, China had established local currency swap lines with 36 other central banks, with a total outstanding value of 3,343 billion RMB (approximately 500 billion USD).[6] The first such swap line was signed with South Korea. Announced on December 12, 2008, the Won-Yuan arrangement was, as the Bank of Korea stated in its press release, "designed to help improve short-term liquidity conditions in the financial systems of the two fundamentally sound and well-managed economies and to promote bilateral trade."

Several characteristics of the swap lines are noteworthy. First, they are standing agreements, with a typical duration of three years that can be renewed indefinitely. In comparison, the US Federal Reserve has established standing swap lines with Canada and Mexico through the North American Framework Agreement since 1994, and with the UK, Japan, the Eurozone, and Switzerland since April 2009. It provided temporary short-term dollar liquidity swap lines to other central banks of Australia, Brazil, Denmark, Korea, New Zealand, Norway, Singapore, and Sweden during the global financial crisis and the COVID-19 crisis.[7] The countries in the last group could not rely on dollar liquidity with certainty before each crisis. Second, China's swap lines are sometimes accompanied by trade settlement support schemes that directly facilitate the use of the RMB in cross-border transactions. While the complete list of countries with such schemes is difficult to trace, media reports suggest that the agreements with South Korea, Malaysia, and Thailand are designed to facilitate trade settlement in local currencies, in addition to supporting financial stability. In contrast, the stated purpose of US swap lines is purely for liquidity support, with no stated objective of supporting trade settlement in US dollars.

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

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

2.2 South Korea Local Currency Swap Lines

South Korean policymakers place particular emphasis on financial stability, partly due to the country's challenging experiences during the Asian Financial Crisis and the Global Financial Crisis. The objective of the Bank of Korea, the nation's central bank, includes financial stability as a core focus in addition to price and output stability.[8] Globally, central bank swap lines are increasingly used to enhance financial stability (Gopinath (2017), Denbee et al. (2016)). Over the past two decades, South Korea has actively participated in both multilateral and bilateral swap line arrangements.

We define central bank swap lines that involve the exchange of both countries' currencies as local currency swap lines, which encompass most of South Korea's agreements. The second type of swap line involves the exchange of the Korean won and the US dollar under the Chiang Mai Initiative in Asia. The size of this second type is typically small compared to the extensive use of the US dollar in cross-border trade. This paper focuses on the impact of the first type of swap line, which are precautionary in nature and established or expired during normal times. Crisis-triggered Korea-US swap lines are not the focus of this study. Since the US dollar is the dominant currency in South Korea's trade across all destinations, US dollar-based financial safety nets are likely to affect its use broadly, making it difficult to achieve clean identification.

We provide a chronological description of South Korea's central bank currency swap lines up until the end of 2019, the final year covered by our trade data. The US dollar swap lines under the Chiang Mai Initiative are detailed in Appendix A.

Local Currency Swap Line with Japan was South Korea's first such swap line and took effect on May 27, 2005, with a maximum amount in Japanese yen and Korean won equivalent to 3 billion US dollars. The goal was to "stabilize regional financial markets by supplying short-term liquidity." [9] Initially scheduled to expire on July 3, 2007, the agreement was extended for another three years, and maximum swap amount was raised to 20 billion US dollars equivalent on December 12, 2008, effective until the end of April 2009. It was extended three more times until April 30, 2010, at which point the 20-billion-dollar swap line expired as scheduled. However, a swap line of a reduced amount of 3 billion US dollars replaced it until July 3, 2013. The swap line was temporarily enlarged to 30 billion US dollars equivalent until October 31, 2012.

As the diplomatic relationship between South Korea and Japan deteriorated in August

[8]For more details on the Bank of Korea's role in maintaining financial stability, see their website: https://www.bok.or.kr/eng/main/contents.do?menuNo=400037. Additionally, in 2009, the Bank of Korea joined the Financial Stability Board (FSB), the successor to the Financial Stability Forum (FSF), founded in 1999 to promote international cooperation in preventing financial crises.

[9]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.

2012, the appetite for further renewal of the swap line disappeared and no more swap line between the two countries after the previous one expired on July 3, 2013. While the two central banks did not comment on the specific reasons for ending the swap agreement, media reports pointed to politics. "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." [10] Interestingly, the political tensions did not result in an immediate decline in Korea's export value to Japan (see Figure J.1 in the Appendix). Table 1 summarizes the Korea-Japan central bank local currency swap lines.

Local Currency Swap Lines between Korea and China initially amounted to 180 billion RMB / 38 trillion KRW (approximately 25 billion USD) and had a duration of three years. The swap line agreement was renewed on November 26, 2011, and the maximum monetary amount was doubled in size. The agreement was subsequently renewed twice, in October 2014 and October 2017. Table 2 summarizes the Korea-China central bank local currency swap lines.

The Korea-China local currency swap line had two main functions: a Trade Settlement Support Program (TSSP) and RMB Liquidity Support (RLS).[11] As the name suggests, the TSSP's objective was to provide short-term RMB loans to Korean importers (through com-

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

[11] The Bank of Korea formally introduced the Liquidity Supply Program (LSP) on July 1, 2015, to clarify the procedures for emergency loans. However, the swap line enabled the Bank of Korea to access RMB, implying that the Korean central bank had been ready to act as a lender of last resort for RMB since the signing of the local currency swap agreement with China.

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. The initial Korea-China local currency swap line was signed on December 12, 2008, but it did not come into effect until April 2009.

mercial banks) to facilitate RMB invoicing in imports. The interest rate on the TSSP loan was the Shanghai Interbank Offered Rate (SHIBOR) plus a spread determined by the bank, and the loan had to be initiated by a firm. Commercial banks paid the Bank of Korea at the SHIBOR rate and were required to post collateral worth 110% of the loan value. Perhaps due to the fact that SHIBOR was typically higher than the Hong Kong Interbank Offered Rate (HIBOR) for RMB prior to 2016 (see online Appendix Figure J.2 for the historical SHIBOR and HIBOR rates), and that Korean banks had to post additional collateral to use the TSSP, the actual usage of the program appeared limited relative to Korea-China trade volumes before 2016.[12] For instance, Woori Bank, the Korean bank with the most transactions with China and the largest user of the TSSP among Korean commercial banks, had only issued 1.3 million USD equivalent in TSSP loans by May 2016. This figure is minuscule compared to RMB invoicing in Korea-China trade, which exceeded 4 billion USD in 2015.

On the other hand, the RMB Liquidity Support (RLS) function allows the Bank of Korea, as the lender of last resort for RMB, to provide emergency RMB loans in the event that Korean commercial banks face an RMB liquidity shortage during a systemic crisis. Although historically no foreign currency liquidity support other than USD has been utilized, the Bank of Korea's ability to offer RMB liquidity loans provides reassurance to Korean banks when conducting RMB-related business.

Local Currency Swap Lines with the United States is part of US Federal Reserve's

[12] After 2016, SHIBOR and HIBOR began to converge, but anecdotal evidence suggests that the role of the TSSP remained limited. For example, KEB Hana Bank exited the TSSP entirely on May 31, 2021. Documents from December 2019 also show that KEB Hana Bank charged a higher interest rate (5.373%) on BOK CNY Loans (TSSP) compared to another trade finance product, the Global CNY Loan, which had an interest rate of 5.316%.

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.

set of swap line agreements with several central banks during the global financial crisis.[13] Table 3 summarizes the details of the Korea-US swap lines. On October 30, 2008, the US and South Korea established a liquidity swap line worth 30 billion USD, which was subsequently extended in February 2009 and June 2009, before expiring on February 1, 2010. The Bank of Korea used this dollar swap line to provide USD liquidity to Korean commercial banks through auctions.

Local Currency Swap Lines with Other Countries South Korea also established local currency central bank swap lines with Switzerland, the UAE, Canada, Australia, Malaysia, and Indonesia. The Bank of Korea's enhanced liquidity support capabilities followed immediately after these agreements, as it can now draw on credit limits in the currencies specified by the swap lines. Additionally, the swap lines with Malaysia and Indonesia include trade settlement programs, which, as mentioned earlier, aim to facilitate the use of the partner's currency when Korean importers conduct transactions with these countries. Table 4 summarizes South Korea's local currency swap lines with these countries.

3 Data Description

Our micro-level trade data were accessed from the Korea Trade Statistics Promotion Institute (KTSPI) with the approval of the Korean Customs Service with disclosure restrictions. We obtained the balance sheet data of exporting firms, along with their main bank information, from the KISValue dataset. The KTSPI integrated this dataset with customs data within its infrastructure, and conducted data analysis under our guidance.[14] The unit of observation is the value of export or import by the trading firm, destination or

[13] 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

[14] We express our sincere appreciation to the KTSPI staff and the Korea Customs Service for their invaluable support.

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).

origin, product category (Harmonized System 4-digit), and the invoicing currency. Our sample has approximately 4,000 Korean exporters from 2006 to 2019. We calculate shares of trade invoicing in each currency for each firm-trade type-destination (or 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 Company. Any firm with a total asset 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.

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

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.

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 micro-level trade sample obtained from the Korean Customs accounts 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 compare our sample with the shares of top export/import partners and product level volumes in the aggregate statistics. 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 exports to China are rising as a share of Korea's total exports from 2006 to 2010. Both figures also show a declining Japanese trade share 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 represents the product-level trade volumes fairly well across the years.

3.3 Invoicing Currency Shares in the Korean Exports

To check the representativeness of our micro data, we compute the shares of major currencies in the Korean firms' export both in the aggregate data as reported by Bank of Korea (Panel (a) in Figure 1), and in the disaggregated data as computed from our micro data (Panel (b)). 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 experienced a declining trend. The Euro share declined significantly during the global financial crisis, whereas JPY started to decline after 2012. In comparison, both RMB and KRW's invoicing share increased over time to be on par with that of JPY by 2019.

The dynamics of the currency shares could come from either changes in the invoicing currency behavior, changes in the relative importance of export destinations, or some combination. For example, one cannot rule out the possibility that the dynamics in the graphs above is driven by evolving trade shares with major trading partners. Thus, we focus on the currency shares in Korean export to China in Figure 2, as both in the Bank of Korea aggregated data in Panel (a) and computed from our disaggregated Customs sample data in Panel (b), respectively. 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 relatively steep decline. 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, in Korea's export to China, RMB invoicing (and KRW invoicing to some extent) is displacing the previously near-monopoly role of the USD.

The evolving patterns of currency invoicing in Korea's exports to Japan is equally interesting. Japan is a former colonizer of Korea, and has held the position of the world's

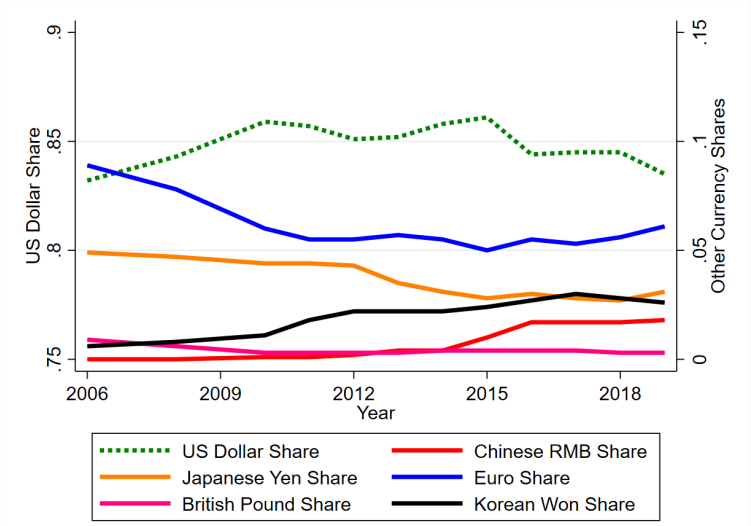
second largest economy from 1968 onwards until it was displaced by China in 2010. From both the Bank of Korea data in Panel (a) of Figure 4 and the customs data in Panel (b), we see that the Japanese Yen and US dollar took dominant positions in this period. The global financial crisis was followed by a decline in US dollar and a rise in Japanese Yen. Indeed, the Japanese Yen share is even larger than US dollar share in 2010, but that was reversed after 2011. Similar to the Korean exports to China, there is also a mild increase in the Korean Won share in the Korean exports to Japan.

In comparison, in Korean exports to the United States, both the Bank of Korea aggregate data in Panel (a) of Figure 3 and the micro customs data in Panel (b), US dollar invoicing share is consistently 98% or higher, rendering other currencies' shares economically meaningless. 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.

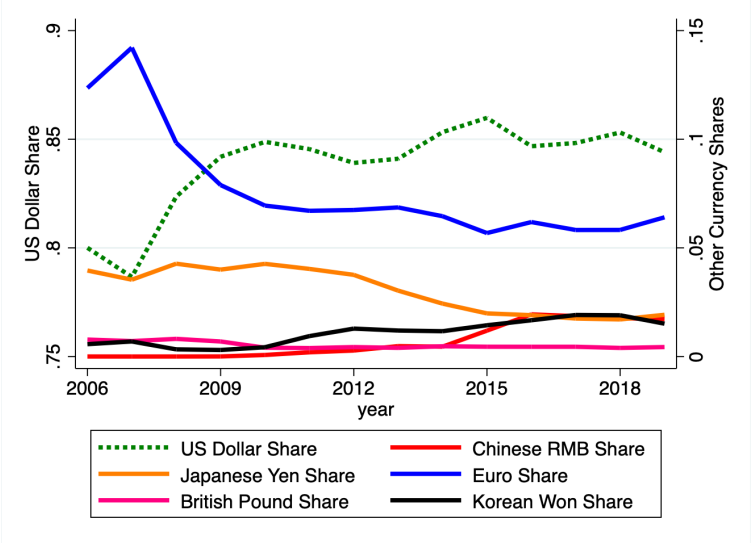
Additional figures in Online Appendix D displays the patterns of Korean import invoicing currency shares from major trading partners. While we observe similar patterns to those found in the export invoicing (except that Korean import from the US increasingly uses Korean Won), we note that our customs 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) shows the share of RMB in Korea's exports to and imports from non-China destinations. The data reveal that the RMB is rarely used in Korea's trade with countries other than China. This suggests that either these third countries have little incentive to use or accept the RMB, or that Korean firms opt not to use RMB with non-China partners. This finding is consistent with the strategic complementarity argument in the currency choice literature, which suggests that firms have incentives to align their currency use with that of their competitors. (Goldberg and Tille, 2008; Mukhin, 2022; Amiti et al., 2022).

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



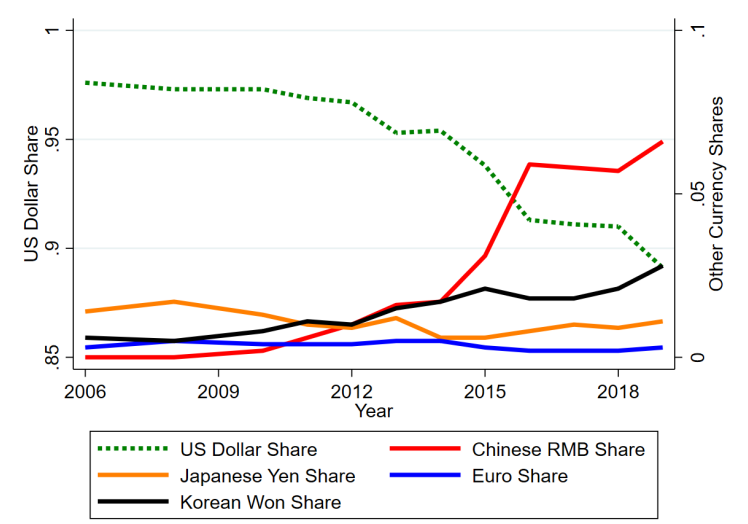
(a) Official Data



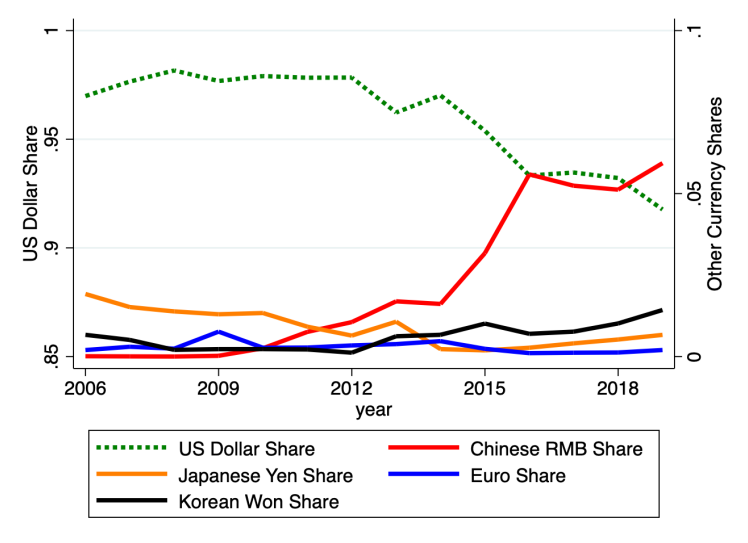
(b) Customs Sample Data

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. The left y-axis corresponds to US dollar shares, while the right y-axis corresponds to other currencies' shares.

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



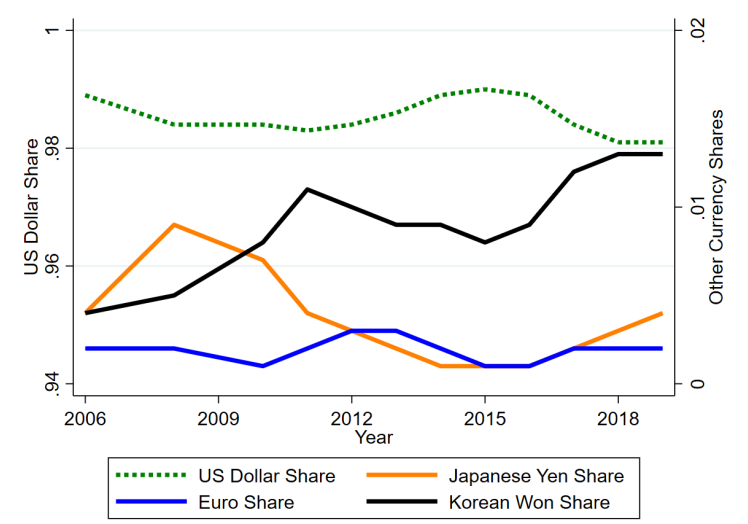
(a) Official Data



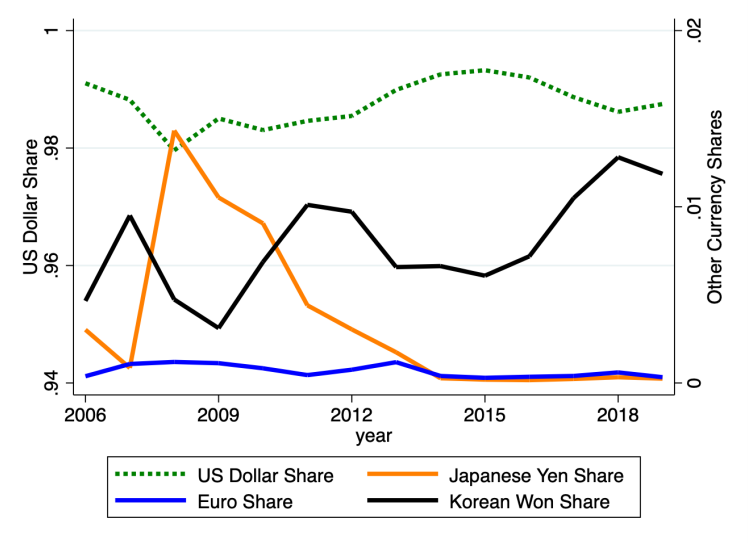
(b) Customs Sample Data

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. The left y-axis corresponds to US dollar shares, while the right y-axis corresponds to other currencies' shares.

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



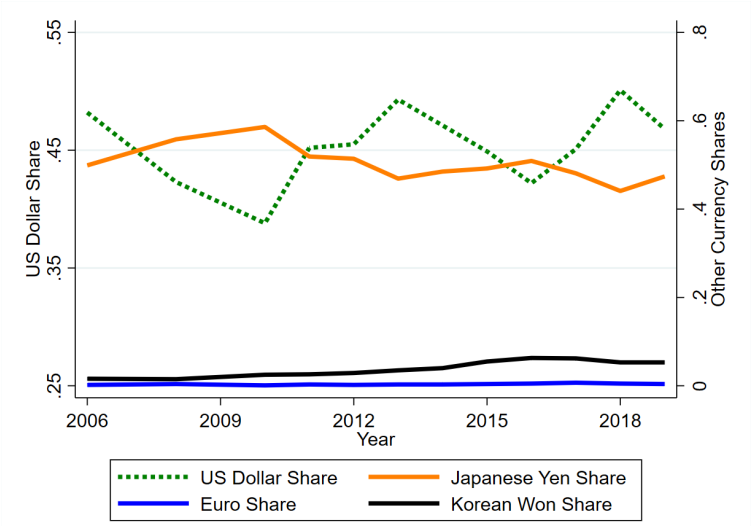
(a) Official Data



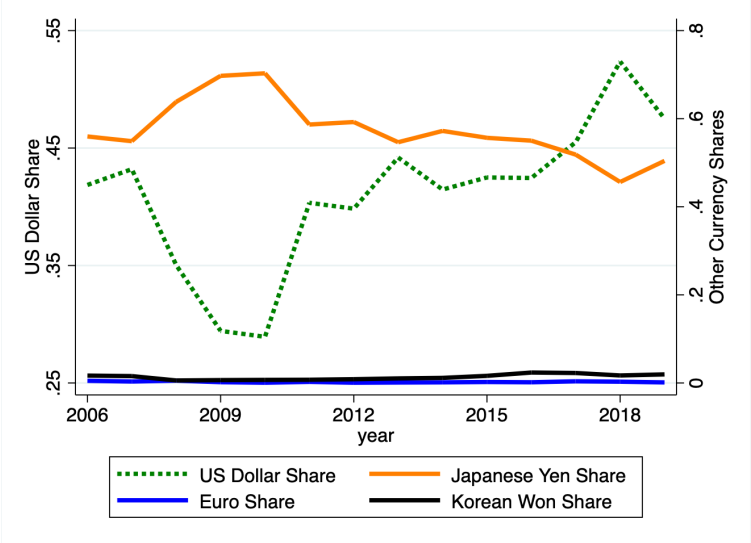
(b) Customs Sample Data

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. The left y-axis corresponds to US dollar shares, while the right y-axis corresponds to other currencies' shares.

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



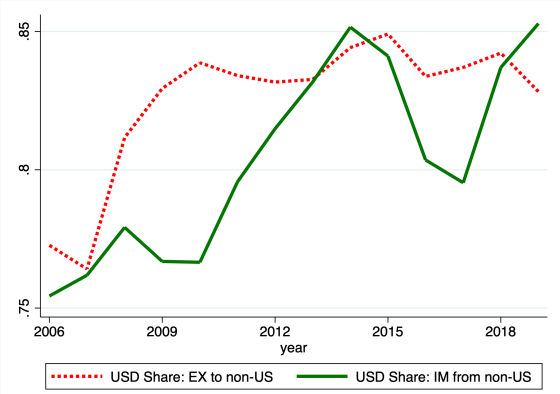
(a) Official Data



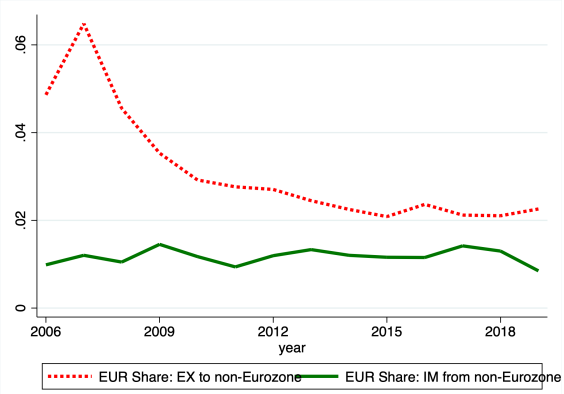
(b) Customs Sample Data

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. The left y-axis corresponds to US dollar shares, while the right y-axis corresponds to other currencies' shares.

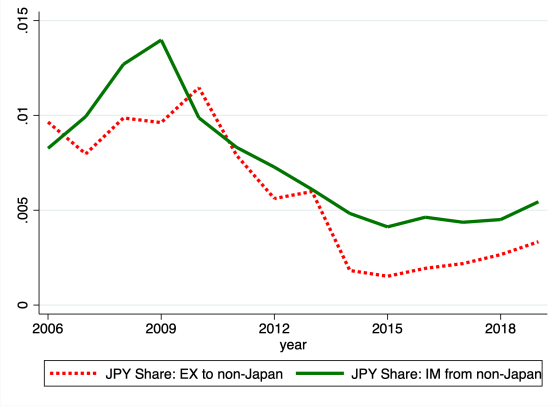
Figure 5: Major Currencies' Use in Korean Trade



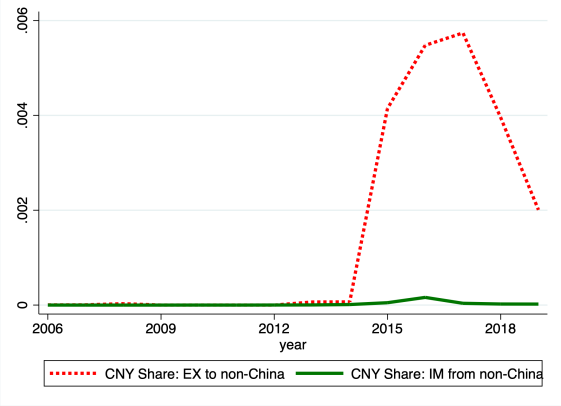
(a) USD Share in Korean Trade with Non-US Destinations



(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.

4 The Effects of Central Bank Swap Lines

In addition to examining invoicing currency shares at the destination-country level, we analyze their compositional changes starting at the firm-country level. Specifically, we break down invoicing shares into four categories: destination currency (local currency pricing, LCP), US dollar (dominant currency pricing, DCP), Korean won (producer currency pricing, PCP), and other currencies. We connect the dates of the swap lines with the dynamics of invoicing currency shares. These data patterns provide an inspiration for a deeper exploration in the next section.

4.1 Firm-Country Level Analysis

Our first empirical setting is

$$exsh^o_{fjt} = \alpha^o_{fj} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline_event_{jt} = \tau) + \epsilon^o_{fjt} \tag{1}$$

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 (other than Japan) and South Korea signed a local currency swap line. In the case of Japan, the date indicates the discontinuation time of the yen-won swap line. The "event year" is treated as the benchmark year. 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 and $T-1$ if the swap line is signed in the first half of T. For example, the event year for China-Korea swap line is recorded as 2008 as the agreement was signed in December 2008, and the recorded event year for the Australia-Korea swap line is 2013 as the agreement was signed in February of 2014. The currency amount in the swap line between Korea and Japan started to decline significantly in October of 2012 (with the expiry of a previous agreement to raise the amount in the swap line in the absence of a renewal). Thus, we choose 2012 as the event year for Japan.

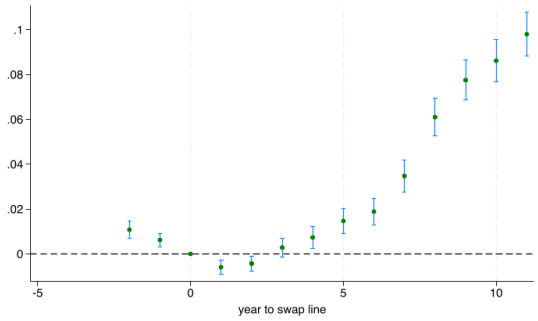
Currency o can be destination country's currency, US dollar, Korean won or other currencies. The coefficients of interest are $\hat{\beta}^o_{j\tau}$, which represents each year's average currency o shares relative to that in the "swap line event" year. The treatment groups will include destinations 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 presents the estimated coefficients for China, $\hat{\beta}^o_{China,\tau}$, along with the corresponding 90% confidence intervals. 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. Note the raw data tells that before 2008, RMB share in Korean export to China is virtually 0. The pre-swap line relative decrease in RMB share is because of the difference-in-difference empirical design. It means that firms in the control group (e.g., Korean exporters that export to UK) increase the local currency share slightly between 2006 and 2008. In any case, 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 percentage points 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 was only realized 10 years after the first Won-Yuan swap line. Finally, all other currencies' shares do not show economically significant trend after 2008. In sum, the Chinese Yuan displaces the US dollars in Korean export to China after 2008.

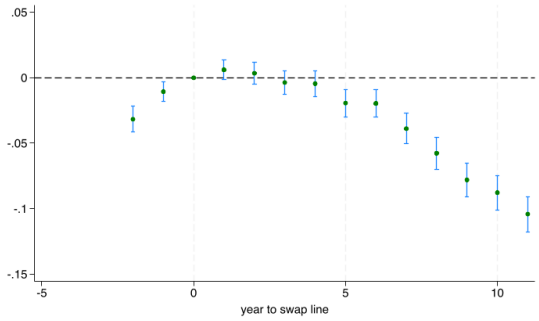
Figure 7 shows the estimated coefficients for Japan, $\hat{\beta}^o_{Japan,\tau}$. Panel (a) corresponds to Japanese Yen share (o=local currency). Before time 0 (year 2012), there was no significant changes in the firm-level Yen share. But it started to decline after 2012 when the two countries entered 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 percentage points 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 invoicing currency shares for Korean exports to other countries that have also signed a swap line with Korea. As an example, Figure 8 shows the

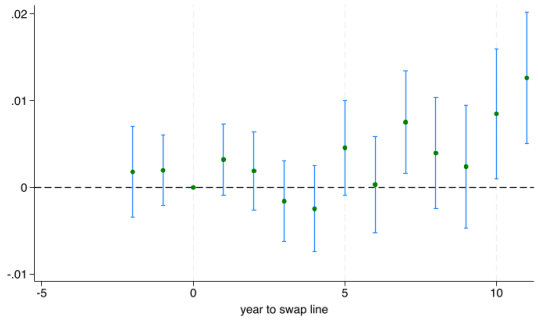
Figure 6: Firm Level Currency Shares in Korean Export to China: No Controls



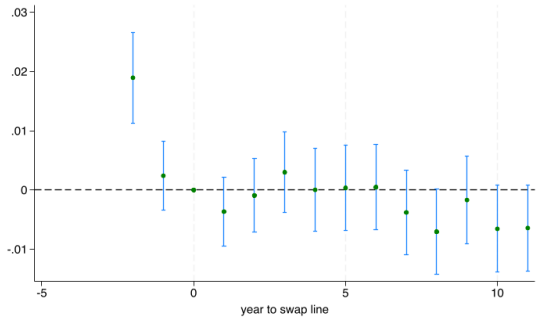
(a) Chinese Yuan Share



(b) US Dollar Share



(c) Korean Won Share

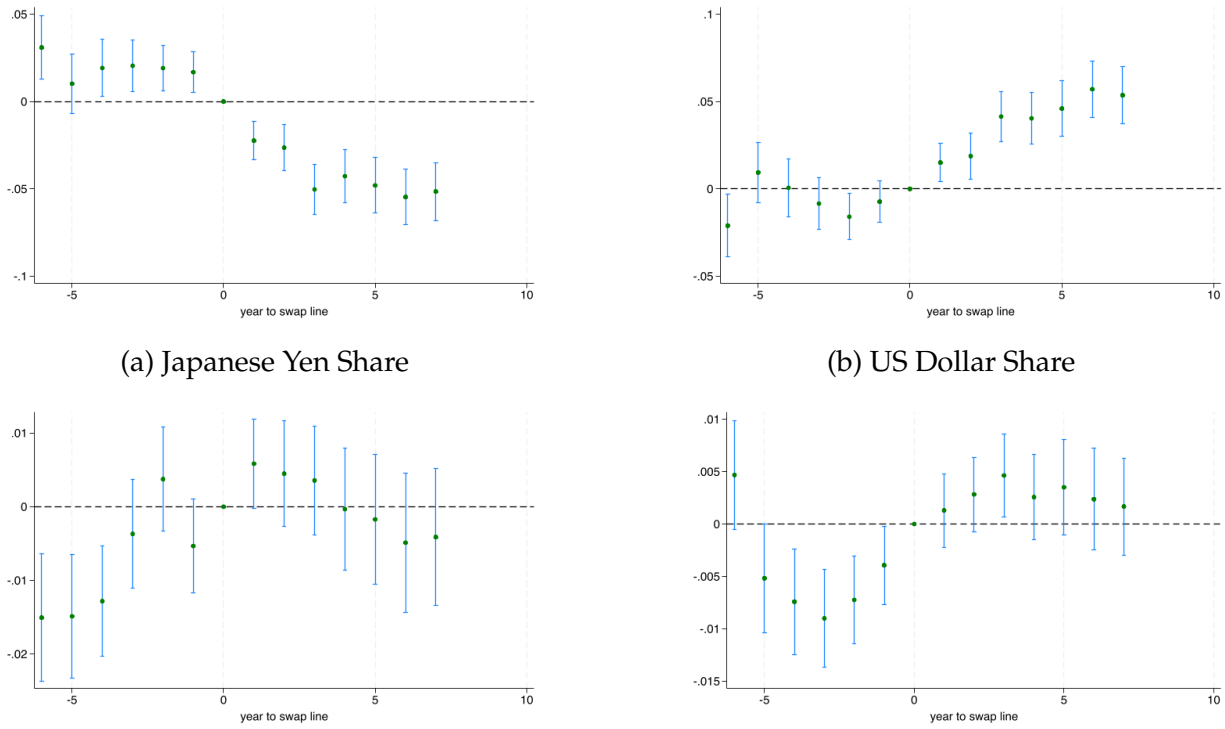


(d) Other Currencies' Share

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.

estimated coefficients for Australia, $\hat{\beta}^{o}_{Australia,\tau}$. Interestingly, we do not find significant changes for the dollar, yen, won, and RMB shares after the Korea-Australia swap line. In general, similar results also hold for other destinations: Switzerland, Canada, UAE, Malaysia and Indonesia. These patterns can be found in the Online Appendix E.

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

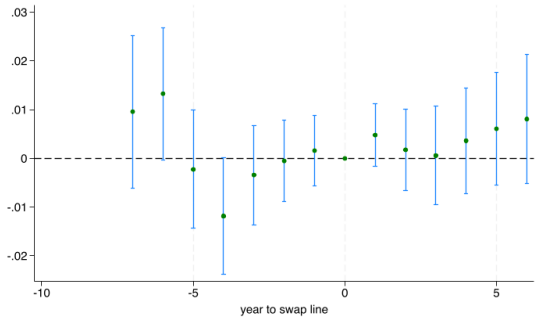
Notes: This figure shows the dynamics of firm-level currency shares of Korean export to Japan. Year 0 denotes 2012 when Japan and Korea started to let their local currency swap lines expire.

We further examine the extensive margin response in currency use. Since some Korean exporters may start to use a fraction of their transactions in RMB, we expect the extensive margin response can be more pronounced. Appendix Section F confirms this conjecture formally. In Appendix G, we see that our results are robust to accounting for compositional shifts at more disaggregated (firm-product-country) level.

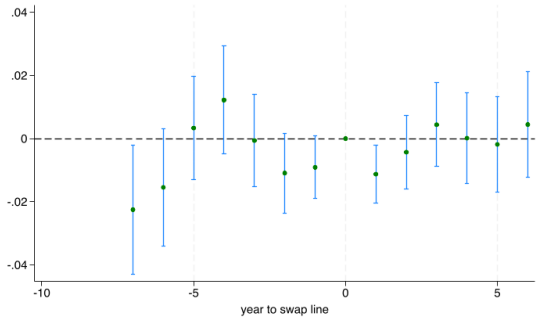
4.2 The Role of Import-Export Nexus in Currency Choice

The import-export connection within a firm plays a crucial role in Bahaj and Reis (2020). Specifically, some exporters begin invoicing in RMB after establishing swap lines

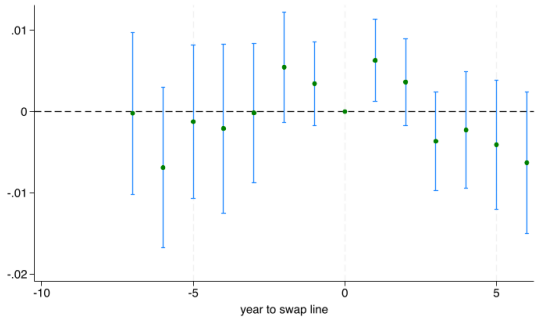
Figure 8: Firm Level Currency Shares in Korean Export to Australia: No Controls



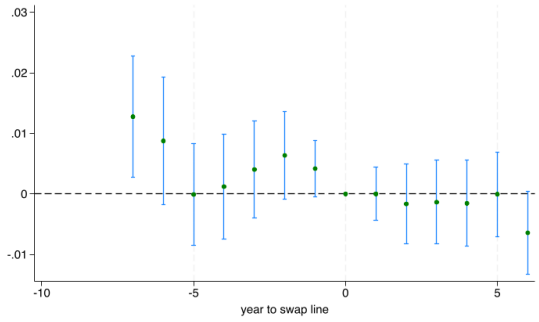
(a) Australian Dollar Share



(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.

because these firms also import in RMB when low-interest RMB loans become accessible. This approach rests on the assumption that many exporters are also importers, enabling them to allocate RMB export earnings to RMB-denominated import expenses within a firm. Using the firm-level data, we assess the significance of this import-export relationship.

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 dummies 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) does not provide explicit predictions for $\beta^o_{j\tau}$, as we observe that a Korean exporter is unlikely to use RMB for imports if they do not source from China.

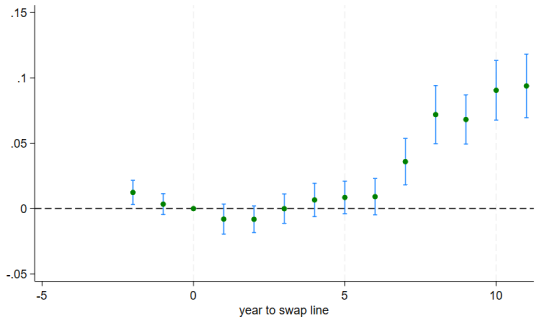
Figure 9 presents the estimation results for $\beta^o_{j\tau}$ and $\zeta^o_{j\tau}$ where j = China, Japan, and o represents the local currency. Our findings reveal no statistically significant differences in RMB (Japanese Yen) usage in exports to China (Japan) between importers and non-importers from China (Japan). Notably, even among non-importers, RMB usage in exports to China (and Japanese Yen usage to Japan) increases significantly after the initiation of swap lines (and decreases following their expiration). [15]

4.3 The Role of Chinese State Owned Importers

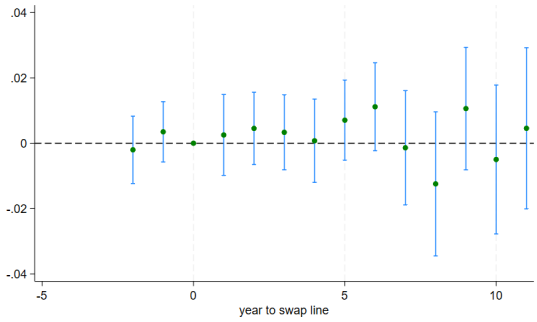
The existing literature suggests that Chinese state-owned firms play a crucial role in advancing the country's global ambitions. Horn et al. (2021) indicate that China's international lending primarily occurs through commercial loans issued by its state-owned firms. In this study, we analyze the role of Chinese state-owned firms in promoting RMB usage in trade. Although we cannot directly identify Chinese importing firms, we can categorize products based on the relative significance of state-owned firms within China. We utilize Chinese customs transaction-level data from 2006 to calculate, for each HS 4

[15] We also consider whether firms in big business groups have significant impacts on our results. Appendix Figure J.3 shows that our results are robust by dropping firms in the top 10 business groups in South Korea from our data.

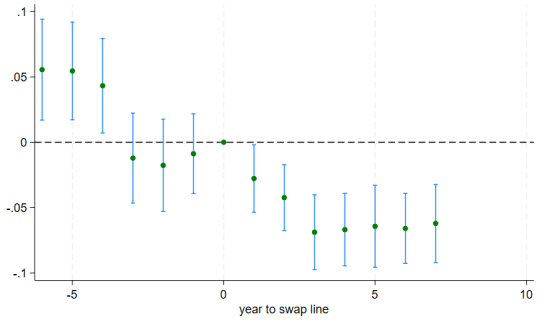
Figure 9: Import-Export Nexus in Currency Choice for Exporters



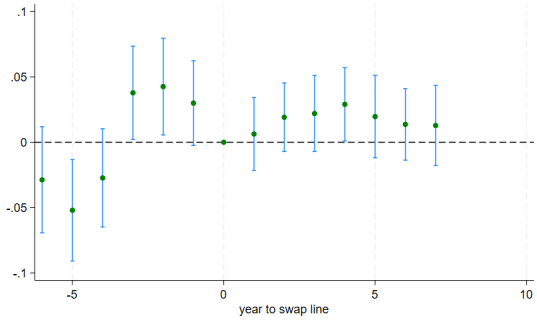
(a) RMB Share for Non-importers from China



(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.

product p, the share of import values attributed to state-owned firms, denoting this fraction as "chnsoe_share$_p$." The empirical setting is as follows:

$$\begin{aligned} exsh^o_{fjpt} =& \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline_event_{jt} = \tau) \\ &+ \sum_{\tau\neq 0} \gamma^o_{China,\tau} I(swapline_event_{China,t} = \tau) * chnsoe_share_p + \epsilon^o_{fjpt}, \end{aligned} \tag{4}$$

where the state-owned share is interacted with the time distance from the swap line event with China.

Our interest lies in the estimated $\hat{\gamma}^o_{China,\tau}$, displayed in Figure 10 for firms' invoicing shares in local currency and USD. We observe that, qualitatively, products with a higher share of Chinese state ownership tend to exhibit a more substantial increase in RMB share alongside a corresponding decrease in USD share. Nonetheless, this difference is not consistently statistically significant, and its economic impact remains limited.

4.4 Additional Controls

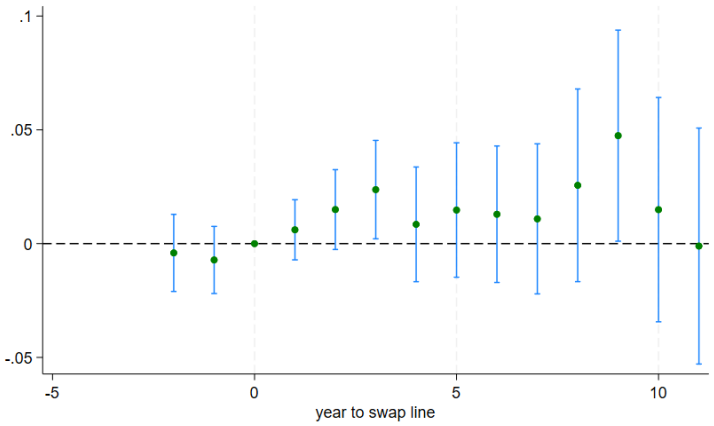
We include additional control variables in our firm-product level regressions and report the point estimates for these controls in Table 6. We first follow Amiti et al. (2022) to construct a market share measure for Korean exporter f's export to market j in year t

$$s_{fjt} = \frac{exvalue_{fjt}}{\sum_h exvalue_{hjt}}. \tag{5}$$

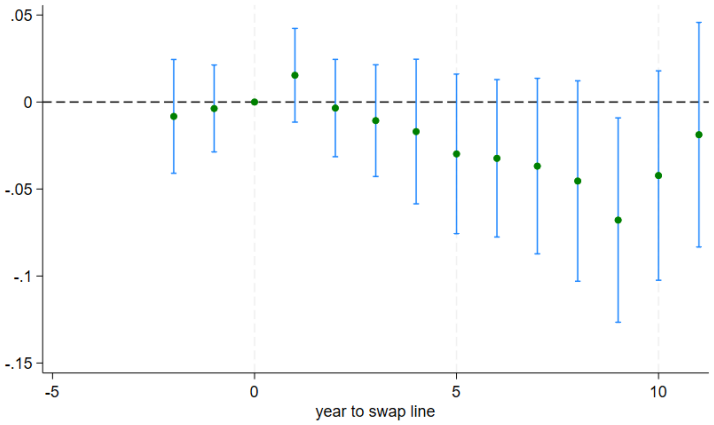
This variable is intended to capture its relative size. We also include firm employment (its natural logarithm) as a control. Moreover, we construct "import LC dummy" to denote whether the exporter uses destination country's currency in their import and "import LC share" to denote the fraction of the exporter's destination country's currency use in their total import.[16] 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. 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. But the economic significance seems limited. Columns (1) and (2) imply that 100% import using destination currency (LC) will increase export share in the destination currency by

[16]We also test a model that includes time-varying industry-level destination market size as an additional control. This market size is constructed using UNIDO industry-level output data along with UN Comtrade export and import data at the product level. Our findings on the effects of swap lines remain robust with this addition despite a much smaller sample due to the limited coverage of UNIDO data.

Figure 10: The Role of Chinese State Owned Importers



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



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

Notes: This graph displays the heterogeneous response of Korean exporters' RMB/USD shares by Chinese state-owned firms' import intensity.

Table 6: Additional Controls

	(1)	(2)	(3)	(4)
Dependent Variable:	LC share	USD share	KRW share	Other share
market share	0.025***	-0.052***	-0.004	0.030
	(0.008)	(0.020)	(0.002)	(0.022)
log(employment)	0.002	-0.002	-0.000	0.001
	(0.001)	(0.002)	(0.002)	(0.001)
import LC dummy	0.021***	-0.019***	-0.002	-0.000
	(0.004)	(0.004)	(0.002)	(0.001)
import LC share	0.030***	-0.025***	-0.002	-0.001
	(0.005)	(0.005)	(0.002)	(0.001)
Year FE	Y	Y	Y	Y
Firm-Product-Destination FE	Y	Y	Y	Y
Observations	1368852	1368852	1368852	1368852
R^2	0.897	0.813	0.682	0.795

Notes: This table reports the regression results on control variables when we add them to our baseline firm-product-country level regression settings.

5.1% (=0.021+0.030) and decrease US dollar share by 4.4% (=0.019+0.025). Lastly, adding these controls does not change our swap line dummies' estimates in a material way (See Appendix Figure J.4).

4.5 Discussion on Other RMB Internationalization Policies

The Chinese authorities have undertaken other actions that could potentially promote the use of the RMB in Korea-China trade, including the establishment of an RMB clearing bank, the Cross-Border Interbank Payment System (CIPS), and direct KRW-RMB interbank exchange. However, these policies took place later than our event date and their effects may show up after 2015, by which time we had already observed a notable increase in RMB usage among Korean exporters.

First, China designated the Bank of Communications as the RMB clearing bank in July 2014, with the RMB clearing operation formally beginning in November 2014. However, none of the Korean exporters in our sample identified the Bank of Communications as their primary bank, and it was not until June 2016 that South Korea's Woori Bank started local currency clearing cooperation with the Bank of Communications.[17] Second, CIPS

[17] See https://www.bankcomm.com/BankCommSite/shtml/jyjr/cn/7158/7162/44912.shtml?channelId=7158. Note that the Bank of Korea designated Woori Bank and Hana Bank as Korean Won clearing banks in China.

Phase I was launched in October 2015, though no Korean banks participated directly.[18] CIPS Phase II, launched in March 2018, expanded functionality to better accommodate growing cross-border transaction needs, introducing additional settlement modes, financial market transactions, and extended service hours.

The Korean and Chinese governments established direct RMB-KRW transactions with designated market makers to reduce transaction costs. At the end of October 2014, the Bank of Korea appointed 12 banks as market makers for direct RMB-KRW transactions, which commenced in mid-December.[19] Subsequently, China launched the KRW-RMB interbank direct exchange in June 2016 with 14 participating banks designated as market makers.[20] Analysis of RMB-KRW bid-ask spreads among Korean banks, as reported in Appendix Figure J.5, indicates that after the establishment of direct RMB-KRW transactions, Woori Bank adjusted its bid-ask spread by the end of 2014, while the other three banks made adjustments only in 2016 or later. In August 2020, a digital central bank currency was introduced by the People's Bank of China on an experimental basis (see Wei and Yue (2023)), but its impact on the RMB internationalization is still minimal.

In conclusion, while additional policies could also contribute to the RMB internationalization, their timing suggests that the central bank swap line still has played a crucial role in the initial surge in the RMB usage in the Korea-China trade, although other actions may have enhanced the momentum in later years.

5 Exploring the Mechanism: The Role of Banks

5.1 Bank Heterogeneity and Export Currency Invoicing

To empirically identify a role of the swap agreement in helping Korean banks to manage their RMB-related risks, we need to work with some heterogeneity across Korean banks. We hypothesize that the Korean banks with branches in China before the currency swap agreement have played a crucial role in expanding RMB lending when the RMB currency risk can be better managed with the swap agreement. Korean banks, for in-

[18]CIPS Phase I had 176 indirect participants connected through direct participants, though the list of indirect participants was not publicly disclosed.

[19]The market makers included Deutsche Bank, Industrial and Commercial Bank of China, JP Morgan Chase, HSBC, Bank of Communications, Shinhan Bank, Woori Bank, the Industrial Bank of Korea, Korea Development Bank, Korea Exchange Bank, and the local branches of Standard Chartered Bank and Citigroup.

[20]The banks included KEB Hana Bank, Woori Bank, Shinhan Bank, Koomin Bank, Korean Development Bank, and major Chinese banks such as the Bank of China, Industrial and Commercial Bank of China, and China Construction Bank.

stance, are likely to conduct RMB lending primarily through their subsidiaries in China. For example, Woori Bank's RMB lending activities are reported in the annual report of its subsidiary in China. [21] We calculate a new variable to measure the initial exposure to RMB business of bank b as follows:

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

The denominator serves to normalize the branch count. Our analysis focuses on the initial infrastructure of (non-government-owned) Korean banks operating in China.

Firms rely on banks for handling international transactions, and we use firms' self-reported main bank information from KIS data. A firm's main bank is typically its largest lender and manages the majority of its transactions, including cross-border dealings. This is similar to the Japanese case as discussed by Amiti and Weinstein (2011). For comparison, we show that RMB deposits held by the branches of Chinese banks in Korea represent only a small fraction compared to those held by the Korean commercial banks. [22] Thus, the Korean commercial banks have likely played a significant role in the rise of RMB invoicing in Korean trade. Our empirical model is:

$$\begin{aligned} exsh^o_{fjpt} =& \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline_event_{jt} = \tau) \\ &+ \sum_{\tau\neq 0} \xi^o_{China,\tau} I(swapline_event_{China,t} = \tau) * branch_initial_b + \epsilon^o_{fjpt}, \end{aligned} \tag{6}$$

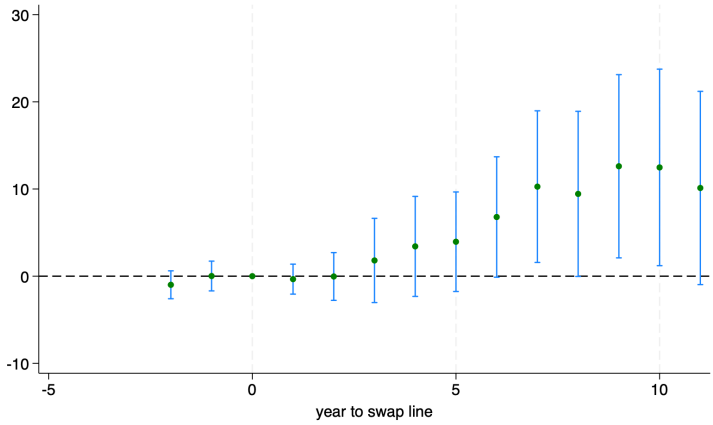
where firm f's main bank is bank b. The coefficient $\xi^o_{China,\tau}$ for the interaction term captures the differential effects on firms' currency choice based on their main banks' branch exposure to China.

Figure 11 presents the estimated values of $\xi^o_{China,\tau}$, where o represents either the RMB or the USD. We see that those Korean firms associated with the banks with a greater initial (normalized) presence in China exhibit a greater relative RMB use and a greater relative decline in the USD usage following the Korea-China swap line. This pattern is consistent with our bank currency risk management channel.

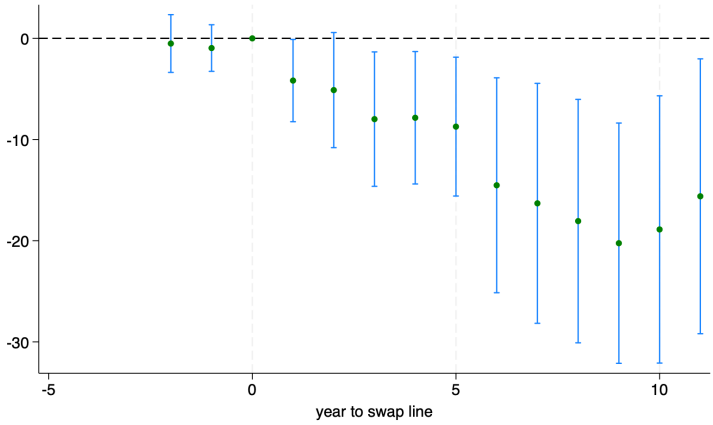
[21] In 2018, Woori China reports its RMB loan value of 28,524 million yuan, while Woori consolidated balance reports its RMB loan value of 29,880 million yuan.

[22] 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 all commercial banks in Korea in 2018.

Figure 11: The Role of Initial Korean Bank Branches in China



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



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

Notes: This graph displays the heterogeneous response of Korean exporters' RMB/USD shares by their main banks' pre-swap line branch/office exposure.

5.2 Interest Rates on Foreign-Currency Deposits in Korean Banks

We manually collect deposit interest rate data for various currencies offered by major Korean banks from their websites. They include Woori Bank, Industrial Bank of Korea (IBK), Shinhan Bank, and Korean Exchange Bank (KEB). Our baseline rate is the 3-month term deposit rate, and if unavailable, we substitute with the ones with another maturity.

Figure 12 illustrates deposit rates for various major currencies at Korean commercial banks. In panel (a), the 3-month Japanese Yen term deposit rate from Woori Bank, available only after 2012, reveals a decline just after the termination of the Korea-Japan swap line. In Panel (b), a similar interest rate from the Industrial Bank of Korea exhibits a similar pattern. In panel (c), Shinhan Bank's 12-month Japanese Yen term deposit rate also drops after 2012 even though it shows an increase after 2005, following the initial establishment of the Korea-Japan swap line. Additionally, the RMB deposit rate after 2016 surpasses the levels observed between 2004 and 2006 (with data gaps from 2007 to 2015). In Panel (d), ordinary deposit rates from Korean Exchange Bank (KEB) show a similar pattern as Shinhan Bank in panel (c), where the RMB deposit rate in the post-swap line period is higher than the pre-swap line period, and a decline in the JPY deposit rate is observed following the expiration of the Korea-Japan swap line.

5.3 Currency Denomination of Korean Banks' Deposits

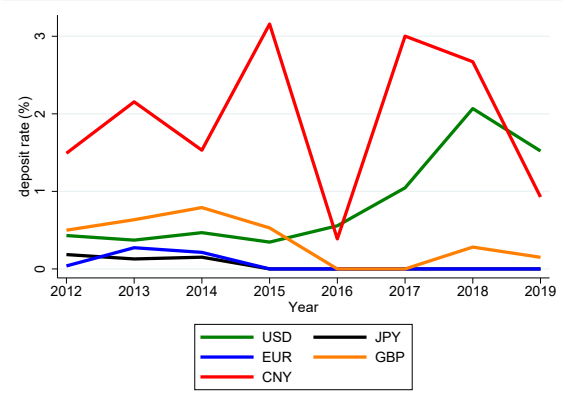
In addition to the interest rate data, we also investigate Korean banks' balance sheet by currencies. We manually gather balance sheet data from major Korean banks, focusing on deposits denominated in various currencies, including the Euro, British Pound, Japanese Yen, and Renminbi. Recall that South Korea has established swap lines with Japan and China but does not have such agreements with the Eurozone or the UK.

For each bank b, we identify the group of firms it serves as the main bank, based on Korean Information Service data, and label these as bank b firms. We examine whether the ratio of bank b's deposits in currency j to the total exports of bank b firms to country j (referred to as the local currency deposit ratio, or $lc_deposit_ratio$) is correlated with the SwapLineDummy. Specifically, we test:

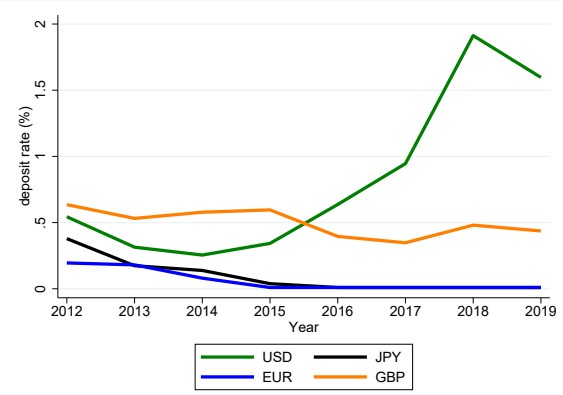
$$lc_deposit_ratio_{bjt} = \alpha_{bj} + \beta * SwapLineDummy_{jt} + \delta_t + \epsilon_{bjt}.$$

To mitigate the impact of outliers, we winsorize $lc_deposit_ratio$ at the 2.5% level on both tails. Given that Korean banks' RMB balance sheet data is only available post-2008 and that the Eurozone and UK did not establish local currency swap lines with Korea, the

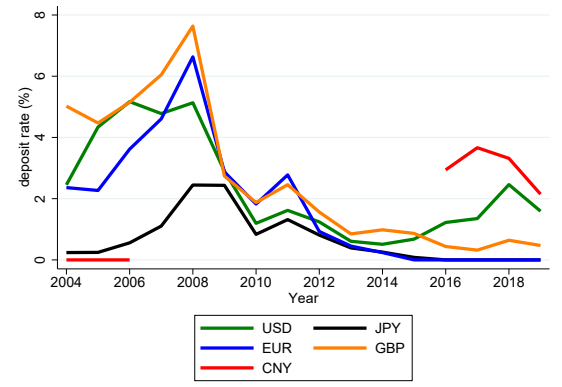
Figure 12: Korean Banks' Deposit Rates on Foreign Currencies



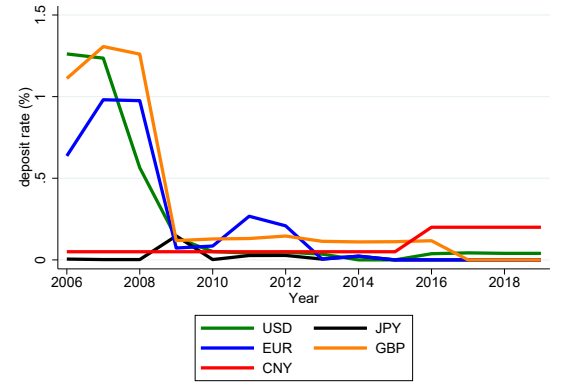
(a) Woori Bank 3-month Term Deposit Rate



(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.

SwapLineDummy variable primarily reflects changes in the status of Korea's swap line with Japan.

From Table 7, we see that the discontinuation of the swap line agreement between Korea and Japan is followed by a fall in the Japanese Yen deposits at the Korean banks (at the bank level, normalized by the export value to Japan by Korean firms associated with that bank). This is consistent with our discussion of a swap line's role in assisting banks to better manage currency risks.

6 Model

We now present a simple model of the equilibrium currency use by firms that highlights the bank risk management channel. The timing of events is as follows. At the beginning of the first period, a representative Korean bank announces the interest rate for deposits denominated in currency l. We consider $l \in \{j, v\}$, where j and v are the local currency in country j (e.g., RMB) and the vehicle currency (USD), respectively. Exporting firms choose an invoicing currency l after observing the bank interest rates. Subsequently, exchange rate shocks $\{\xi_l, \xi_j\}$ are realized, production and consumption take place, and the firms deposit their export revenues in a bank for interest income. The bank immediately lends out the money with a long-term contract (two periods). In the second period, there is an exogenous probability π_j that firms that adopted currency j for invoicing (that we refer to currency-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 from either the market at a higher interest rate $\bar{i}$ or the central bank at 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 currency-j firms with probability $(1-\pi_j)$ and to currency-v firms.

6.1 Firms

We consider a continuum of Korean monopolistically competitive firms exporting to country j (China). A firm's production function can be expressed as

$$y = A\alpha^{-1}h^{\alpha}, \tag{7}$$

where y denotes output, A denotes the productivity level, which is assumed to be common for 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

$$y_l = C_j \left(\frac{\xi_l p_l \tau_l}{\xi_j P_j} \right)^{-\lambda} \quad \text{for } l \in \{j, v\}, \tag{8}$$

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 country j's local currency (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 as ξ_l units of KRW per unit of currency l. p_l is the firm's output price denominated 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

$$\begin{aligned} \Pi_j &= \xi_j p_j y_j \left[\pi_j + (1-\pi_j)(1+i_j)^2 \right] - w h_j \\ \Pi_v &= \xi_v p_v y_v (1+i_v)^2 - w h_v. \end{aligned} \tag{9}$$

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

$$s_l = 1 - \frac{T_l \mathbb{E}(\Pi_l)^{-\theta}}{\sum_{l'} T_{l'} \mathbb{E}(\Pi_{l'})^{-\theta}}. \tag{10}$$

Equation (10) suggests that the share of firms that use currency l for invoicing increases with the relative expected profit in currency l over that in the other currency.

6.2 Banks

While the firm takes the interest rates as given, we now obtain the equilibrium interest rates from the representative bank's profit maximization problem:

$$\max_{i_j,i_v} \Pi_B = \left\{\mathbb{E}(g_j(D_j)) - (1-\pi_j)(1+i_j)^2\mathbb{E}(D_j) - \pi_j((1-\omega)\bar{\imath} + \omega\underline{\imath})\mathbb{E}(D_j)\right\} s_j + \left\{\mathbb{E}(g_v(D_v)) - (1+i_v)^2\mathbb{E}(D_v)\right\} s_v, \tag{11}$$

where $\mathbb{E}(g_l(D_l))$ is the expected return on the bank' loans to other sectors in the economy. We assume that the $g_l(D_l)$ is a homogeneous function of degree 1 to simplify the aggregation over all firms' deposit D_j. Since the bank does not know the realization of exchange rate ξ at the time of its interest rate 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 rate with respect to the signing of the currency swap agreement in the following proposition.

Proposition 1. *The bank's optimal interest rate on currency j deposit increases (and that of currency v deposit decreases) if a currency swap agreement between currency j and home currency is in place.*

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[23]

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

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

[23] See Appendix I for details.

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 $\frac{\partial i_v^*}{\partial \omega} < 0$. □

With the market share of currency-j firms held constant, the option of obtaining currency j from the currency swap reduces the bank's financing costs when the currency-j firms withdraw their currency-j deposits with probability π_j. This incentivizes the bank to expand its balance sheet in currency j. To achieve this, the bank raises its optimal interest rate i_j in currency j. However, the optimal interest rate i_v in the vehicle currency is affected by the agreement in the opposite direction, due to the crowding-out effect from the bank's incentive to increase its balance sheet in currency j.

6.3 A Numerical Example

This proposition on interest rate is consistent with the empirical patterns that we have seen in the previous section. We use a numerical example to illustrate Proposition 1 and conduct comparative statics of other equilibrium variables with respect to the signing of the currency swap agreement.

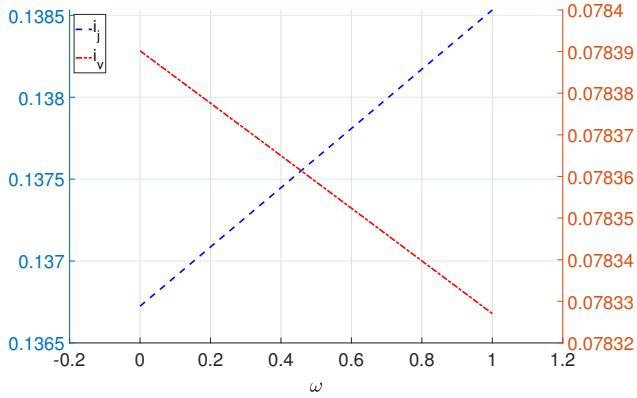
In Figure 13, we plot the changes in interest rates, shares of firms that adopt two different invoicing currencies and the expected deposit from each type of firms. As predicted by Proposition 1, panel (a) shows that the interest rate i_j increases after a swap agreement is signed, whereas i_v decreases. 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.

7 Conclusion

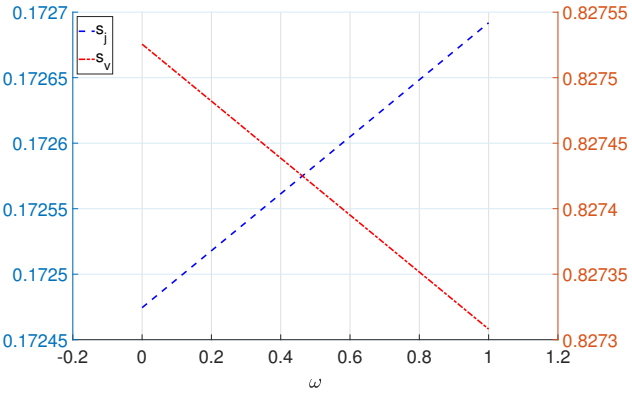
We consider the role of central bank swap lines in promoting the international use of a national currency (Chinese RMB) in trade transactions. In particular, we use detailed customs data from South Korea that record currency use in individual trade transactions. We find that after South Korea's local currency swap line with China, its exporters raise their RMB share in their trade with China significantly. Conversely, after the discontinu-

Figure 13: Model Comparative Statics

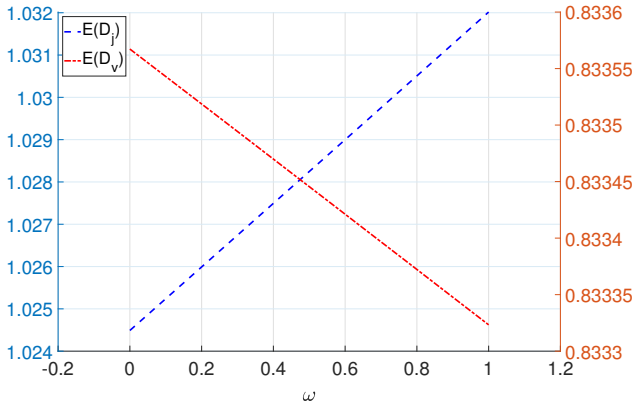
(a) interest rates



(b) share of firms invoicing in each currency



(c) expected deposit



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: $\pi_j = 0.1$, $\lambda = 3$, $\alpha = 0.9$, $T_j = 1$, $T_v = 0.2$, $\theta = 0.2$, $g_j = 3.3\sqrt{(\cdot)}$, $g_v = 3\sqrt{(\cdot)}$, $\bar{\imath} = 0.2$, $\underline{\imath} = 0.1$. C_j, τ_j, τ_v, P_j, w and A are normalized to 1.

ation 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 bank-level risk reduction channel for the role of the currency swap line. When the Korea central bank, following a swap agreement with China, can be the lender of last resort in RMB, the Korean commercial banks become more willing to take risks in expanding RMB business. They raise interest rate on RMB deposits in order to attract more RMB deposits and issue more RMB-denominated loans. To strengthen the empirical identification, we utilize information on each Korean exporting firm's main bank - 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 presence in China such as more bank branches or offices there should respond more to the swap line as it is less costly for them to expand their RMB lending business. Indeed, we confirm this empirically. Similarly, following a discontinuation of the Korea-Japan swap agreement, there is a decline in JPY interest rates on yen deposits at the Korean banks.

Finally, we provide a novel model of invoicing currency choice by exporting firms with special attention to risk management by commercial 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 incentivizes the exporting firms to invoice the export revenue in that currency by a greater extent.

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Online Appendix

(Not For Publication)

A Additional Background on Korean Swap Line Agreements

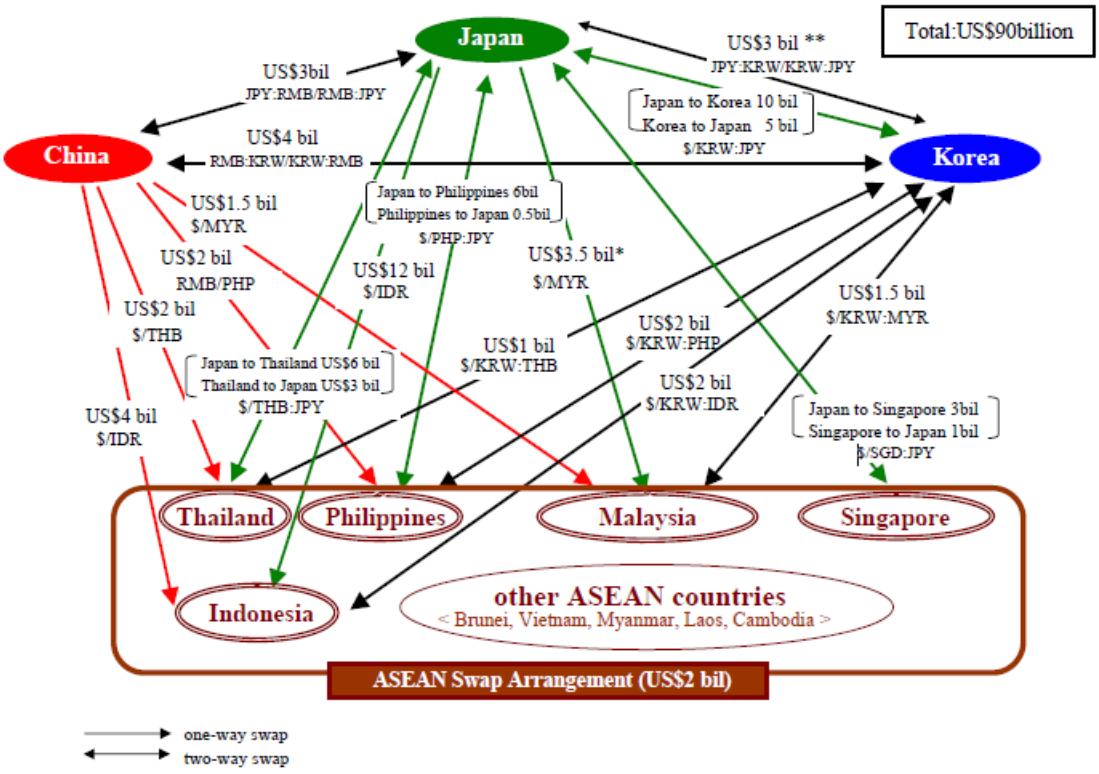
The Chiang Mai Initiative (CMI) is a multilateral currency swap agreement among the ten members of the Association of Southeast Asian Nations (ASEAN), China (including Hong Kong SAR), Japan, and South Korea (the so called "ASEAN plus Three" countries). The CMI started as a set of bilateral swap arrangements 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.

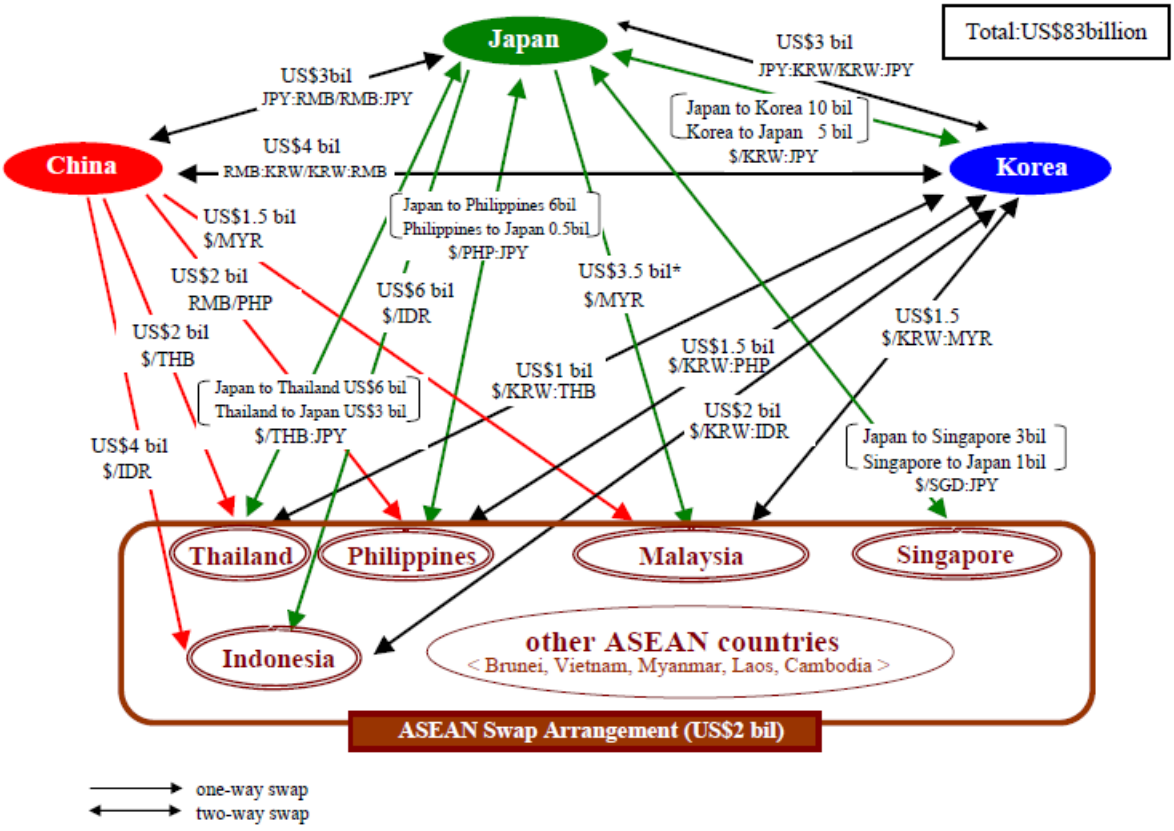
The Chiang Mai Initiative Multilateralization (CMIM) formally turns to the multilateral reserve pool in May of 2009. The reserve pool is 120 billion US dollars in which South Korea contributed 16% and is able to draw US dollars with an upper bound 19.2 billion US dollars, the same as South Korea contributed. 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)



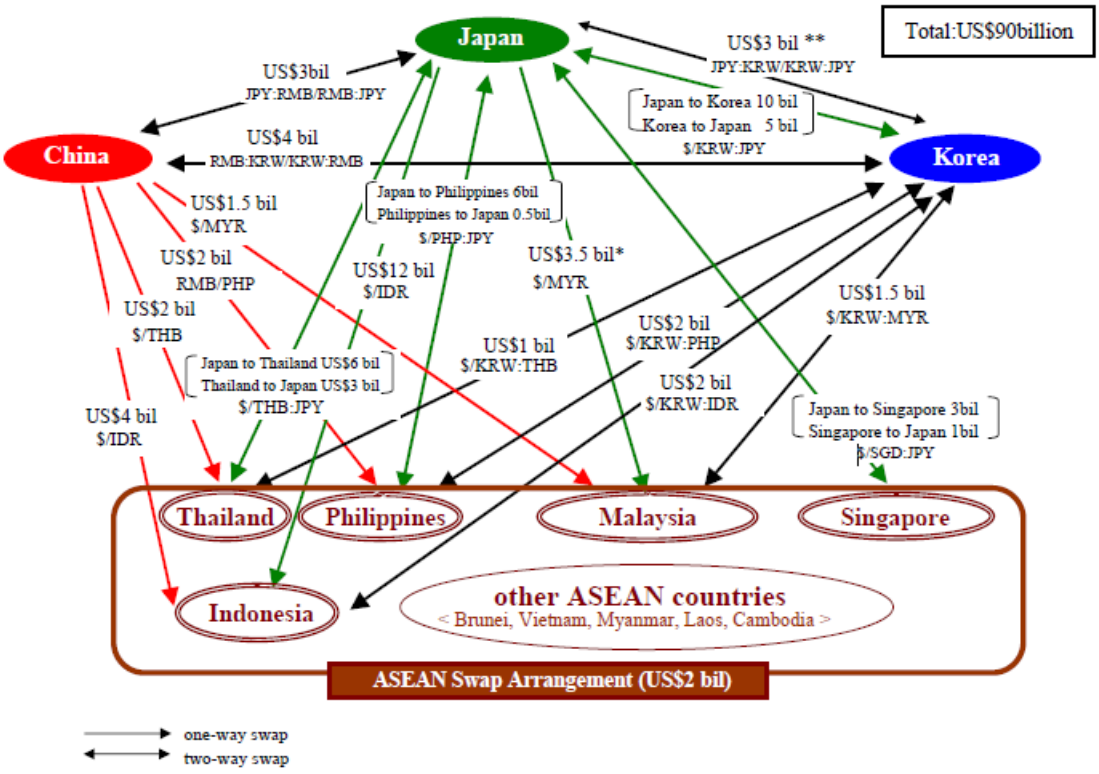
Source: Bank of Japan

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)



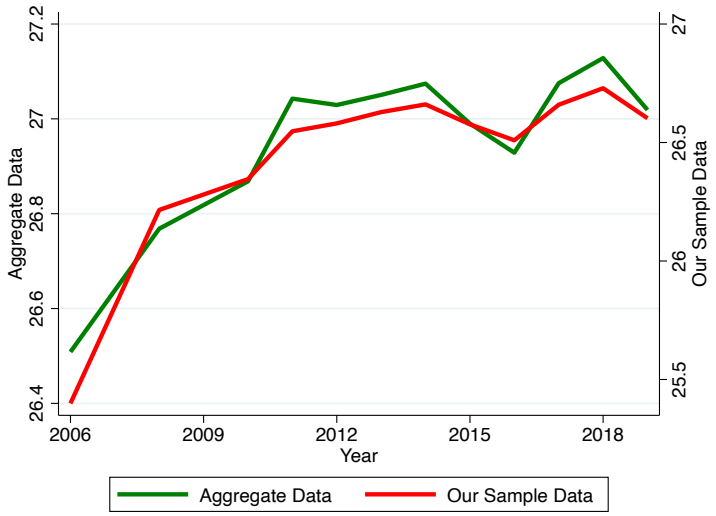
Source: Bank of Japan

Table A.1: CMIM Contributions and Borrowing Multipliers

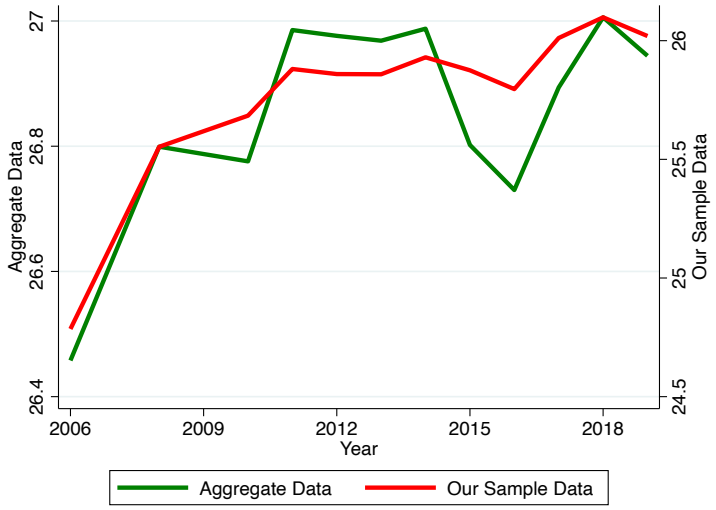
Country/Region	Contributions (US $ Billion)	Borrowing Multipliers
Brunei	0.01	5
Cambodia	0.12	5
PRC, Excluding Hong Kong	34.2	0.5
Hong Kong, China	4.2	2.5
Indonesia	4.77	2.5
Japan	38.40	0.5
Korea	19.20	1
Lao PDR	0.03	5
Malaysia	4.77	2.5
Myanmar	0.06	5
Philippines	3.68	2.5
Singapore	4.77	2.5
Thailand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

B Sample Representativeness

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

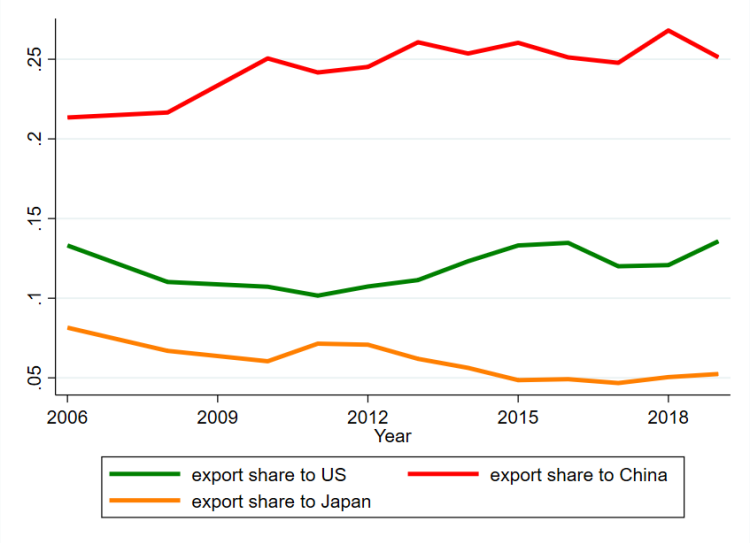


(a) Export Dynamics

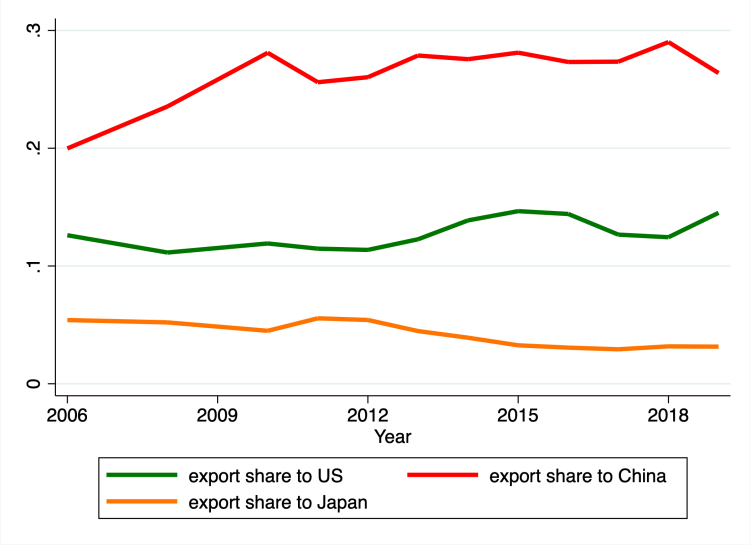


(b) Import Dynamics

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

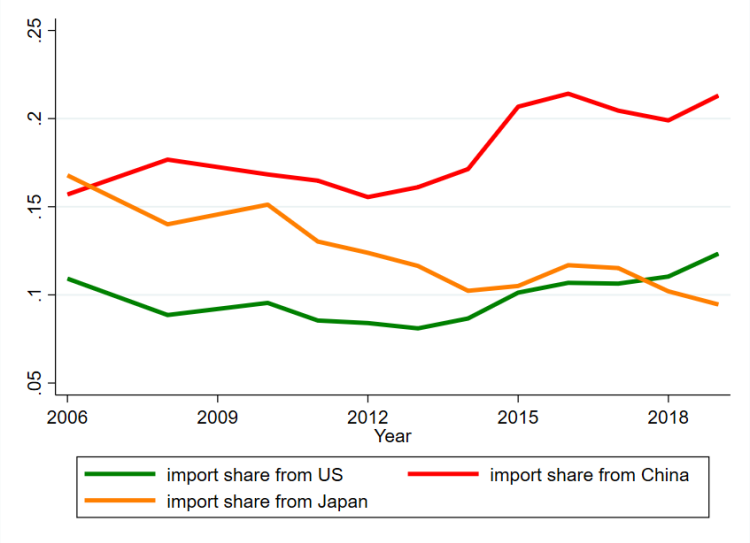


(a) Official Data

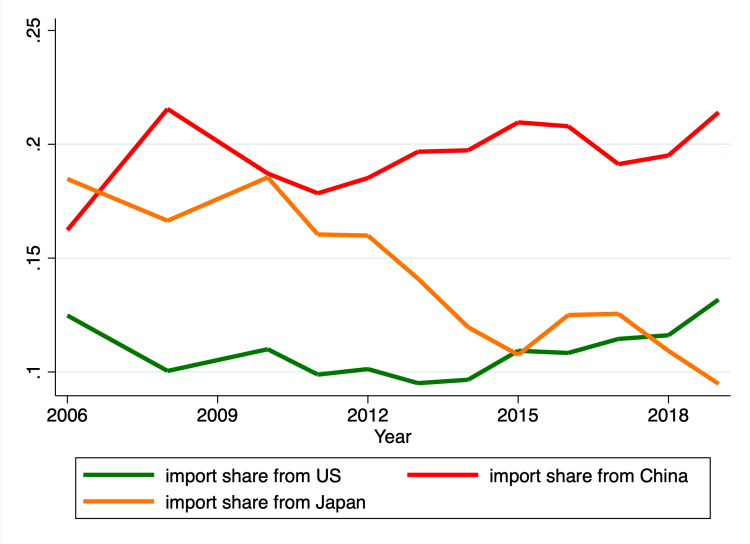


(b) Customs Sample Data

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

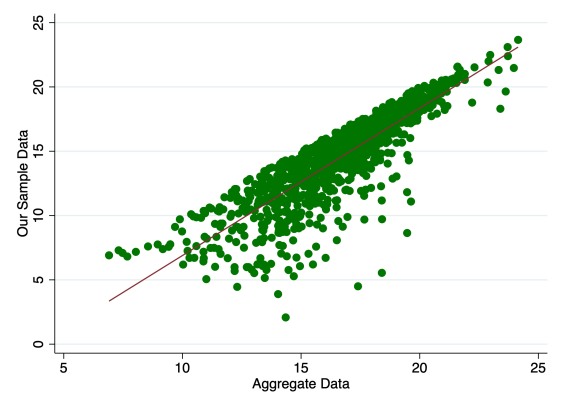


(a) Official Data

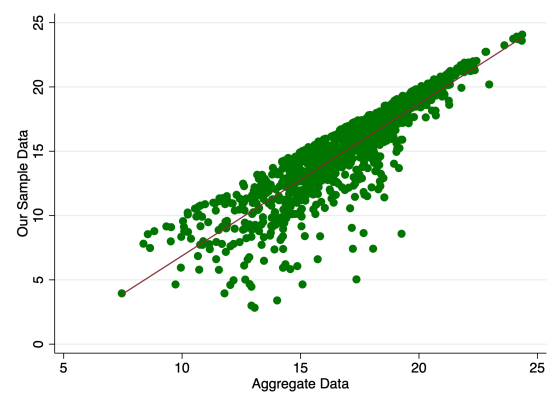


(b) Customs Sample Data

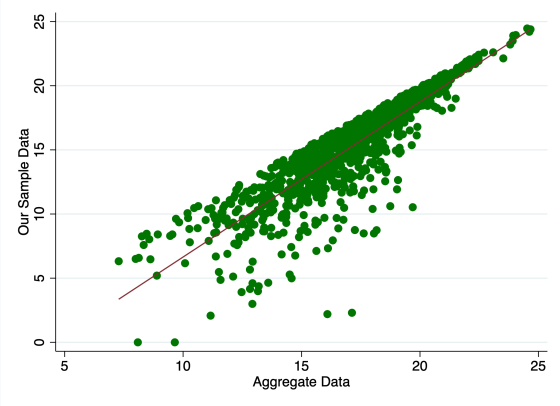
Figure B.4: Korean Export Product Level Comparison by Year: Official vs Our Sample



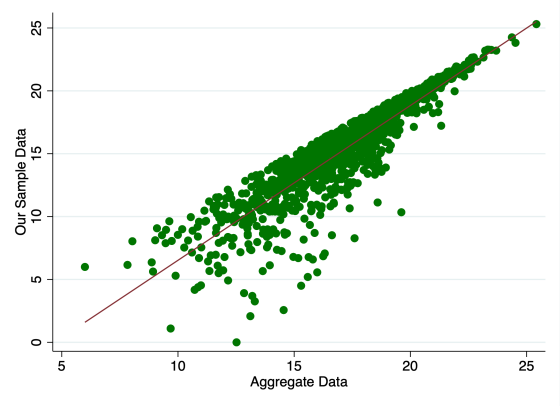
(a) 2006



(b) 2010

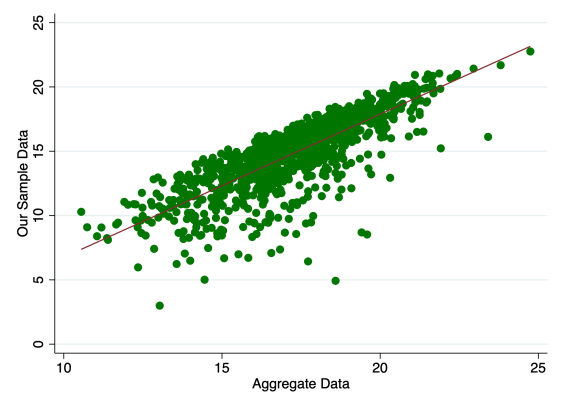


(c) 2014

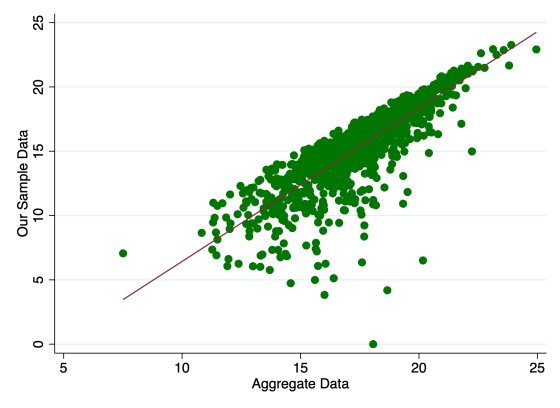


(d) 2018

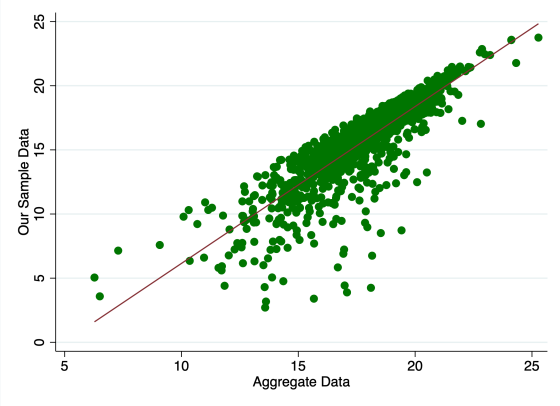
Figure B.5: Korean Import Product Level Comparison by Year: Official vs Our Sample



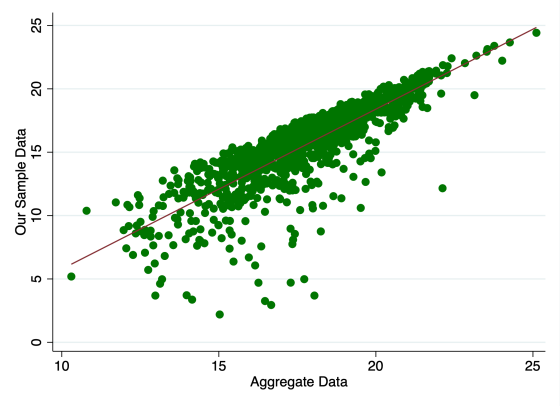
(a) 2006



(b) 2010



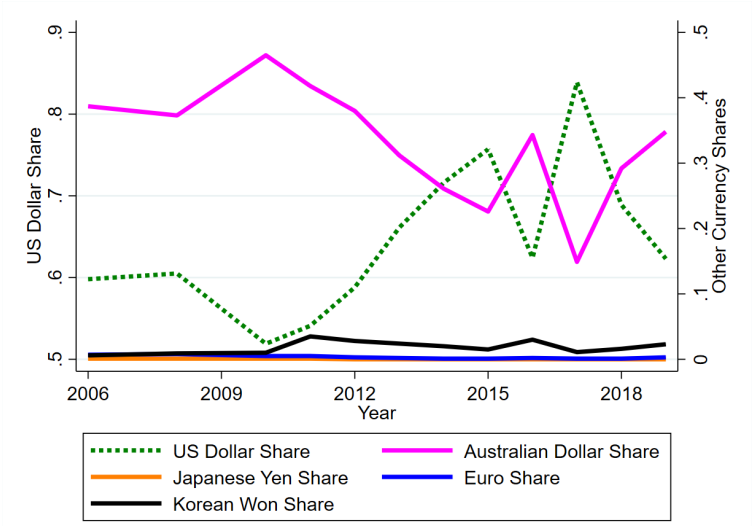
(c) 2014



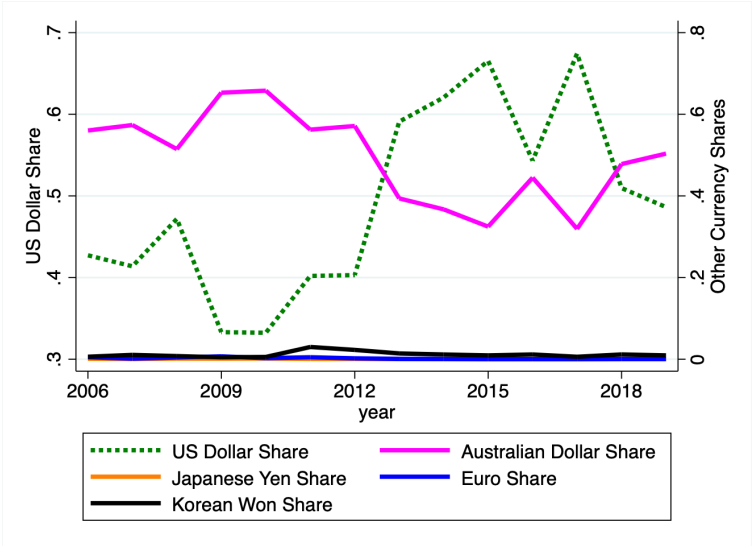
(d) 2018

C Additional Figures on Patterns of Korean Export Currency Shares

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

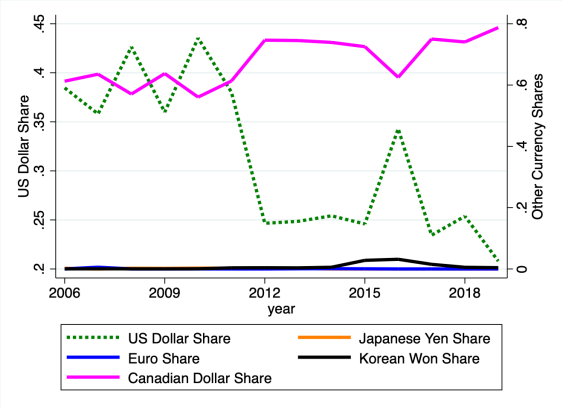


(a) Official Data

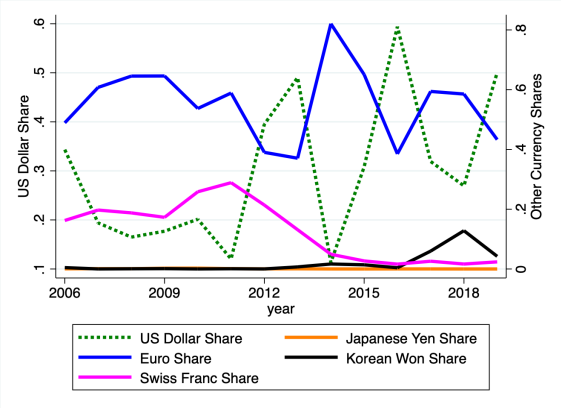


(b) Customs Sample Data

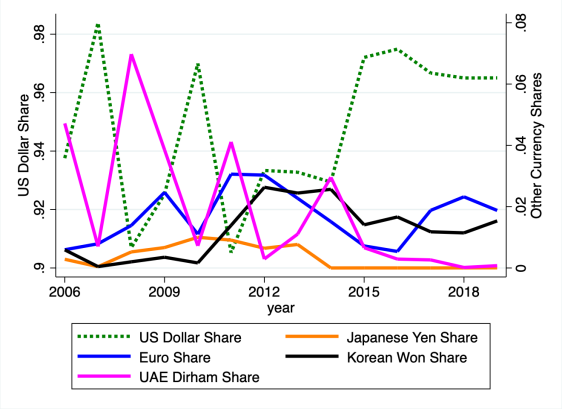
Figure C.2: Currency Shares in Korean Export to Other Destinations with Swap Lines: Customs Sample Data



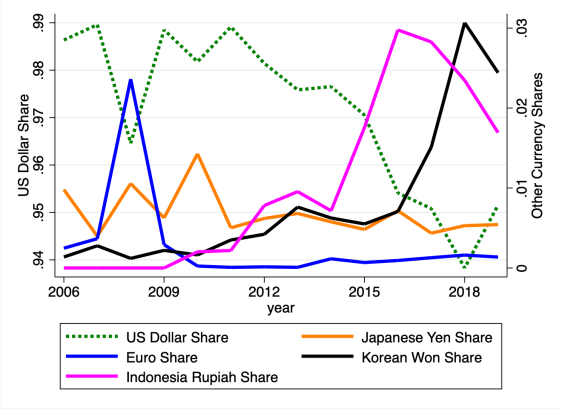
(a) Export to Canada



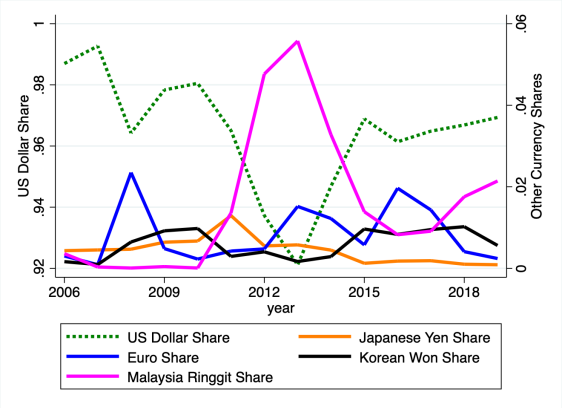
(b) Export to Switzerland



(c) Export to UAE



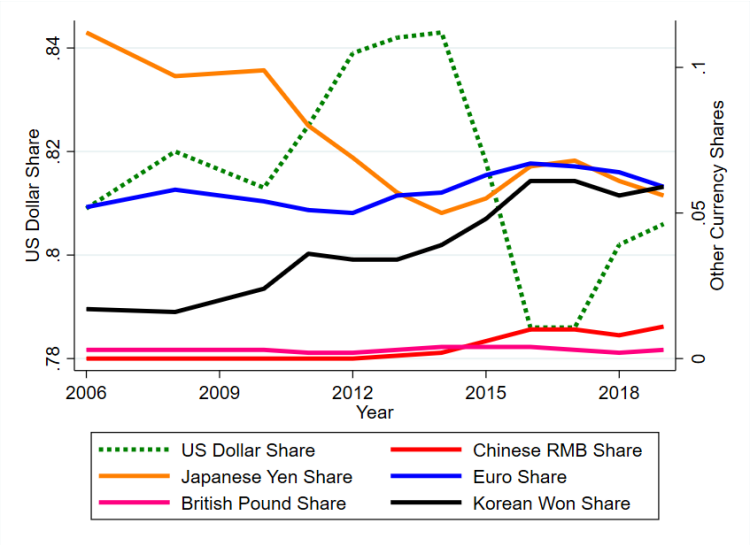
(d) Export to Indonesia



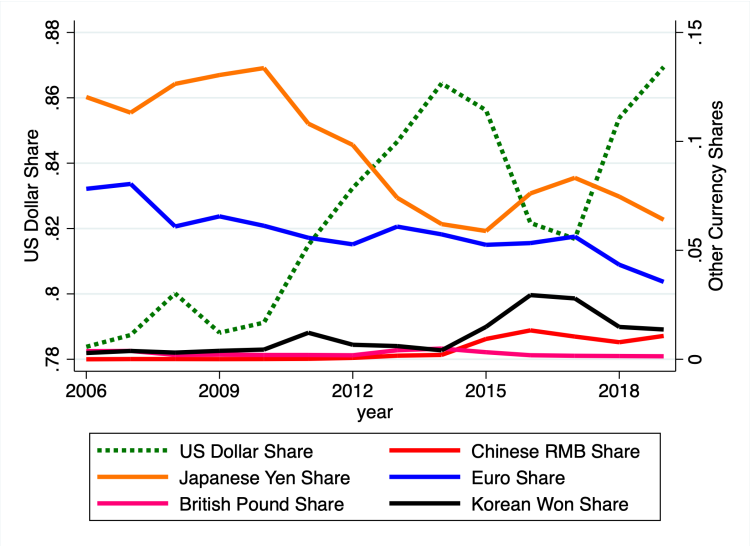
(e) Export to Malaysia

D Patterns of Korean Import Invoicing Currency Shares

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

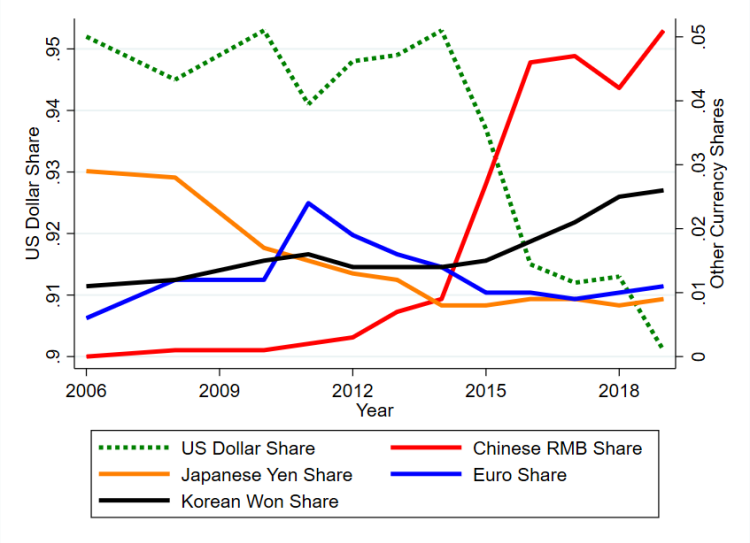


(a) Official Data

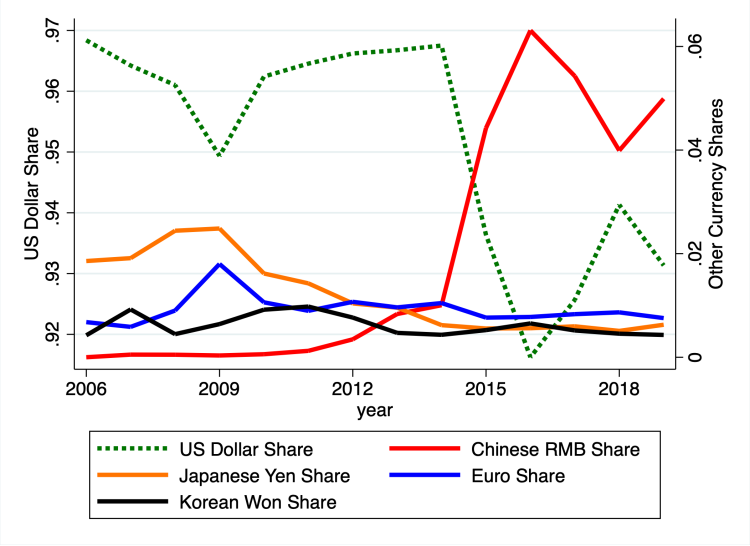


(b) Customs Sample Data

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

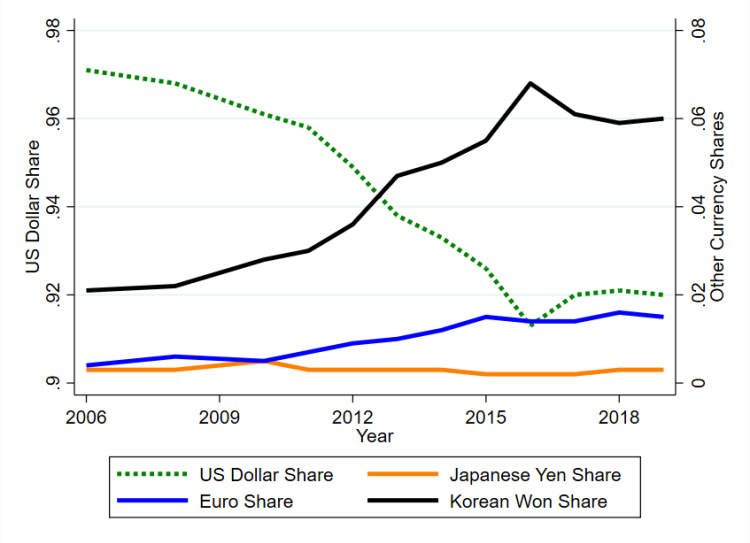


(a) Official Data

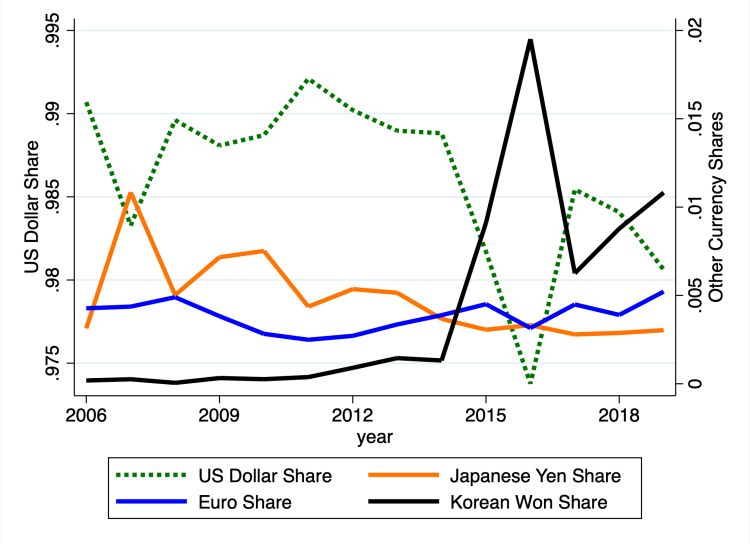


(b) Customs Sample Data

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

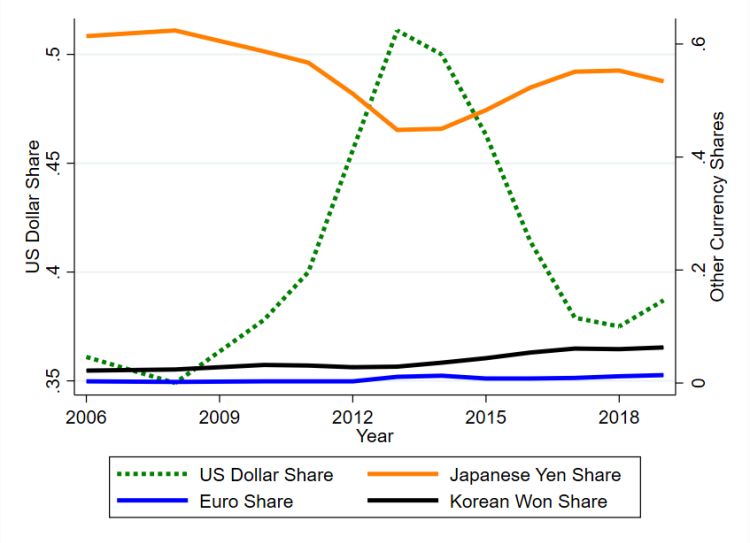


(a) Official Data

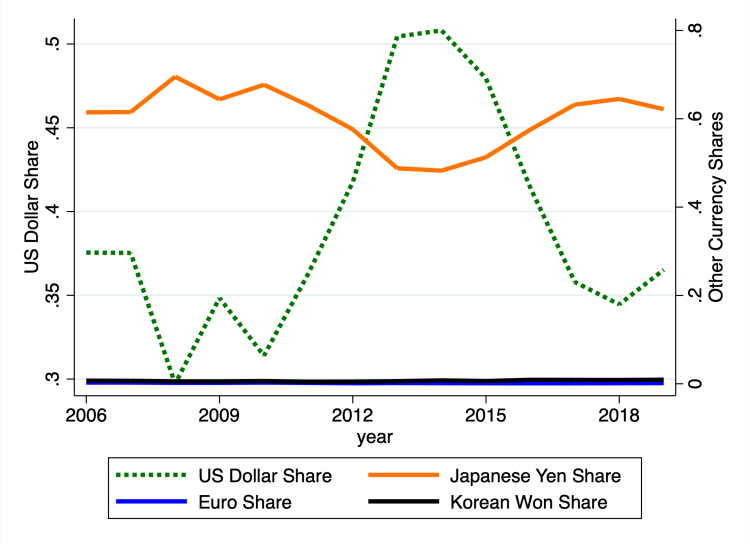


(b) Customs Sample Data

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

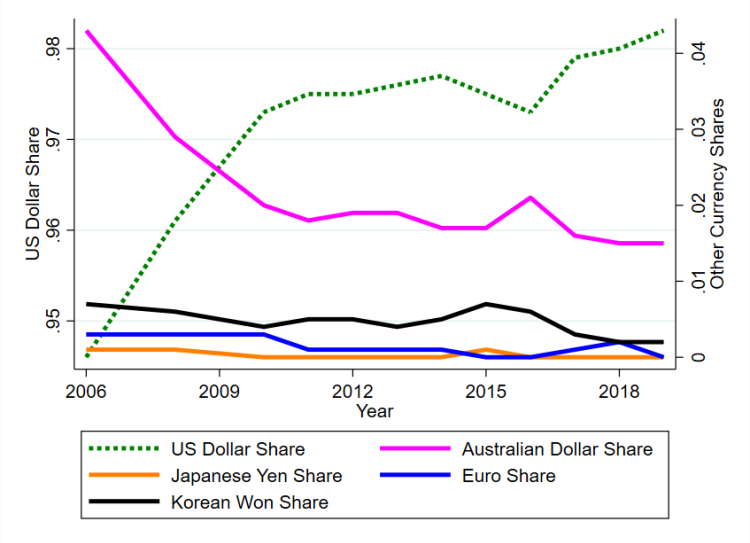


(a) Official Data

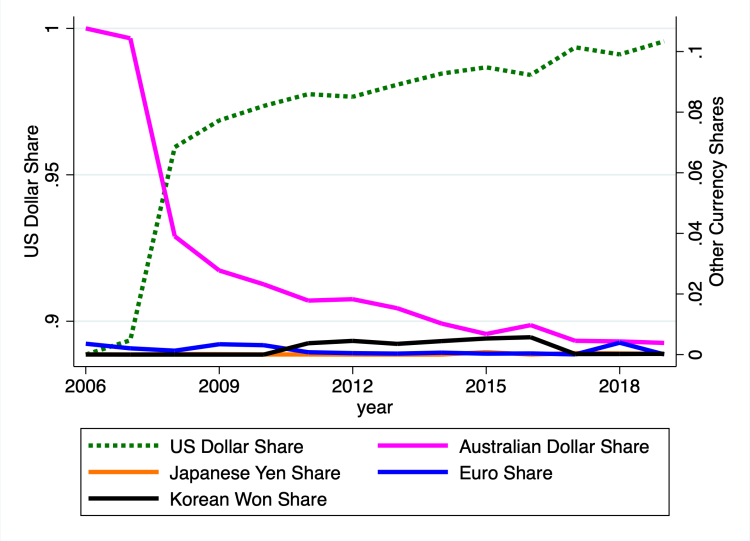


(b) Customs Sample Data

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

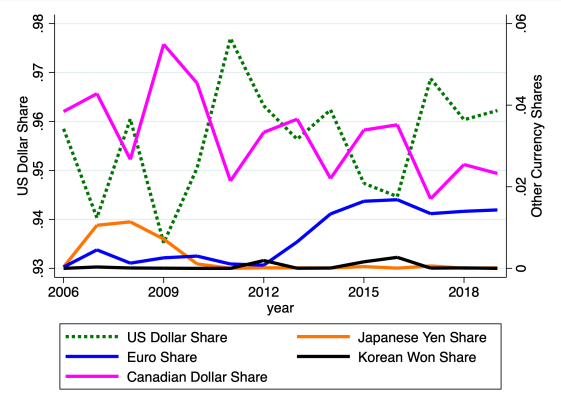


(a) Official Data

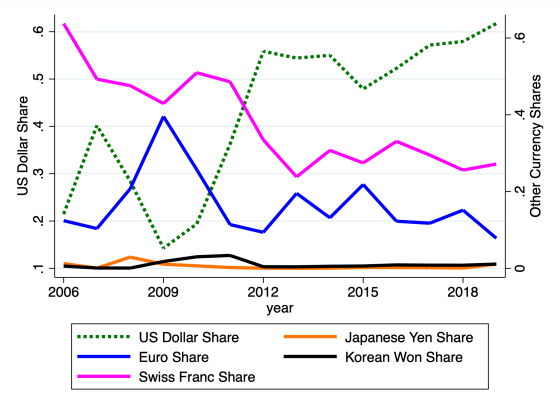


(b) Customs Sample Data

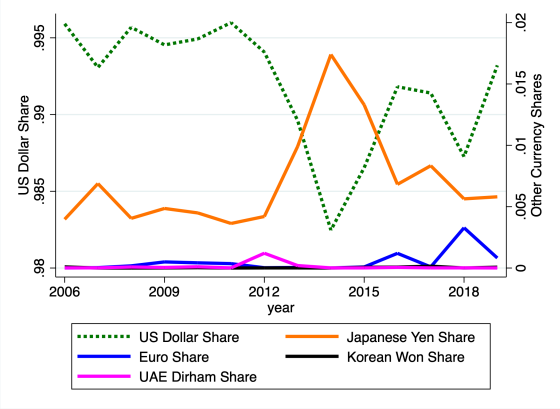
Figure D.6: Currency Shares in Korean Import from Other Destinations with Swap Lines: Customs Sample Data



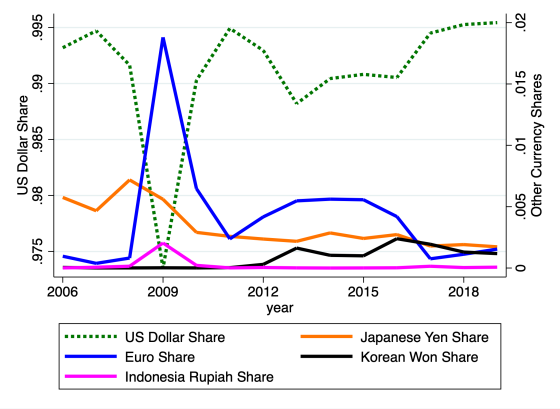
(a) Import from Canada



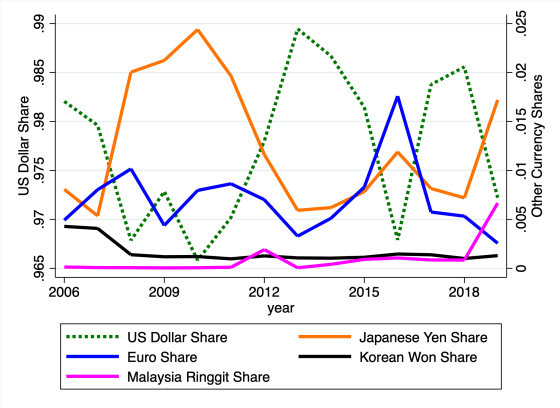
(b) Import from Switzerland



(c) Import from UAE



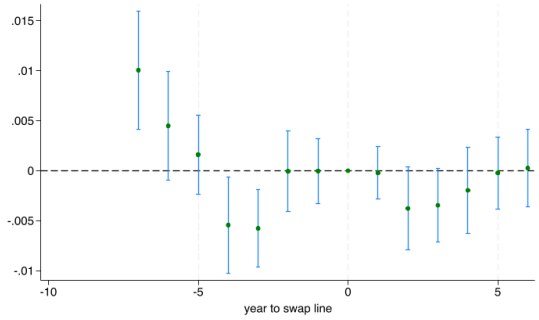
(d) Import from Indonesia



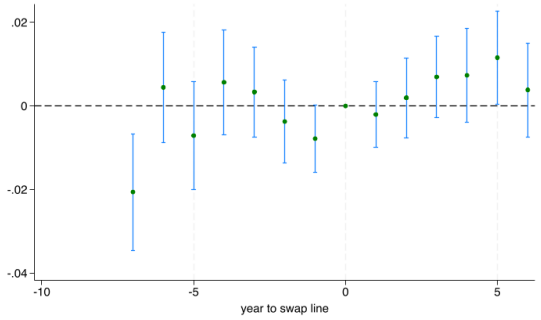
(e) Import from Malaysia

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

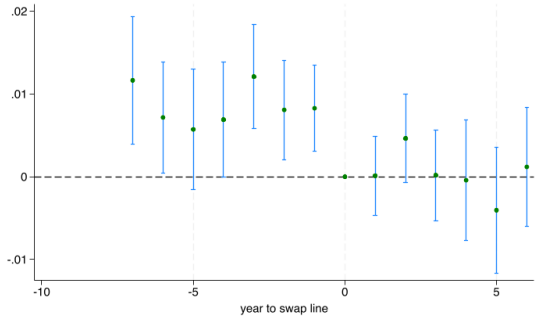
Figure E.1: Firm Level Currency Shares in Korean Export to Malaysia: No Controls



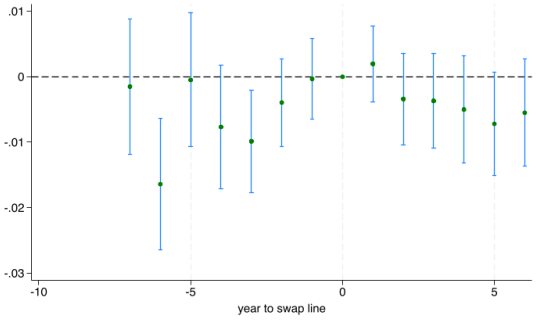
(a) Malaysia Ringgit Share



(b) US Dollar Share



(c) Korean Won Share



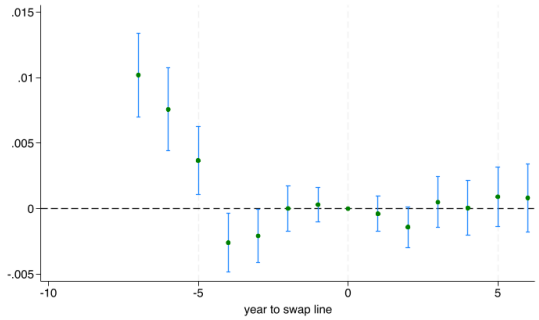
(d) Other Currencies' Share

F The Extensive Margins of Export Invoicing

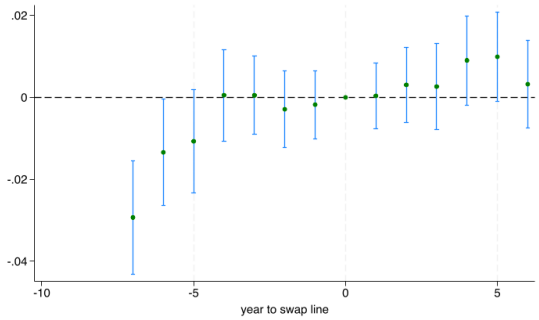
Figure F.1 illustrates the export invoicing currency use in the extensive margin. We compute the fraction of firms in each year that use certain currencies (as long as non-zero use) when they export to China or Japan, respectively. So the sum of the fractions in each panel is larger than 1. They show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

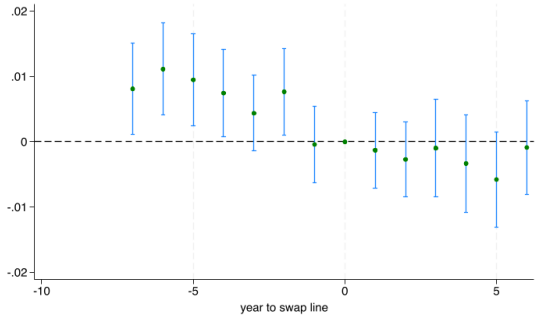
Figure E.2: Firm Level Currency Shares in Korean Export to Indonesia: No Controls



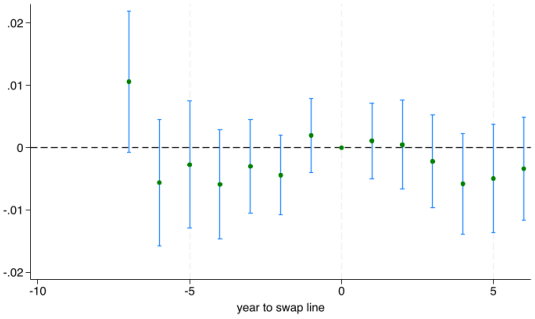
(a) Indonesia Rupiah Share



(b) US Dollar Share

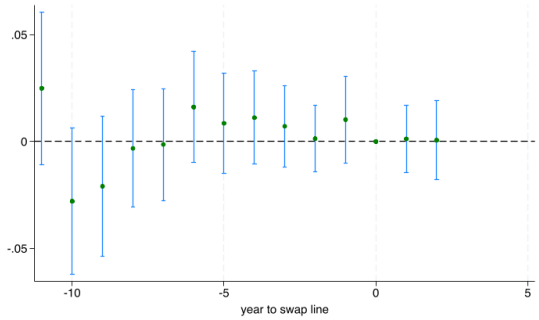


(c) Korean Won Share

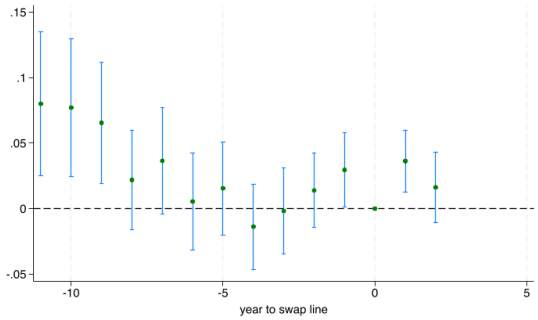


(d) Other Currencies' Share

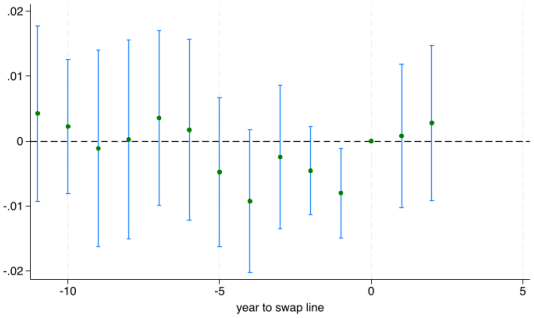
Figure E.3: Firm Level Currency Shares in Korean Export to Switzerland: No Controls



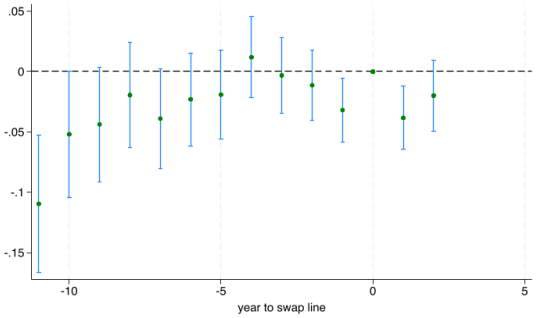
(a) Swiss Franc Share



(b) US Dollar Share

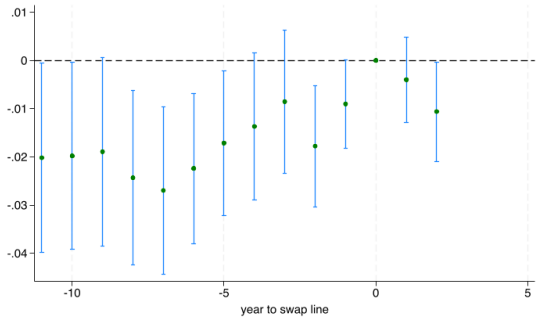


(c) Korean Won Share

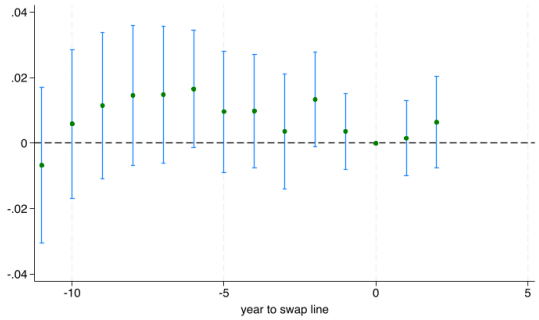


(d) Other Currencies' Share

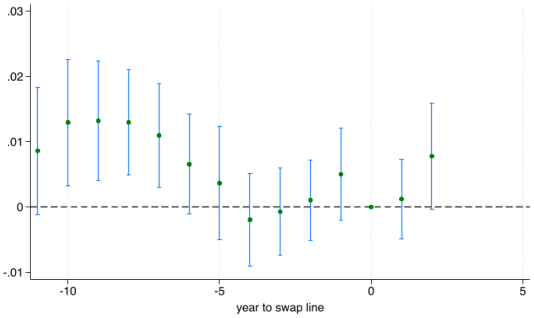
Figure E.4: Firm Level Currency Shares in Korean Export to Canada: No Controls



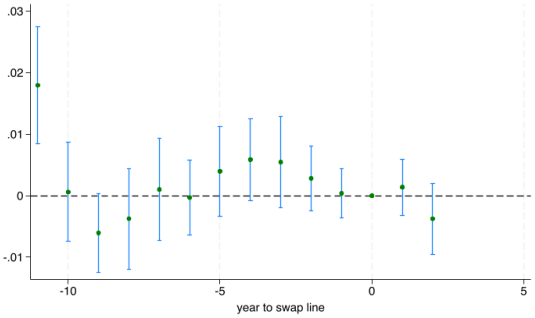
(a) Canadian Dollar Share



(b) US Dollar Share

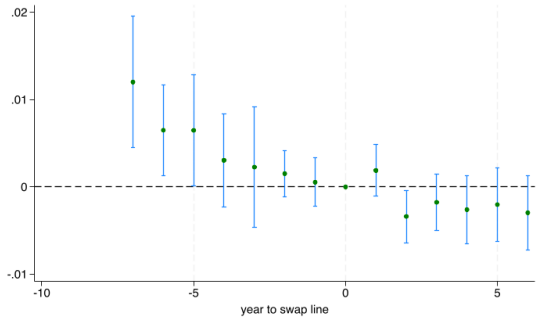


(c) Korean Won Share

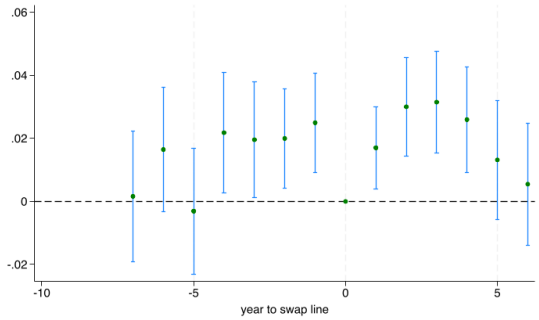


(d) Other Currencies' Share

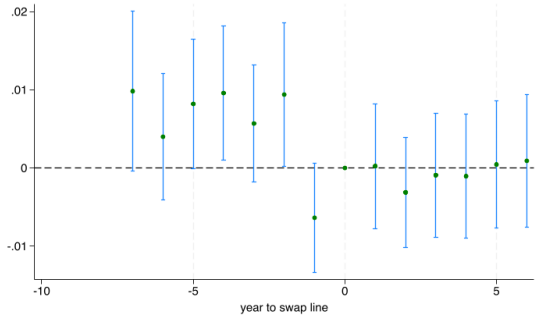
Figure E.5: Firm Level Currency Shares in Korean Export to UAE: No Controls



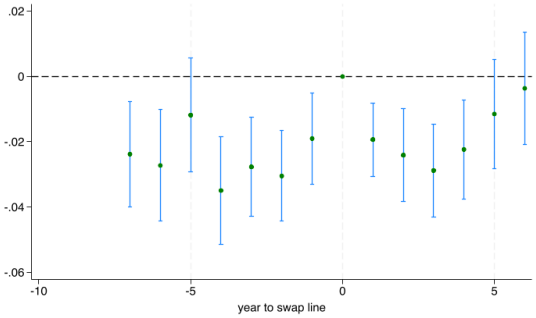
(a) Emirati Dirham Share



(b) US Dollar Share

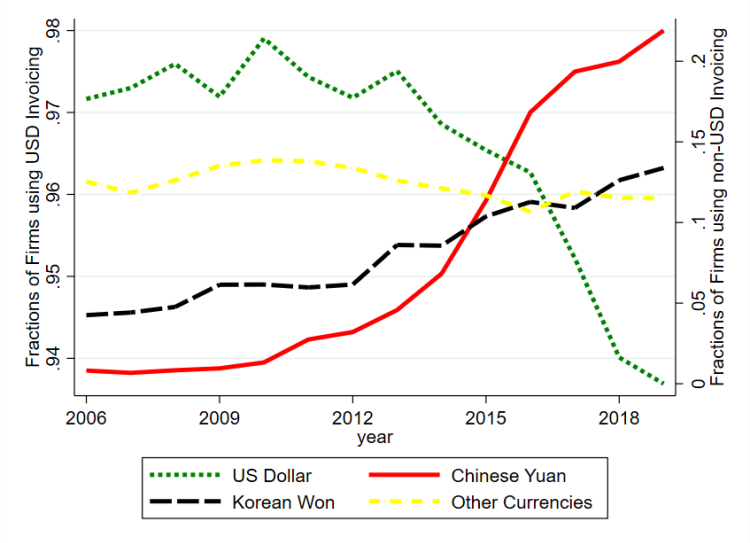


(c) Korean Won Share

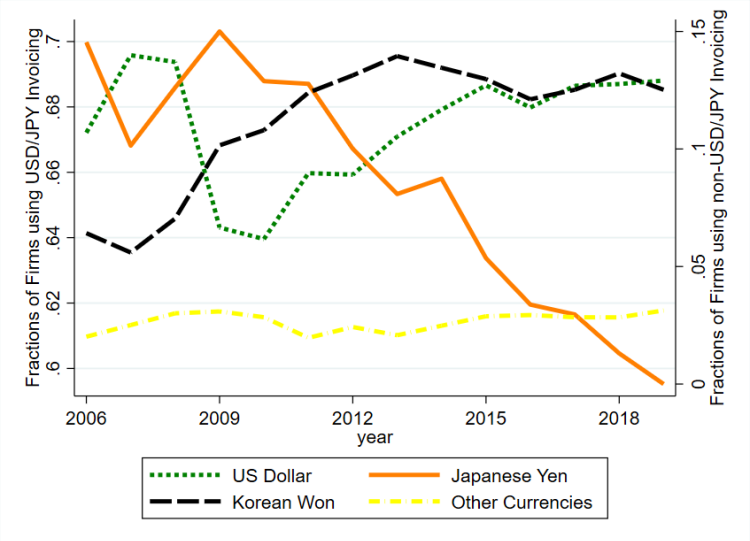


(d) Other Currencies' Share

Figure F.1: 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.

(1) by a dummy variable denoting whether a firm uses currency o or not. Formally,

$$exdummy^o_{fjt} = \alpha^o_{fj} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline_event_{jt} = \tau) + \epsilon^o_{fjt} \tag{F.1}$$

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 F.2, F.3 and F.4 graphically show the regression results for China, Japan and Australia. In Figure F.2, 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 F.3 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 F.4.

G 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

$$exsh^o_{fjpt} = \alpha^o_{fjp} + \delta^o_t + \sum_{j,\tau\neq 0} \beta^o_{j\tau} I(swapline_event_{jt} = \tau) + \epsilon^o_{fjpt} \tag{G.1}$$

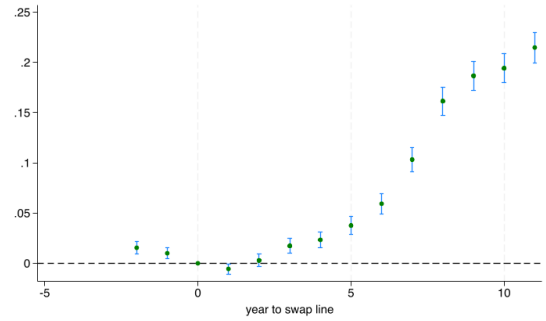
where $exsh^o_{fjpt}$ denotes the share of firm f export to destination j of product p settled in currency o,

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

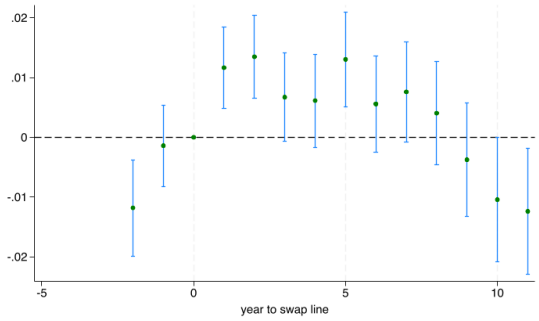
Here $exvalue_{fjpt}$ is the US dollar value of firm f export to destination j of product p and $exvalue^o_{fjpt}$ is the US dollar value of firm f export to destination j of product p settled in currency o. α_{fjp} is firm-product-country fixed effect and δ_t is year fixed effect. The coefficients of 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 G.1 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

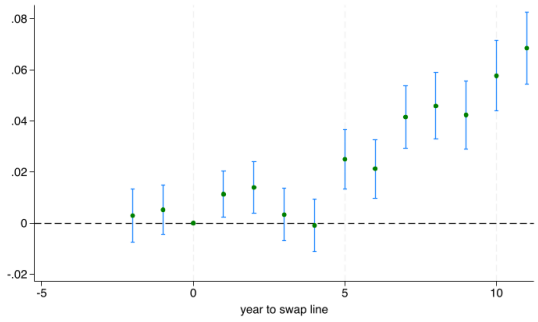
Figure F.2: The Extensive Margin of Currency Shares in Korean Export to China: No Controls



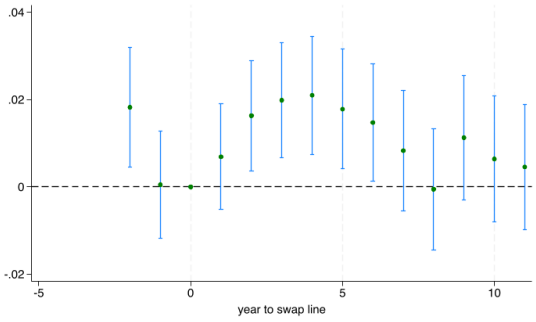
(a) Chinese Yuan Share



(b) US Dollar Share



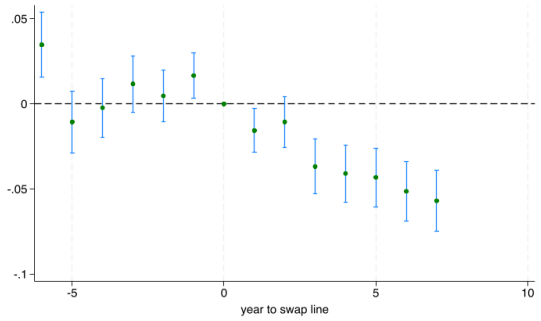
(c) Korean Won Share



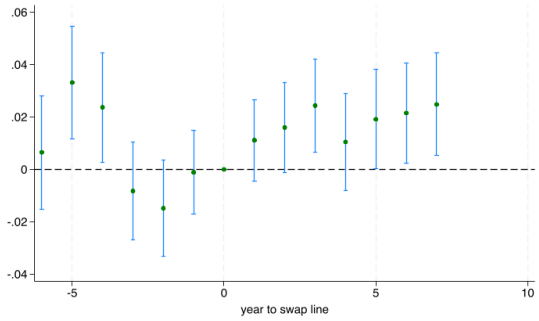
(d) Other Currencies' Share

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.

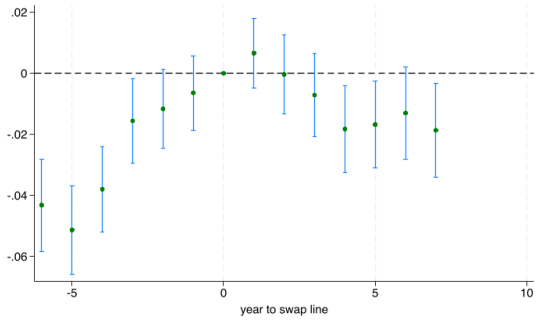
Figure F.3: The Extensive Margin of Currency Shares in Korean Export to Japan: No Controls



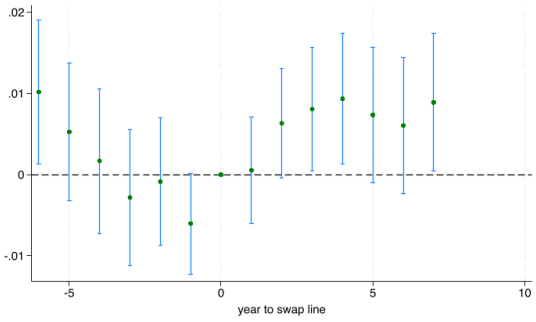
(a) Japanese Yen Share



(b) US Dollar Share



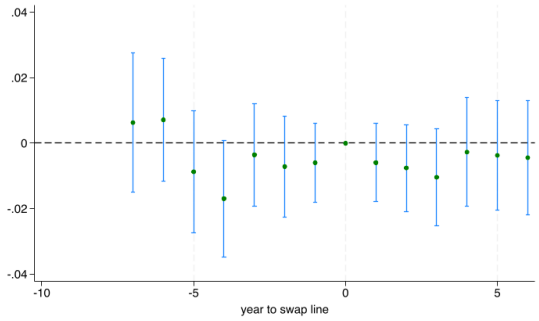
(c) Korean Won Share



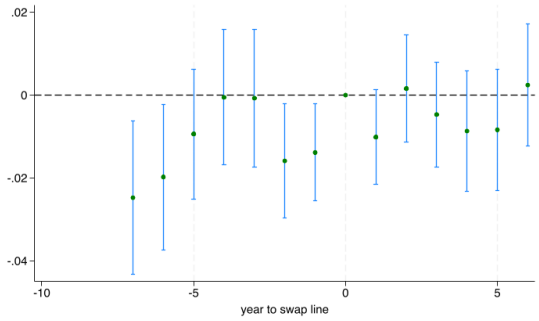
(d) Other Currencies' Share

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.

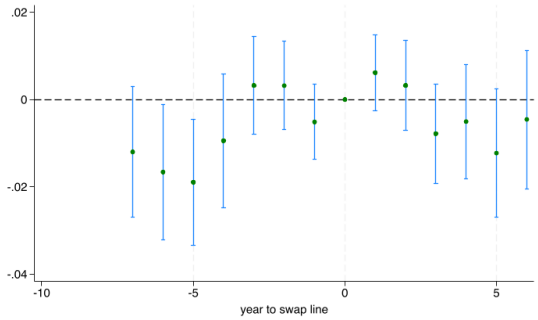
Figure F.4: The Extensive Margin of Currency Shares in Korean Export to Australia: No Controls



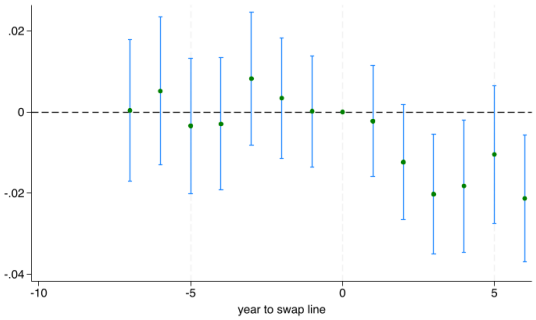
(a) Australian Dollar Share



(b) US Dollar Share



(c) Korean Won Share



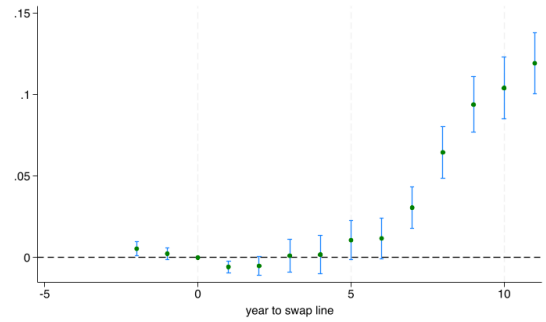
(d) Other Currencies' Share

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.

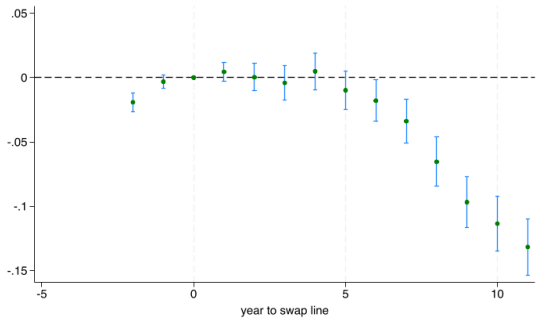
out. However, Korean won and other currencies are barely affected, as illustrated in panels (c) and (d). Overall, Chinese RMB substitutes US dollar since the swap line.

Figure G.2 shows the estimated coefficients for the discontinuation of local currency swap line with Japan. In panel (a), the estimated β^o shows a decline after the disruption of the local currency swap line with Japan. On the contrary, panel (b) shows that US dollar is crowded in. However, Korean won and other currencies are barely affected, as illustrated in panels (c) and (d). Overall, US dollar substitutes Japanese yen after the expiration of the swap line.

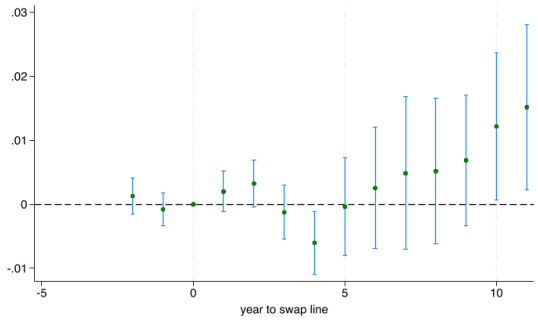
Figure G.1: Firm-Product Level Currency Shares in Korean Export to China: No Controls



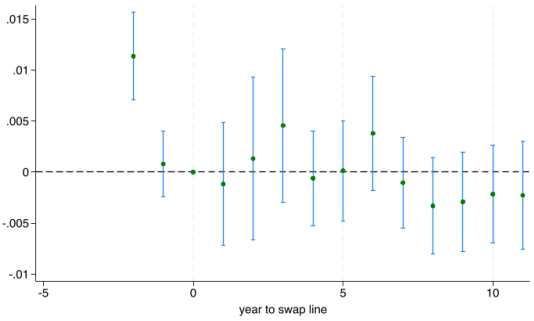
(a) Chinese RMB Share



(b) US Dollar Share



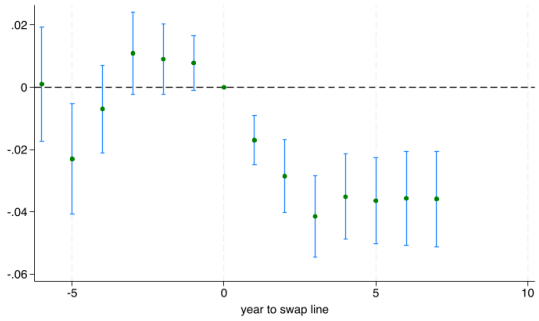
(c) Korean Won Share



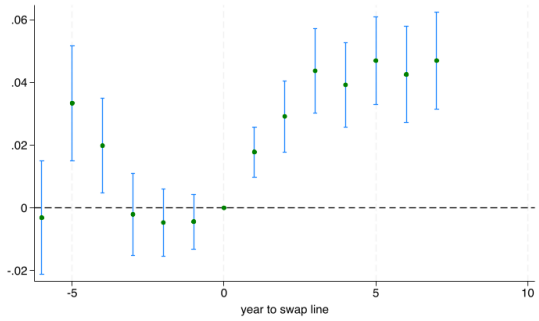
(d) Other Currencies' Share

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.

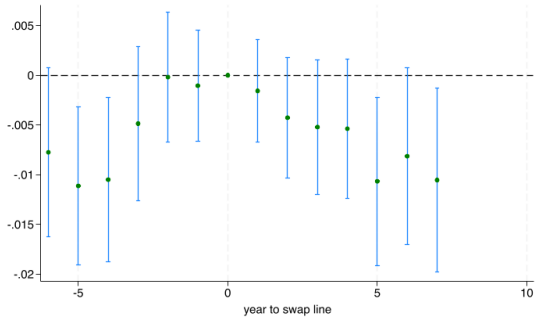
Figure G.2: Firm-Product Level Currency Shares in Korean Export to Japan: No Controls



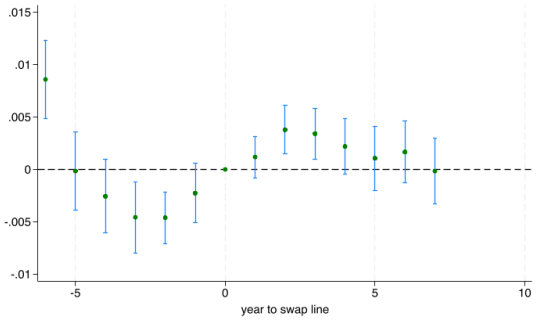
(a) Japanese Yen Share



(b) US Dollar Share



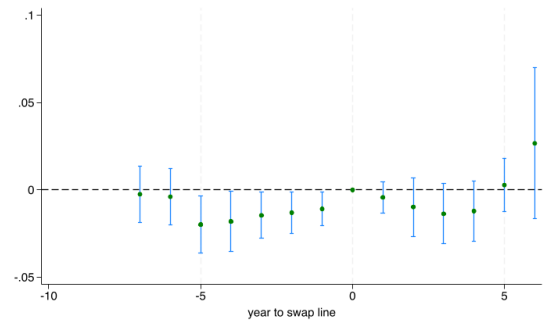
(c) Korean Won Share



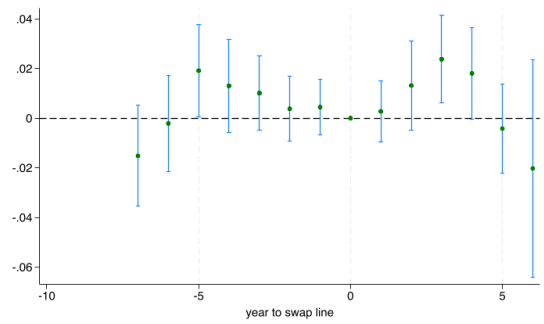
(d) Other Currencies' Share

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.

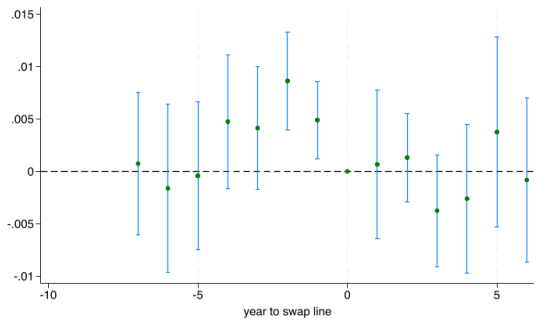
Figure G.3: Firm-Product Level Currency Shares in Korean Export to Australia: No Controls



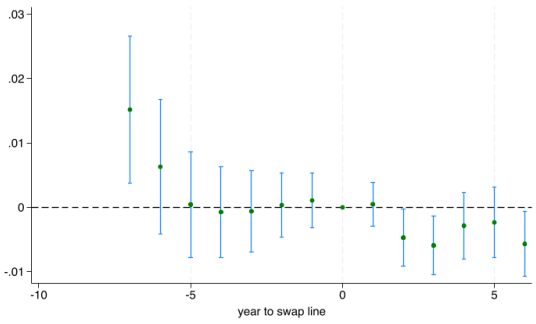
(a) Australian Dollar Share



(b) US Dollar Share



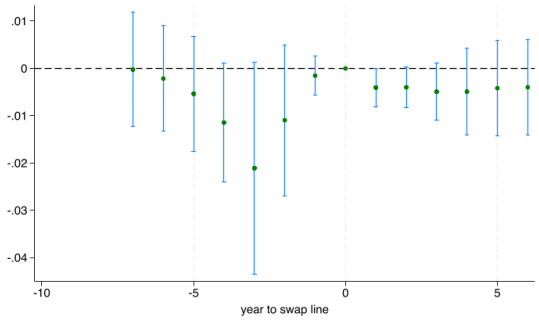
(c) Korean Won Share



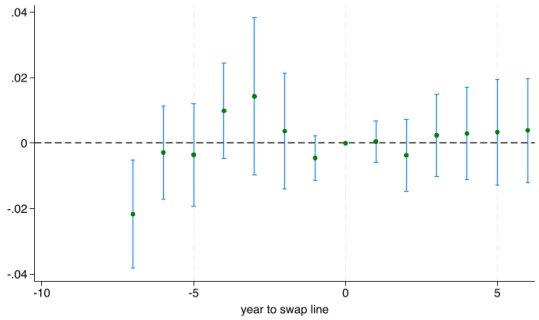
(d) Other Currencies' Share

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.

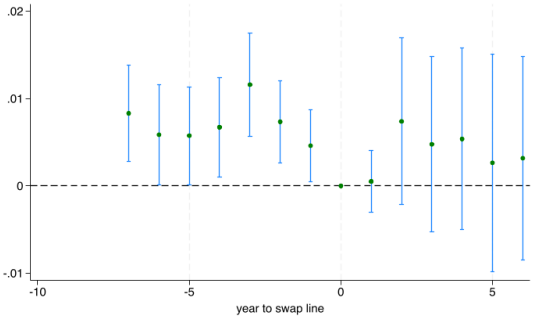
Figure G.4: Firm-Product Level Currency Shares in Korean Export to Malaysia: No Controls



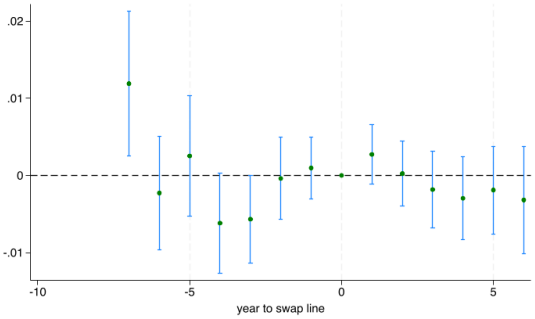
(a) Malaysia Ringgit Share



(b) US Dollar Share

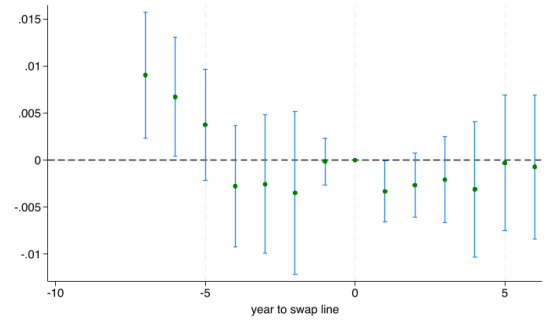


(c) Korean Won Share

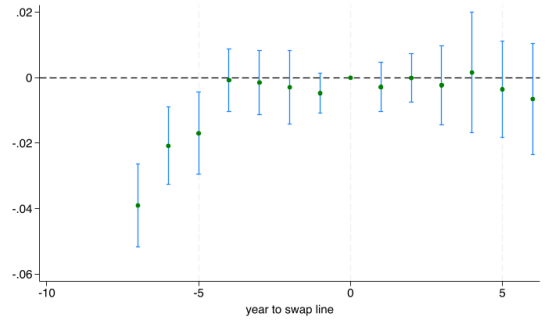


(d) Other Currencies' Share

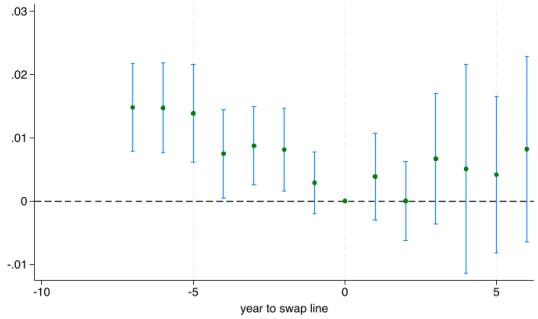
Figure G.5: Firm-Product Level Currency Shares in Korean Export to Indonesia: No Controls



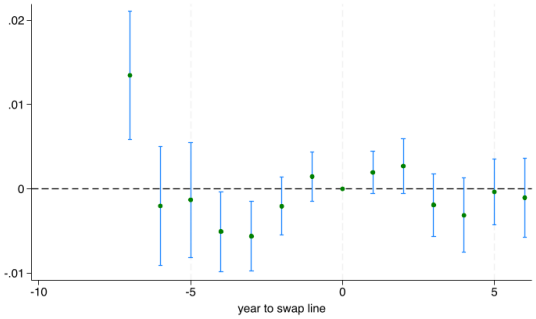
(a) Indonesia Rupiah Share



(b) US Dollar Share

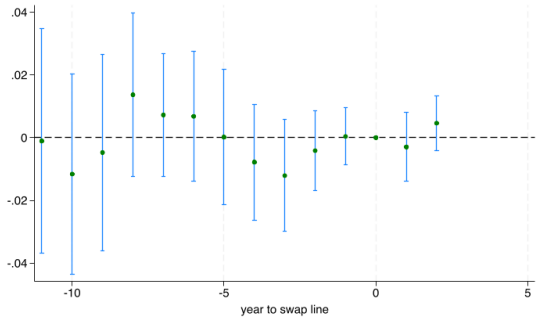


(c) Korean Won Share

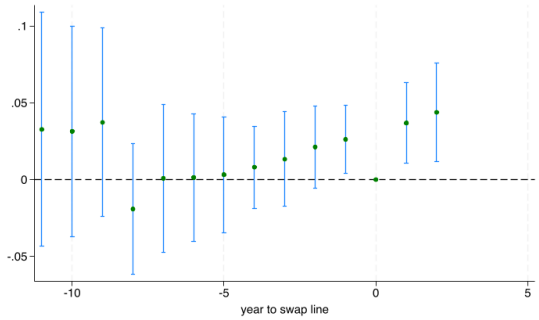


(d) Other Currencies' Share

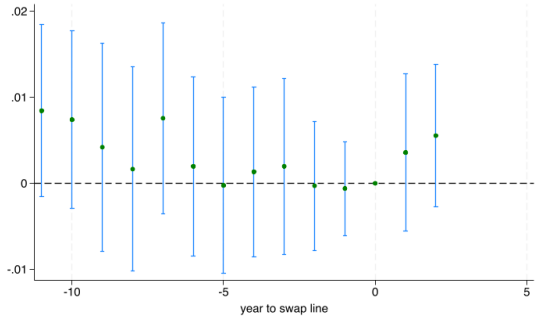
Figure G.6: Firm-Product Level Currency Shares in Korean Export to Switzerland: No Controls



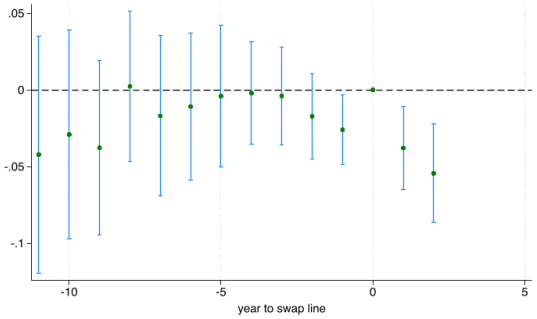
(a) Swiss Franc Share



(b) US Dollar Share

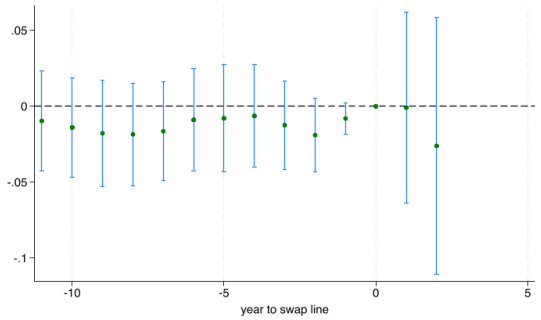


(c) Korean Won Share

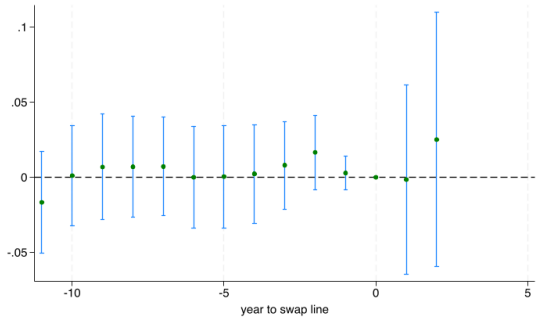


(d) Other Currencies' Share

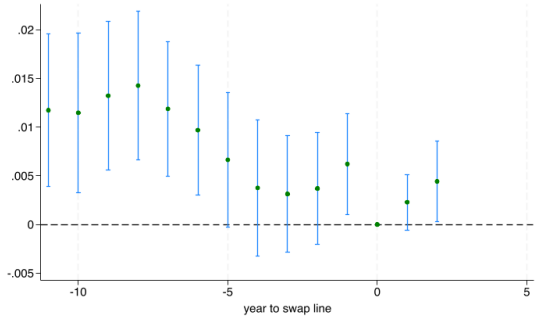
Figure G.7: Firm-Product Level Currency Shares in Korean Export to Canada: No Controls



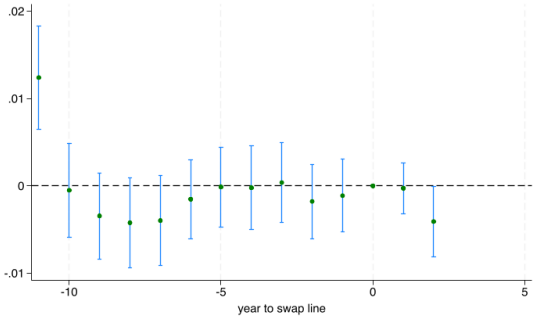
(a) Canadian Dollar Share



(b) US Dollar Share

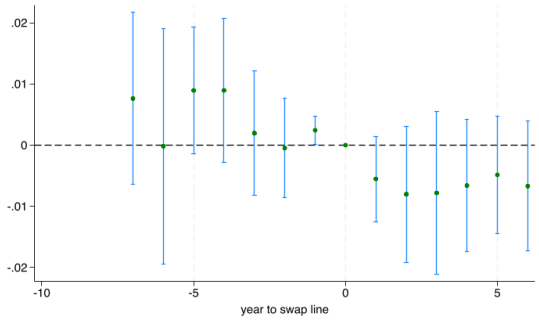


(c) Korean Won Share

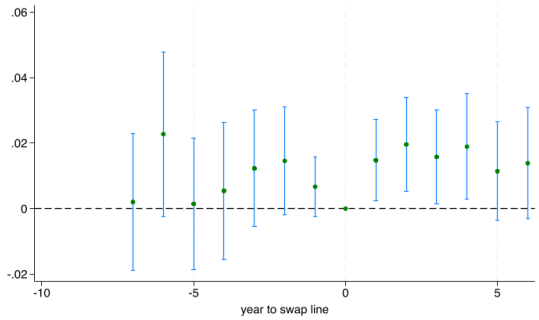


(d) Other Currencies' Share

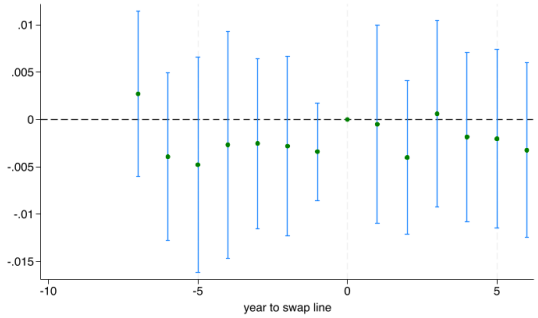
Figure G.8: Firm-Product Level Currency Shares in Korean Export to UAE: No Controls



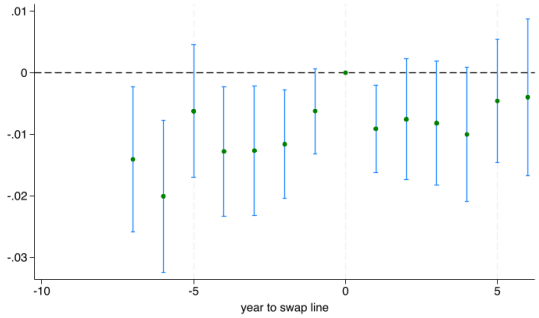
(a) Emirati Dirham Share



(b) US Dollar Share



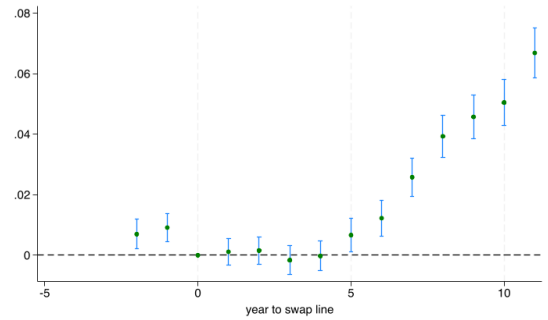
(c) Korean Won Share



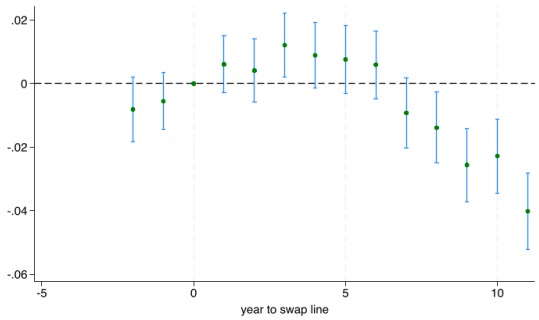
(d) Other Currencies' Share

H Import Invoicing Currency and Central Bank Swap Lines

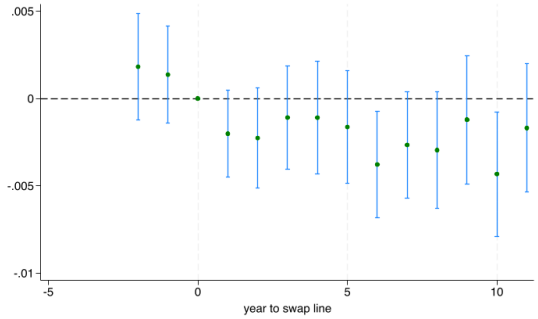
Figure H.1: Firm Level Currency Shares in Korean Import from China: No Controls



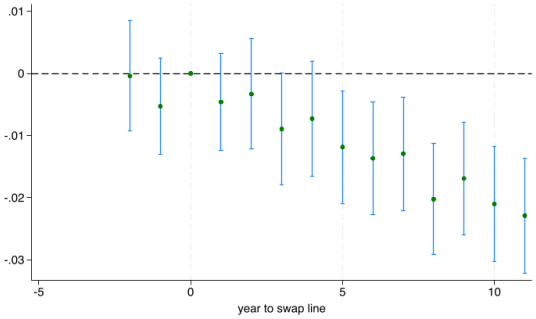
(a) Chinese RMB Share



(b) US Dollar Share

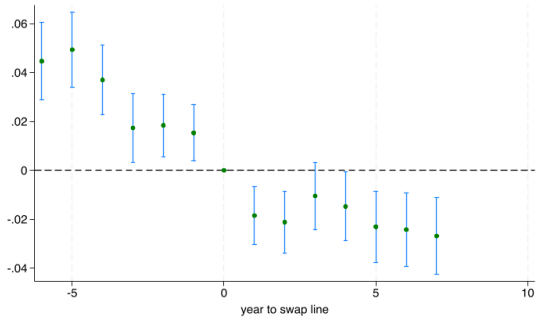


(c) Korean Won Share

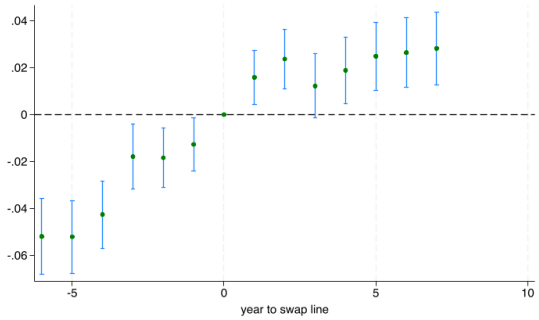


(d) Other Currencies' Share

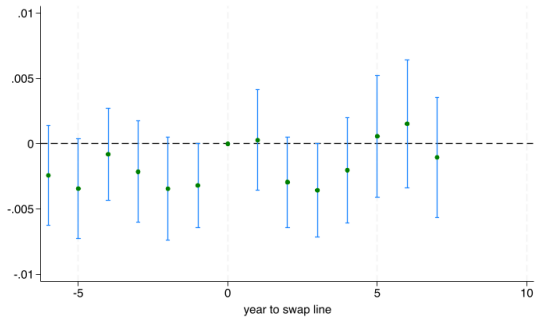
Figure H.2: Firm Level Currency Shares in Korean Import from Japan: No Controls



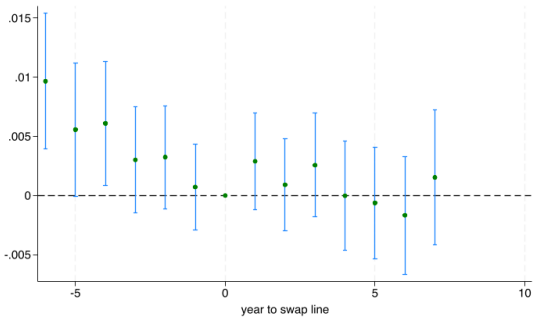
(a) Japanese Yen Share



(b) US Dollar Share

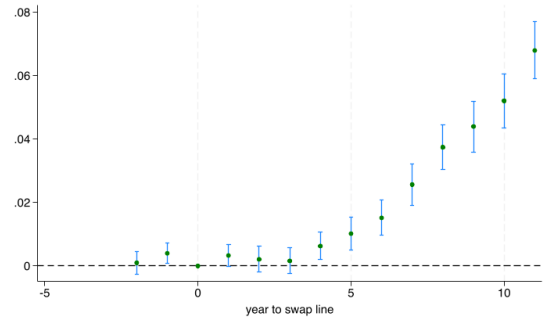


(c) Korean Won Share

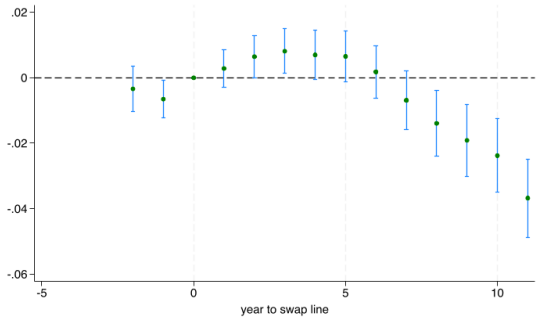


(d) Other Currencies' Share

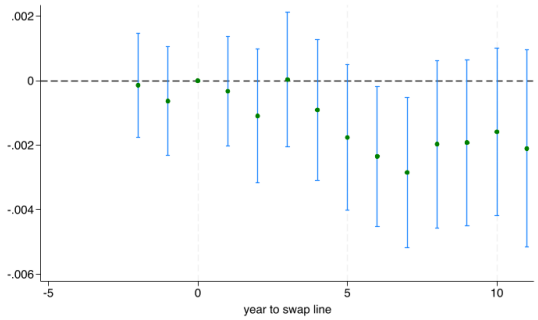
Figure H.3: Firm-Product Level Currency Shares in Korean Import from China: No Controls



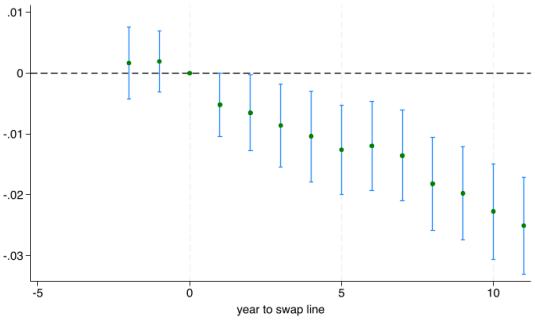
(a) Chinese RMB Share



(b) US Dollar Share

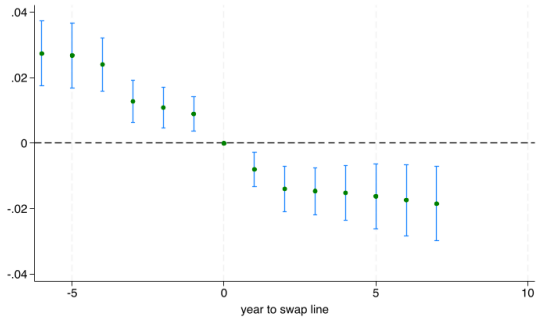


(c) Korean Won Share

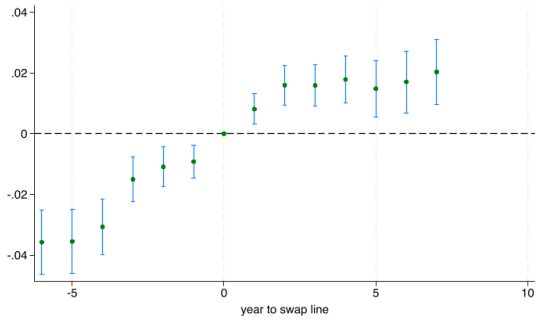


(d) Other Currencies' Share

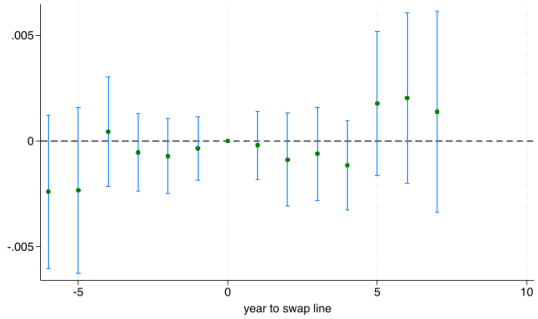
Figure H.4: Firm-Product Level Currency Shares in Korean Import from Japan: No Controls



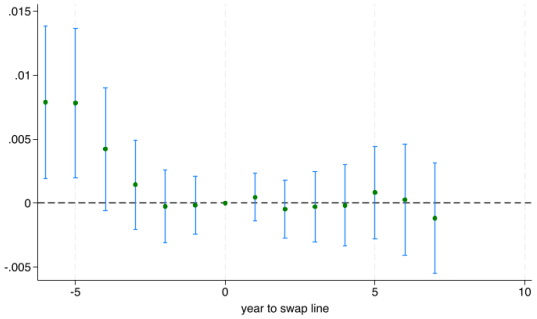
(a) Japanese Yen Share



(b) US Dollar Share



(c) Korean Won Share



(d) Other Currencies' Share

I Firm's Profit Maximization

Using equations (7) and (8), 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

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

After consolidating the parameters, consider a simple problem

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

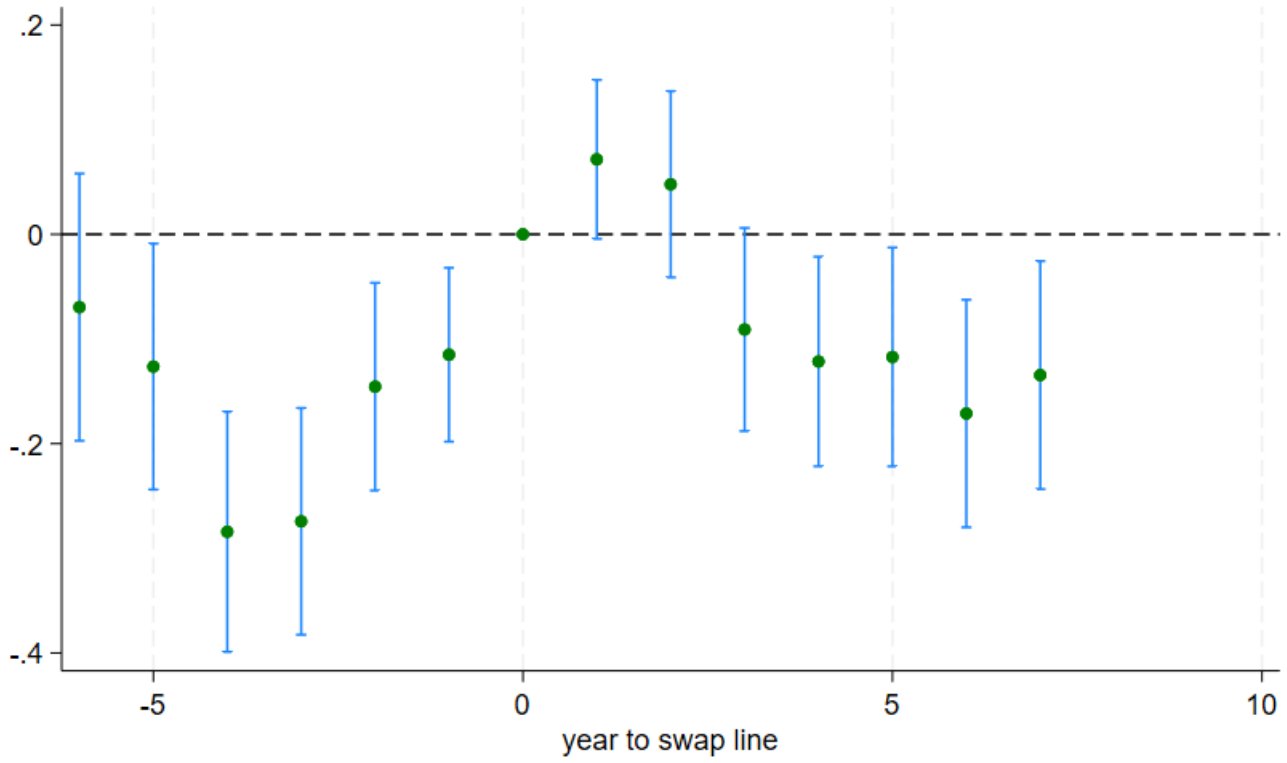
The solution to this problem is

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

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

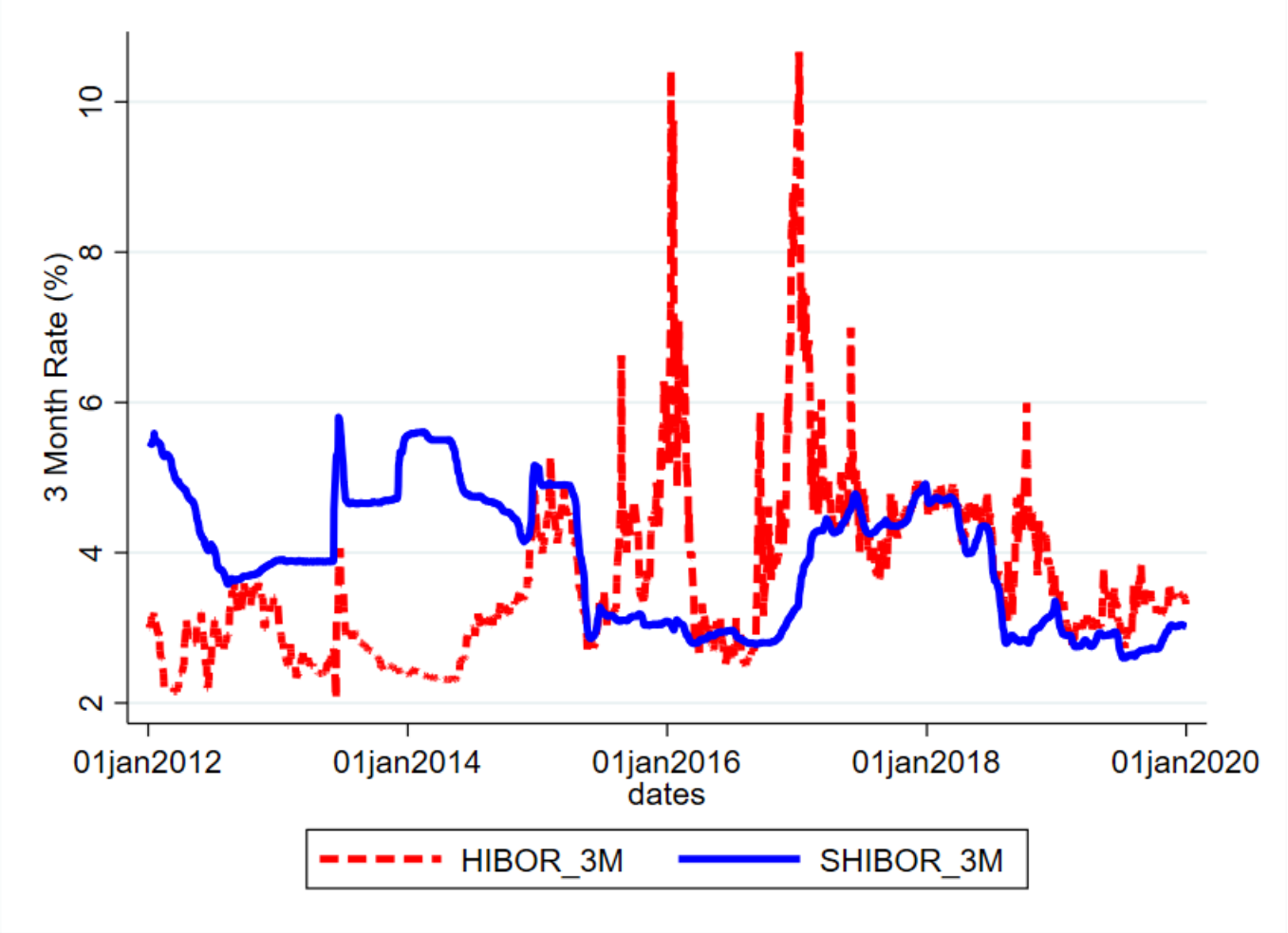
J Additional Figures and Tables

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



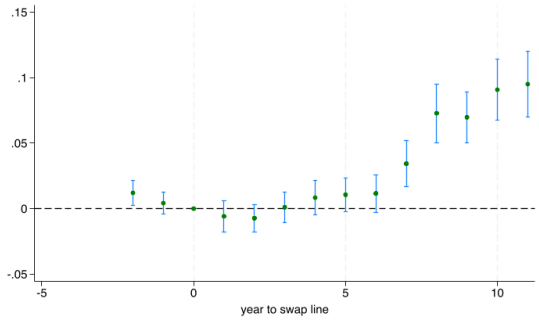
Notes: This figure shows the dynamics of Korean ln(export value) to Japan at the firm level. We substitute the dependent variable in equation 1 by $ln(exportvalue_{fjt})$ and control for log(employment), market share and destination GDP. The figure plots the estimated coefficients $\beta^{j\tau}$, where j denotes Japan. Year 0 is 2012 when Korean and Japan decide not to renew their swap lines.

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

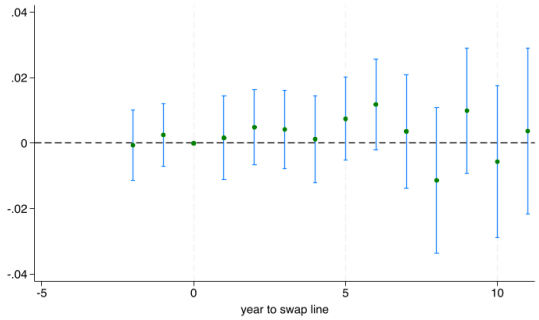


Source: https://www.chinamoney.com.cn/ and WIND Terminal

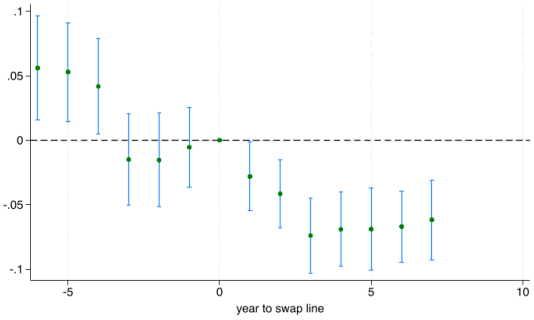
Figure J.3: Import-Export Nexus in Currency Choice for Exporters: Dropping Big Business Groups



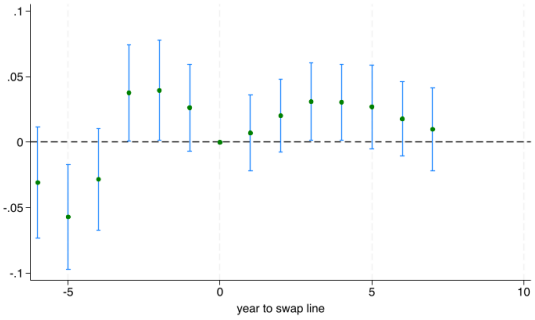
(a) RMB Share for Non-importers from China



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



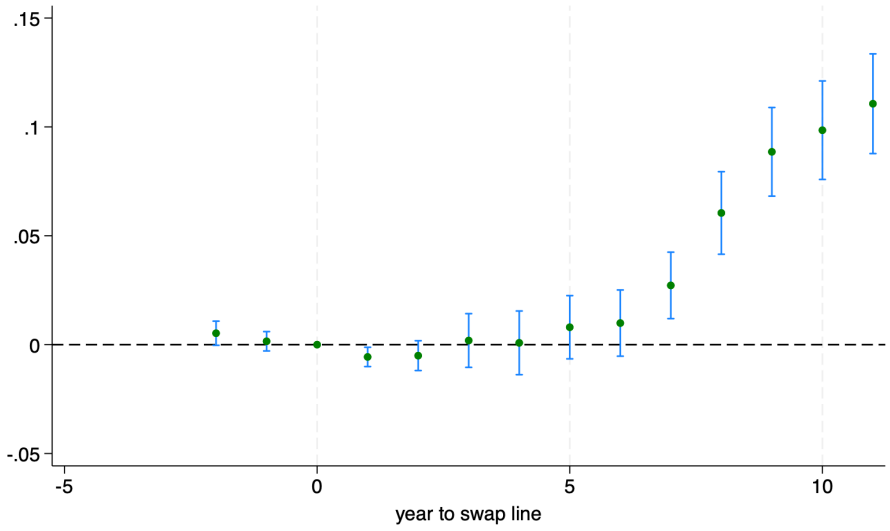
(c) Japanese Yen Share for Non-importers from Japan



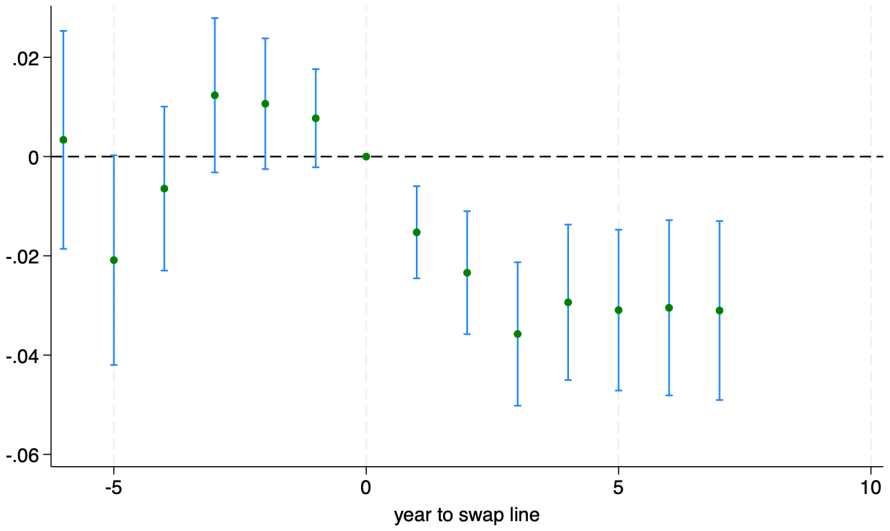
(d) Difference in Japanese Yen Share between Importers and Non-importers from Japan

Notes: This figure shows the role of import-export nexus in exporters' currency choice by dropping firms in top 10 business groups (measured by 2019 asset).

Figure J.4: The Effects of Swap Lines on Local Currency Use: Adding Controls



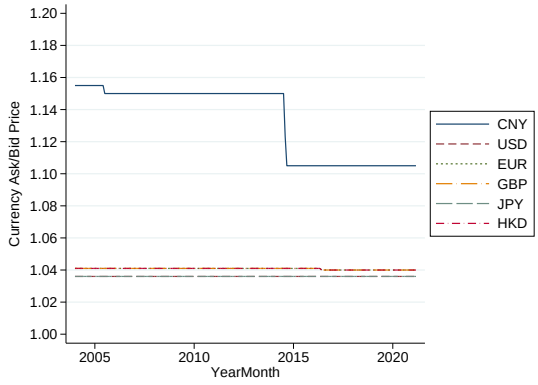
(a) RMB Share in Korean Firms' Export to China



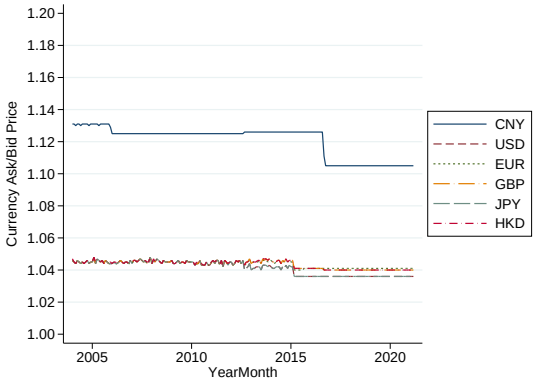
(b) Japanese Yen Share in Korean Firms' Export to Japan

Notes: This figure shows Korean firms' usage of RMB (Japanese Yen) in exports to China (Japan) after controlling for several variables. In the left subfigure, Year 0 represents 2008, the year China and South Korea signed a swap line. In the right subfigure, Year 0 represents 2012, when Japan and South Korea began allowing their swap lines to expire.

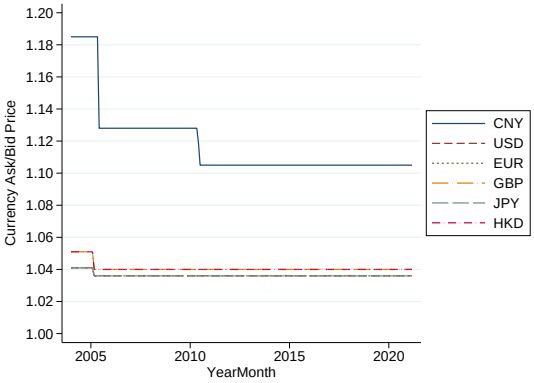
Figure J.5: The Currency Bid-Ask Spreads by Korean Banks



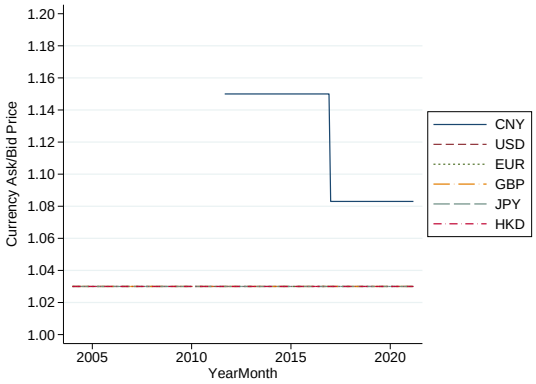
(a) Woori Bank



(b) KEB Hana Bank



(c) Shinhan Bank



(d) KDB Bank

Notes: The four subfigures report major currencies' bid-ask spreads against Korean Won by Korean banks.

Table J.1: Korean Banks' Exposure in Chinese Cities before 2009

Bank Name	*City*
Kookmin Bank	Guangzhou (2007), Harbin (2008)
Daegu Bank	Shanghai (2008)
Woori Bank	Shanghai (1995), Beijing (2003), Shenzhen (2005), Suzhou (2007)
Shinhan Bank	Tianjin (1996), Shanghai (2003), Qingdao (2005), Beijing (2007), Wuxi (2008)
Hana Bank	Shanghai (2000), Qingdao (2003), Shenyang (2004), Yantai (2006), Beijing (2007), Changchun (2008)
Korea Exchange Bank	Tianjin (1993), Dalian (1995)

Notes: This table reports Korean banks' branch/office openings in Chinese cities. The number in parenthesis denotes the year of the first-time opening of a branch/office in a city in China.