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Abstract

I exploit a quasi-natural experiment in South Korea to examine the real effects of foreign exchange derivatives (FXD) hedging. By using cross-bank variation in the tightness of an FX regulation designed to discourage risk-taking by financial intermediaries, I show that the regulation caused a decline in the supply of FXD, resulting in a substantial reduction in exports, especially for small firms that relied heavily on FXD hedging. I provide a mechanism involving firms' costly external financing, as well as their costly switching of banking relationships and banks' costly equity financing, that explains the empirical findings.

Key words: real effects, macroprudential policy, international finance, derivatives hedging, FX risk management

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1 Introduction

Firms with currency mismatches in their costs and revenues face substantial foreign exchange (FX) risk. In trade-dependent economies with nondominant currencies, nonfinancial firms' FX risk management is critical, even at the macroeconomic level. FX derivatives (FXD) contracts may provide a valuable means for such firms to manage their FX risk. Then, it would be reasonable to think that, when such valuable hedging instruments are less available, firms may optimally reduce the underlying exposure by cutting their real output. Therefore, understanding the real implications of FXD hedging is a question that is not only fundamental to finance, but also very important for macroeconomic policymakers. However, empirical evidence on the real effects of FXD hedging has been sparse in the literature due to challenges in identification, the most notable of which is the endogeneity of corporate hedging decisions.

In this paper, I exploit an exogenous shock to the supply of FXD hedging to examine whether such hedging has real effects. Specifically, I use a quasi-natural experiment in South Korea, studying how a macroprudential FX regulation that limits bank ratios of FXD positions to equity capital affects the supply of FXD and firm exports. I find that the regulation caused a shortage of FX hedging instruments, and consequently, led to a reduction in exports. My findings have important implications. First, they imply that FXD is an essential hedging instrument for firms to manage their FX risks. Second, they suggest a well-functioning FXD market can facilitate international trade. Third, they imply macroprudential FX regulations can have a negative effect on real economic outcomes of the nonfinancial sector, even if they mitigate financial sector vulnerabilities. To the best of my knowledge, this is the first paper to show that macroprudential FX regulations can affect the real side of the economy, especially exports, by creating a shortage of FX hedging instruments.

For several reasons, the quasi-natural experiment in Korea offers a suitable setting to study the real effects of FXD hedging. First, it provides a setting in which the exogenous shock to the supply of FX derivatives hedging varies across firms. This heterogeneity ultimately comes from the fact that exposure to the regulation shock varies across banks. When the regulation was imposed in Korea, only a subset of banks was constrained. This allows me to estimate the bank-specific tightness of the regulation. This cross-bank heterogeneity in the strictness of regulation provides an identification strategy for my empirical analysis, as the firm-bank relationship in the FXD market is persistent. It is highly unlikely that firms switched banking relationships in anticipation of which banks would be constrained by the regulation. Second, data are available on the details of FXD contracts at the firm-bank pair level, information not readily obtainable in many other countries. This allows me to isolate bank hedging supply from firm hedging demand by comparing contracts with constrained banks and contracts with unconstrained banks. Comparisons are made between firms with similar characteristics and within the same industries to control for changes in hedging demand. Third, firm-level FXD holdings and export sales are observable. Therefore, I can evaluate real outcomes at the firm level by comparing firms that traded with constrained banks and those that did not. Fourth, the regulation that limits bank net positions of FX spot and/or derivatives is not specific to Korea. As of 2018, approximately three out of four countries globally, including developed economies, had limits on financial sector open FX positions.[1] Thus, the results based on the quasi-natural experiment in Korea are relevant to other emerging market economies as well as developed economies.

To understand how the regulation shock to banks propagates to firms, I proceed in three steps. First, I conduct a bank-level analysis to evaluate bank responses following the regulatory imposition. The regulation requires all banks located in Korea to maintain ratios of FXD to capital below a certain level. When this regulation was first announced, the constraint was binding only for a fraction of banks. I define the treatment group as the banks whose ratio of FXD to capital exceeded the regulatory cap when the regulation was introduced. I compare their responses with those of banks whose regulatory constraint was not binding. Using a difference-in-differences specification, I find constrained banks reduced their FXD positions more than unconstrained banks. I find the gap between the FXD positions of the two groups decreased as regulations were tightened. These findings suggest it is costly for banks to raise equity capital, and therefore banks prefer to cut FXD positions to meet the regulatory requirement.

In the second step, I use contract-level FXD data observed during the six months before and after the regulation was imposed. With these data, I estimate transmission of the

[1] Based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), 147 out of 192 countries have imposed limits on the financial sector's open FX positions as of 2018. Of these, 27 are advanced economies. See Figure A.1 for the number of EM and developing economy countries using macroprudential FX regulations over time.

regulation shock from banks to firms. I control for changes in hedging demand by examining hedging with constrained banks and hedging with unconstrained banks for *similar* firms. For this purpose, I define similar firms as those in the same industry with similar characteristics. I find the net FXD position of contracts with constrained banks increased 45% relative to that with unconstrained banks. The increase in the net FXD position implies a contraction in hedging for exporters and an expansion in hedging for the non-exporters, including importers and the firms hedging their exposure to FX risk from foreign currency debt. Both cases help loosen bank regulatory constraints, since banks' long foreign currency positions in FXD would decrease. I find the effect on hedging was much stronger for exporters than for non-exporters. Exporter hedging with constrained banks declined 47% more than their hedging with unconstrained banks within a year. These results suggest that regulation caused a reduction in the supply of FXD.

In the third step, I conduct a firm-level analysis to understand how the regulation shock transmitted from banks to firms affected real outcomes of firms. I define exposed firms as those whose counterparty bank for FXD was constrained. I then compare changes in firms' FXD positions with changes of non-exposed firms. I find total hedging of exposed exporters fell 40–45% compared with the total hedging of non-exposed exporters. This firm-level reduction in hedging implies firms were not able to offset the shock because switching counterparty bank relationships is costly to them. Further, I examine whether the reduction in the supply of FXD affected firm exports, which are the primary source of exposure to FX risk. I find firms that used to hedge at least 10% of their export sales with FXD, which I refer to as high-hedge firms, substantially reduced their exports. For a one-standard-deviation increase in a firm's exposure to the regulation shock transmitted by banks, export sales fall 17.1% for high-hedge firms and rise 5.7% for low-hedge firms, resulting in a 22.8% differential effect. In addition, I find exposed exporter profitability fell compared with profitability of non-exposed exporters.

My finding that macroprudential FX regulations influence firm exports highlights multiple layers of frictions. I present a mechanism involving firms' costly external financing, as well as their costly switching of banking relationships and banks' costly equity financing, that explains the empirical findings. I show this mechanism by answering three questions: First, how do macroprudential FX regulations cause a reduction in the supply of FXD? Second, how does a reduction in the supply of FXD lead to a decline in firm-level hedging? Third, how does the unavailability of FX risk-hedging instruments result in a decline in exports?

The first question on how the regulation causes a reduction in the supply of FXD can be answered by an imbalance between the hedging demand of exporters versus importers in the economy and costly equity financing by banks. If exporter and importer hedging demands were balanced, banks could simply match the two sides of offsetting demand and the FX regulatory constraint would not bind. Similarly, if it were costless for banks to raise equity capital, banks could raise equity to meet the regulatory requirement. Under that condition, the supply of FXD would not be reduced. However, I show that banks chose to reduce their FXD positions instead of raising capital to meet the regulatory requirement. This is an optimal choice for banks if it is costly to raise equity. In fact, the two factors—the imbalance between exporter and importer hedging demands and the intermediary constraint—are not confined to emerging markets. Du et al. (2018) find that the interaction between the two factors—global imbalance in investment demand versus funding supply, and intermediary balance sheet constraints—has resulted in covered interest rate parity (CIP) deviations in the currencies of developed markets.

The second question concerning the decline in firm-level hedging can be answered by considering the inability of firms to find alternative sources of hedging to ease the regulation shock transmitted by banks. Even if a fraction of banks reduced the supply of FXD following the regulation, firms might substitute part of their hedging toward banks less constrained by the regulation. However, I show this is not the case. Firm hedging with constrained banks fell compared with their hedging with unconstrained banks, and total firm-level hedging also fell. This is evidence that firms were not able to fully replace the FXD hedging lost with constrained banks. These results suggest the inability of firms to borrow from alternative sources in order to offset the liquidity shock transmitted by banks is not limited to the credit market and can extend to the derivatives market.

The last question relates to firms' FX risk management when their external financing is costly. It can be answered by a mechanism a la Froot et al. (1993). Exporters in countries with nondominant currencies are exposed to FX risk because invoice currencies are typically in dominant currencies, such as U.S. Dollar (USD) or euro (EUR). As a result, their internal funds for future investment opportunities are also exposed to FX risk through export outcomes. FX hedging, therefore, adds value because exporters would have to rely on costly external financing if their internal funds fall short. When hedging becomes less available, it is optimal for firms to reduce export quantity to manage the volatility of internal funds. My empirical finding that the unavailability of FX risk-hedging instruments results in a decline in exports implies that FXD contracts are indeed crucial risk management tools for firms exposed to FX risk. I further show evidence consistent with my proposed mechanism. The mechanism predicts that due to risk-taking incentives, when hedging becomes less available, firms with more internal funds are expected to reduce exports by more than those with less. Consistent with the prediction, I find firms with higher cash and high hedge ratio before the regulation reduced export sales and switched to the domestic market to a greater extent.

I perform several robustness tests throughout the analyses to confirm the validity of the results. First, I find that the results are robust to including bank fixed effects in the bank-level analysis. They are also robust when bank, firm, and contract characteristics are included as control variables in the contract-level and firm-level analyses. Second, I analyze changes in FXD separately for foreign banks and confirm the relative reduction in FXD of constrained banks was large and significant even among foreign banks. This suggests the result is not driven by a difference in business models between foreign and domestic banks. Third, I estimate the impact of the regulation on bank foreign currency lending to test the potentially confounding effect of a credit shock. I find no significant change in the share of foreign currency lending of constrained banks compared with that of unconstrained banks. Fourth, I estimate the impact on firm domestic sales as a placebo test and find that the effect was small and insignificant. This result implies that the decrease in export sales is indeed caused by a regulation shock as opposed to a systemic relationship between troubled firms and constrained banks. Fifth, I show cash explains the decline in exports for exposed firms only when interacting with hedging and not by itself, which confirms that the hedging channel is the mechanism at work. Lastly, I document additional suggestive evidence that the reduction in the FXD position was driven by a reduction in supply as opposed to a reduction in demand, by looking at the FXD pricing.

Based on my analyses, I show a decline in the supply of FXD can lead to a reduction in exports by affected firms. This finding is important because it implies that FXDs are crucial risk management instruments affecting real outcomes. The muted effect on importers combined with the negative effect on exporters has an important macroeconomic implication: FXD markets can impact the trade balance. Further, my findings imply that, although macroprudential regulations may mitigate financial sector vulnerabilities, they can have a negative effect on real economic outcomes of the nonfinancial sector. These effects should be carefully considered in future policy development.

Related Literature

This paper is related to various strands of literature. My work here contributes to the literature concerning the implications of derivatives hedging. A closely related paper of Alfaro et al. (2021) carefully documents Chilean firms' currency risk exposures and their hedging behaviors. Empirical studies have found that hedging is associated with increases in firm values (Allayannis and Weston (2015), Carter et al. (2006), Jin and Jorion (2006), Campello et al. (2011), Gilje and Taillard (2017), and others). Here, I highlight the real implications of FXD as a corporate hedging tool for managing exposure to FX risk by showing that firms' exports fall as they face a reduction in the supply of FXD. I further present a mechanism a la Froot et al. (1993) in which it is optimal for firms to reduce export quantity to reduce the volatility of internal funds when hedging becomes less available.

My paper also adds to the literature examining the effects of friction in financial intermediation in an FX market context. On the theory side, Du et al. (2022) and Gabaix and Maggiori (2015) apply intermediary-based asset pricing models to the exchange rate literature. On the empirical side, Cenedese et al. (2021), Du et al. (2018), Avdjiev et al. (2019), and Fleckenstein and Longstaff (2018) document the link between large, persistent CIP deviations and the intermediary constraints imposed after the GFC.[2] Ivashina et al. (2015) explain how regulatory capital constraints may lead to a violation of CIP. Liao and Zhang (2020) study how institutional investors' hedging demand coupled with intermediary constraints can affect exchange rate dynamics. I contribute to the field by documenting that FX macroprudential regulation may inadvertently create friction in financial intermediation to the extent that it even leads to real consequences.

My paper builds on a large body of literature on the effect of financial shocks on the real economy. In the international trade context, Demir et al. (2017) show the trade finance channel of exports by exploiting Turkey's adoption of Basel II as a quasi-natural experiment. Paravisini et al. (2014) study the effect of credit on exporting firms and find credit shortages reduce exports by raising the variable cost of production. On the financial market side,

[2]CIP had been close to zero before the GFC (Frenkel and Levich (1975) and Frenkel and Levich (1977)).

Gilje et al. (2020) suggest asset prices can have important real implications. More broadly, theoretical work from Bernanke and Blinder (1988), Bernanke and Gertler (1989), Holmstrom and Tirole (1997), and Stein (1998) shows financial shocks only affect the real economy if there are credit market imperfections at both the bank and firm levels. Empirical studies by Khwaja and Mian (2008) and Schnabl (2012) identify the transmission of liquidity shocks using a within-firm estimator. Studies including Jimenez et al. (2017) and Gropp et al. (2019) exploit exogenous policy shocks and examine the real effects of banks through the credit channel.[3]. Here, I add to this body of literature by documenting evidence in the derivatives market that is similar to the bank lending channel and the firm borrowing channel. Macroprudential FX regulation combined with costly external financing leads to a market imperfection for banks. The market imperfection for firms is that they are not able to offset the shock by switching banks, which suggests such switching is costly for firms in derivatives markets, as it is in credit markets. Moreover, like the findings in credit markets (Khwaja and Mian (2008)), larger firms appear to cope better with the unfavorable effects of bank shocks in the derivatives market than do smaller firms.

This paper also contributes to a growing body of literature concerning both positive and negative effects of macroprudential regulations. Studies showing the effectiveness of macroprudential FX regulations include Acharya and Vij (2020), Bruno et al. (2017), and Ostry et al. (2012). By contrast, studies including Aiyar et al. (2014), Cerutti et al. (2015), and Reinhardt and Sowerbutts (2015) document leakages and unintended negative consequences. I extend this literature by providing new evidence for an unintended consequence of macroprudential regulation: a substantial decline in exports due to a shortage of hedging instruments. This paper is also related to that of Keller (2019) who analyzes regulations in Peru to identify a capital control shock transmitted through loans, which resulted in risk-shifting from banks to firms. In my paper, the transmission channel is through FXD and I focus on the real effects arising from a shortage of firms' hedging instruments. Another related paper is that of Ahnert et al. (2020), which evaluates the effectiveness and unintended consequences of macroprudential FX regulations using cross-country panel data. In my paper, I use bank-level data that can be traced through firms and I control for firm-level changes in export opportunities by using contract-level data.

[3]Berger et al. (2020) provides an excellent review of the literature that studies the effects of banks on the real economy.

My empirical results add to the growing body of literature studying the implications of bank capital regulations on bank behavior. Greenwood et al. (2017) show both the aggregate level of activity and the distribution of activity across banks are distorted by multiple competing capital requirements. Duffie (2018) finds bank capital regulations have been increasingly successful in improving financial stability, but have been accompanied by some reduction in secondary-market liquidity. Studies including Allahrakha et al. (2018), Anbil and Senyuz (2018), Bicu et al. (2017), and Van Horen and Kotidis (2018) examine the effect of leverage ratio constraints on repo markets. Haynes et al. (2019) study the impact of the leverage ratio on the derivatives market. Although the macroprudential FX regulation I study limits bank FXD positions, not their leverage, it takes the form of imposing a leverage-based cap. I find banks chose to shrink their balance sheet exposure rather than raise equity to meet the FXD capital requirement, which is consistent with the model of Admati et al. (2018).

Outline of the Paper

The remainder of the paper proceeds as follows: Section 2 discusses the regulatory background of the FXD position limit. Section 3 describes the sample and data. Section 4 develops empirical methodology and reports the results. Section 5 presents robustness results. Section 6 concludes.

2 The Setting

This section explains what had been happening before the regulation and why the regulation was introduced.

2.1 Background

Reducing the volatility of capital flows is a challenge in many emerging market economies. In the case of Korea, a large part of the volatile capital flows before the GFC was attributable to the banking sector's short-term cross-border foreign currency (FC) liabilities.

From 2000 to 2007, Korea had twin surpluses in its balance of payments. Figure 1 plots Korea's gross foreign capital inflows and shows that Korea had a surge in capital inflows during 2006–2007. The rapid increase in capital inflows was primarily driven by banking sector borrowing, which subsequently reversed dramatically during the GFC. The outflow in the fourth quarter of 2008 was close to $40 billion, or 4% of the country's annual GDP.

Korea's total external debt had increased throughout the 2000s before the GFC and the short-term component of that debt rose substantially. Even after taking the huge accumulation of FX reserves into account, FX liquidity—defined as FX reserves less short-term debt, scaled by GDP—had been deteriorating since 2005.[4,5]

The surge in the banking sector's short-term borrowings could have been related to an increase in domestic credit demand. However, in Korea's case, it was closely related to an increase in exporter hedging demand. During 2006–2007, high global demand led exporters to have long-term USD receivables. Exporters sold large amounts of USD forwards to banks to hedge FX exposure from these USD receivables.[6] The left panel of Figure 2 presents the structure of firms' FX position. Because banks purchased USD forwards from exporters, they were long USD forwards. Had there been importer hedging demand matching that of exporters, banks could have covered long positions by selling USD forwards to the importers. However, importer hedging demand fell far short of exporter hedging demand for several reasons. First, importers' FX liabilities are typically short-term and easier to predict. Second, it could be optimal for importers not to hedge when the central bank aggressively accumulates FX reserves, anticipating the reserves would be used to reduce currency depreciation (Acharya and Krishnamurthy (2019)). Third, the main importing sector in Korea is energy. In that sector, firms have sufficiently large market power to pass FX risk to their customers through pricing (Kim (2010)).

Given the shortage of natural USD forward buyers, banks needed to cover their long positions in USD forwards by constructing short positions in synthetic forwards. A short position in synthetic forwards is constructed by borrowing USD, converting USD to Korean Won (KRW) in the FX spot market, and investing in risk-free KRW-denominated bonds.[7] Had banks matched the maturities of their short positions in synthetic forwards and their long positions in USD forwards, banks would have been hedged. However, banks left maturity

[4] A measure of FX liquidity is in Acharya and Krishnamurthy (2019).

[5] See Appendix IA.A for time-series plots of Korea's balance of payments, total external debt, short-term external debt, FX reserves, and FX liquidity.

[6] See McCauley and Zukunft (2008) and Ree et al. (2012) for further details.

[7] See Appendix IA.B for illustration of cash flows.

mismatch unhedged. Foreign bank branches typically used short-term USD borrowings from their parent banks while their purchased USD forwards were long-term.[8] The structure of bank FX positions is illustrated in the right panel of Figure 2.

As a result, although Korean firms and banks hedged their FX mismatches, the country as a whole was left with a substantial FX *maturity* mismatch, which made the financial system vulnerable. Korea suffered severely from a USD funding liquidity crisis during the GFC, as its banks were not able to roll over short-term external debt. The average KRW CIP basis—a measure of FX funding liquidity—was -300bps between 2007 and 2009.[9] The KRW also depreciated rapidly and Korea nearly suffered a currency crisis.[10]

To illustrate the importance of exporter hedging demand on bank FXD positions, Figure 3 shows forward hedging demand of non-bank sectors. Bank of Korea (2008) documents that during the first three quarters of 2007, exporters sold 24 billion USD in forwards to banks, which amounted to 65% of banks' aggregate net USD forward position.

2.2 Regulation: FXD Position Limit

Korea introduced a macroprudential FX regulation in June 2010 limiting banks' FXD positions relative to capital:

$$\frac{\text{FXD Position}}{\text{Capital}} < \text{Regulatory Cap} \tag{1}$$

The FXD position is defined as the monthly average of the daily net aggregate delta-adjusted notional value of all FXD contracts a bank holds, including FX forwards, swaps, and options.[11] Since the net FXD position is aggregated across all currencies, banks' FXD positions in a currency pair that does not involve KRW (for example, a EUR-USD pair) has virtually no effect on the constraint. A bank's equity capital base is defined as the

[8]Domestic banks' maturity mismatches were not as severe as those of foreign bank branches (Ree et al. (2012)).

[9]See Figure A.2 for the CIP basis over time. I define CIP deviation for maturity n at time t ($x_{t,t+n}$), as the difference between the USD rate ($y^{\$}_{t,t+n}$) and the USD rate implied by the forward exchange rate ($f_{t,t+n}$), spot exchange rate (s_t), and KRW rate ($y^{₩}_{t,t+n}$): $x_{t,t+n} = y^{\$}_{t,t+n} - \left(y^{₩}_{t,t+n} - \frac{1}{n}(f_{t,t+n} - s_t)\right) = \frac{1}{n}(f_{t,t+n} - s_t) - (y^{₩}_{t,t+n} - y^{\$}_{t,t+n})$. The spot and forward exchange rates are defined as the value of 1 USD in terms of KRW. The average for G10 currencies during the same period was -20.8bps with a maximum deviation of -63.1bps for Danish Krone (Du et al. (2018)).

[10]The USD appreciated 34% during 2008. See Figure A.3 for the spot exchange rate over time. See International Monetary Fund (2012) for further details of the crisis.

[11]For non-USD FXDs, the notional values are converted to USD based on the day's exchange rate.

sum of Tier 1 capital (paid-in capital) and Tier 2 capital (including borrowing longer than a year from its parent bank) in all currencies. The exchange rate for converting a KRW-denominated capital base to USD is the average of the exchange rate used for the previous year's calculation and the previous year's average exchange rate.

The limit (1) is placed on each bank, namely the FXD position of a bank must be below a certain specified level relative to its equity capital at the end of the previous month. The current regulatory cap is 50% for domestic banks and 250% for foreign banks. Table 1 shows the historical change in the regulatory caps imposed on foreign and domestic banks. The regulation was tightened in the first three changes and loosened in the last two. For my empirical analysis, the last change in 2020 is not included. According to the regulator's statements, the main underlying factors that led to adjusting the limit were the banking sector's aggregate short-term external debt and the USD funding liquidity condition.[12]

The regulation seeks to induce banks to use more stable sources of funding and thereby lower the volatility of capital flows. Banks with ratios of FXD to capital above the regulatory cap must either reduce their FXD position or raise their capital to meet the requirement. Given the structure of the FX position of banks as shown in Figure 2, banks' FXD positions are closely related to their short-term borrowing.[13] Bank of Korea (2008) documents that during the first three quarters of 2007, 73% of USD that banks funded for their USD forwards was via short-term cross-border borrowing as opposed to cross-currency swaps, which are typically long-term (Figure 3). Therefore, as banks reduce their FXD positions, the policy could induce banks to reduce short-term FC borrowings from abroad. Since long-term borrowings from their parent banks count as capital, the policy could induce banks to borrow FC longer term.

[12]See International Monetary Fund (2012) and Bruno and Shin (2014) for further details.

[13]Figure A.4 in Appendix shows that the aggregate net FXD position and the aggregate cross-border short-term FC borrowing of the banking sector move together, as banks mostly fund their FXD position using short-term FC borrowing.

3 Data and Summary Statistics

3.1 Data Sources

I use three data sets for analysis: bank data, FXD contract data, and firm data. All data are publicly available. Bank FXD position data are hand-collected from bank financial statements. The rest of bank financial data are downloaded from the Korean Financial Statistics Information System managed by Korea's financial regulator, the Financial Supervisory Service.[14] FXD contract data of all listed nonfinancial firms are hand-collected from firm financial statements published on the Korean Data Analysis, Retrieval and Transfer (DART) System.[15] DART is a repository of Korean corporate filings, from which disclosure filings of all Korean firms subject to external audit can be downloaded. The data source for firm-level financial data is TS2000, a commercial data aggregator managed by Korea Listed Companies Association. Market data, such as spot and forward exchange rates, as well as interest rates, are obtained from Bloomberg and Datastream.

3.2 Bank Data

I focus on 46 banks that were operating as of December 2009, the last reporting period before the imposition of FXD position limits.[16] Among them, 29 are foreign banks and 17 are domestic banks. Banks' on-balance sheet FX positions (defined as FC assets less FC liabilities), FXD positions, and FXD-position-to-capital (DPTC) ratios are observed on a monthly basis. Other financial variables of banks are observed quarterly. The sample period is from 2008 to 2018.

The size of regulatory shock in aggregate was substantial. The constrained banks in aggregate needed to reduce their FXD position by about 15 billion USD, or approximately 40%.[17] The tightness of regulation differed across banks when it was introduced. To study the effect of the FXD position limit on banks, I exploit the cross-bank heterogeneity in the tightness of regulation. Figure 4 compares the histograms of the DPTC ratios of foreign

[14] `http://efisis.fss.or.kr/fss/fsiview/indexw.html`

[15] `https://englishdart.fss.or.kr/`

[16] The list of full names of sample banks are in Table IA.C.1.

[17] Appendix IA.D reports each bank's assets, FXD position ($DerivPosition$), capital, DPTC ratio, size of derivatives positions in excess of the limit ($DerivExceeded$), and size of shock (defined as $DerivExceeded/DerivPosition$) as of December 2009, before the regulation.

banks before and after the first announcement of the regulation. It shows 14 foreign banks had DPTC ratios exceeding the regulatory cap, and all of them except one reduced their DPTC ratios below the regulatory cap six months after the announcement. Figure 5 shows two domestic banks with DPTC ratios above the regulatory cap reduced their DPTC ratios below the cap six months after the announcement. The heterogeneity in DPTC ratios comes from both its numerator and denominator, but is driven more strongly by its numerator, the FXD position.[18]

Table 2 reports bank summary statistics by whether the bank was constrained by the regulation as of December 2009. Most constrained banks were foreign, on average smaller, and more leveraged with lower loan-to-assets ratios. The differences in these characteristics are statistically significant. Therefore, I control for such differences in my empirical analysis. I also run separate analyses for foreign banks and domestic banks.

3.3 FXD Contract Data

All nonfinancial firms in Korea have been required to disclose the details of their existing financial derivatives contracts since 1999 (Ban and Kim (2004)). I hand collected the details of FXD contracts for the years 2009 and 2010. I focus on 148 firms that used FXD in both 2009 and 2010.[19] Of these, 132 firms fully disclosed their counterparty information, while 16 firms disclosed only that of their main counterparty.[20] Although I am not able to include those 16 firms (with large FXD market shares) in the contract-level analysis, I include them in the firm-level analysis.

An FXD contract is defined as a firm-bank pair. I aggregate all contracts for a single firm-bank pair in case a bank had multiple contracts with the same bank in the same year. The net FXD position is computed by aggregating the delta-adjusted notional of individual FXD contracts for a firm-bank pair. A positive net FXD position indicates a long position in USD or in a USD equivalent amount for a non-USD foreign currency such as the EUR. While

[18] The standard deviation of $FXDPosition/Asset$ is 0.19 and that of $Capital/Asset$ is 0.12.

[19] Only about 19% of listed firms with non-zero FX gains or losses had non-zero FXD assets or liabilities.

[20] The top 10 firms' market share of FXD usage (sum of FXD assets and FXD liabilities) is 88%, yet none of them report the full list of counterparties. This is because the regulator allows firms to disclose at the aggregate level, as opposed to the contract level, if: (1) the number of contracts is excessively large, and (2) the payoff structure is simple enough such that profit and losses from the contracts would be predictable, given future movements in the exchange rate. When firms report at the aggregate level, they typically do not disclose the full list of counterparties.

the delta of forwards, futures and swaps is 1, the delta of each option needs to be calculated. The regulatory enforcement authorities use the Black-Scholes model to calculate the delta of options. I take a simplified assumption that the delta of every option contract is 0.5. With this assumption, a long position in a call and a short position in a put would result in delta of 1, which is consistent with the delta of forwards. This assumption is conservative. Using the Black-Scholes delta would only make the results stronger.[21] To illustrate the calculation of net FXD position of a firm, suppose exporting firm A sold a USD forward with notional of \$100 and wrote a USD call option with notional of \$100 to bank B in year 2009. In this case, the net FXD position of the firm-bank pair (A,B) is \$ -150. The negative sign indicates that the firm would record a loss from its FXD trades with bank B if the USD appreciates.

The sample contains 251 contracts between 132 firms and 33 banks.[22] The contracts that do not involve KRW and the contracts without directional (buy or sell) information are excluded.[23] Roughly half the contracts are firms taking long positions in foreign currency. In terms of pairs, the USD-KRW pair is most common (86%). All contracts that involve KRW, but not USD, JPY, or EUR are categorized as one group. Forwards are the most common type of contract, composing 53% of all contracts in the sample.

Table 3 reports contract-level summary statistics by exposure. A contract is "constrained" if the firm dealt with a constrained bank, that is, a bank that was required to reduce its DPTC ratio at the end of the 2009 calendar year. About 40% of the contracts are constrained and 60% are unconstrained. The contract characteristics (size, side, pair, and type) of exposed firms are different in statistically significant ways from those of non-exposed firms. Therefore, I control for contract characteristics in my analysis.

3.4 Firm Data

The contract-level data are aggregated at the firm level. Table 4 provides summary statistics on firm-level data by exposure.[24] A firm is classified as "exposed" if its main FXD counterparty bank in terms of FXD notional is constrained. Exposed and non-exposed firms are

[21]Most of the options are exotic options with a Black-Scholes delta between 0.7 and 0.9.

[22]Thirteen banks in the bank data set do not have any FXD contracts with sample firms.

[23]Non-KRW FXD contracts, such as those in a EUR-USD pair, do not affect banks' FXD position limits and they compose only 4% of total contract notional.

[24]For completeness, Table IA.E.2 shows summary statistics of the subsample excluding the 16 firms that disclosed only their main counterparty.

similar in terms of all characteristics except FC liability share. The full-sample average net FXD position of firms is -8% of assets (or -10% of sales). That means on average, if the USD appreciates by one Won, firms make losses from their FXD positions equal to 8% of assets if the USD appreciates by one Won. This translates into a 20% net FXD–position–to–export–sales ratio, given the average export sales share of 47%.

To better understand firm hedging behavior, I categorize firms into net FXD buyers and net FXD sellers.[25] The net FXD buyers are firms with a positive net FXD position. These firms profit from their FXD trades when the USD appreciates. They are typically importers or firms with FC borrowings. They mostly use swaps that match the exact cash flows of their FC loans or the FC bonds they issued. Their mean FC liability hedge ratio, defined as the amount of FXD bought divided by FC liabilities, is 0.6. The correlation between FC liabilities and net FXD position is 0.78.

The FXD sellers are firms with negative net FXD position, typically exporters. They primarily use forwards to hedge their export sales. Their mean export–hedge ratio, defined as FXD sold divided by export sales, is 0.6. The hedge ratio of FXD sellers does not provide much information about whether firms used FXD for hedging or speculating because unearned revenues are not captured in sales. To be specific, a manufacturing firm "Jinsung TEC" had an export hedge ratio of 9.95, which may look like its FXD position served a speculative purpose. However, the firm received export orders for the next ten years and its FXD position was for hedging future USD cash inflows. Since the orders flow into the unearned revenue account until products are delivered, they do not affect sales. This kind of case makes it difficult to identify whether firms were hedging or speculating by simply looking at the hedge ratio. Nevertheless, the strong correlation of -0.95 between export sales and net FXD position suggests that the primary purpose of holding FXD was to hedge rather than speculate.

Due to the transition of accounting standards from Korean Generally Accepted Accounting Principles to Korean International Financial Reporting Standards in 2010, many firms stopped reporting export sales in 2011. Thus, my main analysis on exports focuses on the change during 2009 and 2010.

[25] Appendix IA.F provides the list of firms.

4 Empirical Methodology and Results

The facts that the regulation was drawn in terms of the DPTC ratio and that not all banks exceeded the regulatory cap when it was implemented provide an identification strategy. By exploiting cross-bank heterogeneity in the DPTC ratio, I first estimate the impact of regulation on bank FXD positions, capital, FC liabilities, and FC loans from 2008 to 2018 with a difference-in-differences (DiD) estimator. Second, in order to disentangle bank hedging supply from firm hedging demand, I use FXD contract-level data for the years 2009 and 2010 and estimate the transmission of the regulation shock from banks to firms. Third, I study the impact of the regulation shock on the real outcomes of firms.

4.1 Impact of Regulations on Banks

This section studies the impact of the regulations on bank FXD positions and capital.[26]

Since the regulation is enforced in terms of DPTC ratio, banks may manage their ratios by adjusting their FXD positions or their capital bases (or both). I show that banks primarily adjusted the former using the following baseline specification:

$$Y_{it} = \beta_0 + \beta_1 Constrained_i \times Regulation_t + \beta_2 Constrained_i + \gamma_t + \varepsilon_{it} \tag{2}$$

The outcome variable is either log of derivative holdings ($LogFXD$), log of capital ($LogCapital$), or DPTC ratio ($FXD/Capital$). $Constrained_i$ is a dummy variable that indicates whether the constraint was binding for bank i. $Regulation_t$ captures the time variation in the overall tightness of the regulation. $Regulation_t$ is defined as the minimum FXD capital requirement (an inverse of the regulatory cap on the DPTC ratio); it is 0 before the regulation's imposition and higher values indicate a tighter regulatory constraint. Because the minimum FXD capital requirement is different for foreign banks and domestic banks, I construct $Regulation_t$ by taking either a simple average or a weighted average. $Regulation_t^{Avg}$ denotes the simple average and $Regulation_t^{WAvg}$ denotes the weighted average, where the weight is the derivatives positions. I use official announcement dates rather than effective dates whenever the minimum FXD capital requirement is adjusted because banks may preemptively react to

[26] I analyze the impact of regulations on FC liabilities and FC loans in section 5. The regulation also affected bank security holdings. See Appendix IA.G for details.

the regulation upon the announcements before the effective dates.[27] I include monthly time fixed effects γ_t to control for any potential trends. I also estimate the above specification (2) by weighted least squares, where the weights are the size of bank FXD positions as of December 2009. For some specifications, I add bank fixed effects δ_i to control for differences in time-invariant factors among banks:

$$Y_{it} = \beta_0 + \beta_1 Constrained_i \times Regulation_t + \delta_i + \gamma_t + \varepsilon_{it} \tag{3}$$

I cluster standard errors by bank.

The top panel of Figure 6 plots the normalized average FXD position by treatment, and the bottom panel plots $Regulation_t$. The top panel shows that the constrained banks reduced their FXD positions after the imposition of regulation relative to unconstrained banks. In addition, as the regulation gets tighter, shown in the bottom panel, the gap between the FXD position of constrained banks and that of unconstrained banks gets wider in the top panel.

Table 5 reports the regression results. The top panel results are based on the simple average minimum FXD capital requirement, $Regulation_t^{Avg}$. The main coefficient of interest is β_1; it is expected to have a negative sign for $LogFXD$ because constrained banks' FXD position relative to that of unconstrained banks is expected to decrease as the regulation gets tighter (reflected in a higher $Regulation_t$). The estimated β_1 coefficients in columns (1) and (2) imply that the constrained bank FXD position is reduced by 60–62% more than that of unconstrained banks per unit increase in $Regulation_t$.[28] Further, β_1 remains negative and significant when bank fixed effects are added (column 2) and when estimated under the weighted least squares models where the weight is the pre-shock FXD position.[29] Columns (3) and (4) in Table 5 are the results when the outcome variable is $LogCapital$. I find that the estimated β_1 coefficients are small and insignificant. Columns (5) and (6) confirm that the regulation was indeed binding for constrained banks and therefore reduced their DPTC ratios after the regulation. These results are robust to using the weighted average minimum

[27] The first news article mentioning that regulators are considering introducing a regulation related to bank FXD positions was published about two weeks before the official announcement date on May 27, 2010. My results are robust to changing the imposition date from the official announcement date of June 13, 2010 to the first news date, May 27, 2010.

[28] $1 - \exp(-0.913)$

[29] Table IA.H.1

FXD capital requirement, $Regulation_t^{WAvg}$, as reported in the bottom panel of Table 5.

The DiD specification requires the parallel trends assumption. To test for the assumption, I estimate the impact of the regulation with the following specification without $Regulation_t$:

$$Y_{it} = \beta_0 + \beta_1 Constrained_i + \beta_2 Post_t + \sum_t \lambda_t Constrained_i \times \gamma_t + \varepsilon_{it} \tag{4}$$

where Y_{it} is $LogFXD$ and $Post_t$ takes the value of 1 for the time period after the introduction of the regulation. In Figure 7, I plot the monthly coefficient λ_t over time. It shows that λ_t is not significantly different from 0 before the regulation but turns negative after the imposition of regulation and declines further as the regulation gets tighter. Figure 6, which plots the normalized average FXD position by treatment (top panel), also confirms that the trends were indeed parallel. It would be concerning if banks in the control group are indirectly affected by the regulation as firms substitute the banks in the treated group with the banks in the control group. However, in subsection 4.2 and subsection 4.3, I document that firms are typically unable to switch banks.

In robustness analysis, I run the same analyses separately for foreign banks and domestic banks, and I show that the results are not driven by differences in characteristics or differential exposure to the GFC across foreign banks and domestic banks.

In sum, the results suggest that the constrained banks chose to reduce their FXD position instead of increasing their capital. While it is not surprising to find that the DPTC ratio of constrained banks decreased after the regulation, the result that banks reduced the DPTC ratio by adjusting their FXD position rather than their equity capital is not obvious. If equity financing is costly, banks would choose to reduce the DPTC ratio by cutting down their FXD positions along with short-term external borrowing from their parent banks rather than by increasing their equity capital.

4.2 Transmission of Shock to Firms

This section uses contract-level data to estimate the transmission of the regulation shock from banks to firms. An identification challenge is to disentangle hedging demand and supply. The observed relative reduction in hedging by firms that traded with constrained banks could have been due to an increase in the hedging demand of firms that traded with unconstrained banks as opposed to a decrease in the supply from constrained banks. To illustrate the identification challenge, suppose that exporters predominantly trade FXD with constrained banks while non-exporters predominantly trade with unconstrained banks. If exporting opportunities were impaired during the GFC, the exporting firms that traded with constrained banks may have demanded less hedging than the firms that traded with unconstrained banks.

To address this problem, I examine the change in FXD hedging across contract relationships *within* the same industry and within groups of firms with similar characteristics. Since half of the sample firms have a single contract relationship, the firm fixed effects approach (in Khwaja and Mian (2008) and Schnabl (2012), for example) would excessively reduce the sample size. Therefore, I estimate an OLS specification with controls for firm characteristics:

$$\Delta FXD_{i,j} = \alpha + \beta\, Constrained_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j} \quad (5)$$

The identification assumption is that the change in hedging demand is uncorrelated with the exogenous supply shock, conditional on observed characteristics.

The outcome variable is change in the net FXD position of firm j with bank i (scaled by firm j's assets) between 2009 and 2010. I winsorize the top 2% and bottom 2% of the scaled net FXD position to ensure that the results are not driven by outliers. $Constrained_i$ is a dummy variable that takes the value of 1 if the contract is dealt with a constrained bank and 0 otherwise. Firm controls include log size, scaled net FXD position before the shock, FC liabilities share, and seven industry dummies. I also include contract and bank characteristics to ensure that the results are not confounded by pre-shock differences in these characteristics. Bank controls include log size, loans–to–assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD position, derivative type, and currency pair. The derivative type for contract (i, j) is the percentage of FXDs dealt between firm j and bank i classified as forwards, swaps, options, and futures. Similarly, currency pair is the percentage of FXDs categorized as USD-KRW pair, JPY-KRW pair, EUR-KRW pair, and other pairs involving KRW. All control variables are computed as of 2009, before the shock. I cluster standard errors at the bank level.

I estimate the transmission separately by the direction of FXD contracts. I define the exporter's FXD contract as the contract in which the firm takes a short position in foreign currency. I define the non-exporter's FXD contract as the contract in which the firm takes a long position in foreign currency. Non-exporters include importers as well as firms with FC liabilities. I classify sample contracts by their direction rather than by the exporting status of the firm because direction is what matters for constrained banks. From the perspective of constrained banks, either a reduction in exporter contracts or an increase in non-exporter contracts (or both) reduce bank long positions in FXD and therefore make them less constrained. Since a decrease in bank long positions in FXD corresponds with an upward adjustment in firm net FXD position, the expected sign of β is positive for both exporter contracts and non-exporter contracts.

Table 6 shows the results. Column (1) reports the result for exporter contracts. The scaled net FXD position of contracts dealt by constrained banks increased 5.3% after the shock compared with contracts with unconstrained banks. Given that the pre-shock average scaled net FXD position of exporter contracts was -8%, the change translates into a 66% reduction in hedging.[30] Column (2) adds firm controls, bank controls, and contract controls. It shows that the relative reduction in hedging was 47%, which is economically significant. I further find that net option positions increased 8.6% relative to forwards. As the firm pre-shock net option position was negative, an increase in net position means a reduction in hedging via options. This result is related to the fact that firm exotic option positions incurred huge losses during the global financial crisis, which I explain in further detail in the next subsection.

Columns (3) and (4) show that the regulation shock did not strongly affect non-exporter hedging. This is likely related to the reasons why importer hedging demand had been weak. Potential reasons include central bank puts, the market power of Korea's importing sector, and the relatively easier predictability of importer, as opposed to exporter, cash flows. I report the full sample results in columns (5) and (6) for completeness. In terms of magnitude, firms on average reduced their FXD hedging with constrained banks 45%, compared with their hedging with unconstrained banks.[31]

Since the bank-specific tightness of regulation (*Shock*) is observed, I also use the following specification by replacing binary variable $Constrained_i$ in (5) with continuous variable,

[30] The pre-shock average scaled net FXD position of the exporter contracts is presented in Table IA.E.1.

[31] The pre-shock average scaled net FXD position of the full sample is -2.9% (Table 3).

$Shock_i$:

$$\Delta FXD_{i,j} = \beta + \beta_{Shock} Shock_i + FirmControls + BankControls + ContractControls + \varepsilon_{i,j} \quad (6)$$

$Shock_i$ is the percentage of bank i's FXD position that was required to be reduced when the regulation was imposed.[32] Table B.2 presents consistent results. Columns (1) and (2) show that the impact on exporter contracts remains large and significant. Column (2) shows that a one-standard-deviation increase in *Shock* leads to a 2% increase in scaled net FXD position (corresponding to a 28% reduction in hedging) for exporter contracts.[33] Columns (3) and (4) show that non-exporter contracts were not strongly affected.

All results are robust to replacing the dependent variable, assets-scaled FXD position, with sales-scaled FXD position. The results with sales-scaled FXD position are reported in Appendix IA.I.

Relation to Exotic Options Crisis

Many of the options in the sample are Knock-In/Knock-Out (KIKO) exotic options that firms entered into before the financial crisis. A typical payoff structure of KIKO options involves earning small profits if the KRW appreciates or depreciates slightly but incurring huge losses if the KRW depreciates substantially.[34] The continued appreciation trend with low volatility of the KRW increased the popularity of KIKO options and many firms presumably entered into these contracts without having a good understanding of the risks. After incurring large losses during the financial crisis, some firms sued banks for not fully informing them of the potential risks. Cases of nonfinancial firms suffering from exotic FXD positions are not unique to Korea; many EM countries had similar experiences.[35]

To test whether option contracts are driving the main results, I use the same specification without the option contracts. These results are independent of the simplified assumption that the delta of options is 0.5. Table B.3 presents the results for specification (5), and Table B.4 shows the results for specification (6). The results of exporter contracts are still significant after excluding the options. Columns (1) and (2) of Table B.3 show that the scaled net

[32]Bank-specific shocks are presented in Table IA.D.1.
[33]The standard deviation of *Shock* is 17.5%.
[34]An example is illustrated in Figure IA.J.1.
[35]Korea, Sri Lanka, Japan, Indonesia, China, Brazil, Mexico and Poland (See Dodd (2009)).

FXD position of sell contracts with constrained banks increased 2.6–3% (corresponding to a 33–37% reduction in hedging). Columns (1) and (2) of Table B.4 show that a one-standard-deviation increase in *Shock* leads to 1.7–1.8% increase in the scaled net FXD position (or, a 22–22.5% reduction in hedging).

In summary, the results from the contract-level analysis suggest that the regulation caused a reduction in the supply of hedging, and the effect was particularly large for the exporter contracts. Exporter hedging with constrained banks decreased considerably within a year compared with their hedging with unconstrained banks.

4.3 Impact on Real Outcomes of Firms

This section uses firm-level data to estimate the impact of the FXD supply shock on firm-level FXD hedging and real outcomes of firms.

Firm-level Reduction in Hedging

If a firm can substitute unconstrained banks for constrained banks, firm-level hedging may not fall and consequently the regulation shock may have no effect on the real outcomes of firms. Therefore, I first test whether the regulation shock causes a reduction in FXD hedging at the *firm-level*, using the following OLS specification:

$$\Delta Y_j = \beta_E \, Exposed_j + FirmControls + \varepsilon_j \tag{7}$$

for the full sample of 148 firms, including the 16 firms that do not fully disclose the list of their counterparties. ΔY_j denotes the change in firm-level FXD position (scaled by assets) between 2009 and 2010. The dummy variable $Exposed_j$ is 1 if firm j's main bank is constrained and is 0 otherwise. The main bank is defined as the firm's counterparty bank with the largest FXD position. The firm control variables are the same as those in the contract-level regressions. The identification assumption is that the change in hedging demand is uncorrelated with bank exposure, conditional on observables.

For the subsample of 132 firms that disclosed complete lists of their counterparties and notional amounts for each counterparty, I use the following specification:

$$\Delta Y_j = \beta_{\overline{E}} \, Exposure_j + FirmControls + \varepsilon_j \tag{8}$$

where $Exposure_j$ is the notional weighted average shock of firm j's counterparty banks.

First, I report the effects on firm-level FXD positions by firm size. Table 7 presents the result for the full sample. Columns (1) and (2) show that the net FXD position of exposed firms rose 43–47% relative to non-exposed firms, given that the pre-shock average scaled FXD position was −8.2%.[36] Columns (3)–(6) show that the effects are large for small firms, but small and insignificant for large firms. The results when the continuous variable, *Exposure*, is used for the subsample with complete disclosure of counterparties (Table B.5) corroborate that firms were not able to offset the regulation shock transmitted by banks. Small firms in particular had difficulty finding an alternative source of FXD hedging. These results are analogous to evidence in the credit market (Khwaja and Mian (2008), for example).

Second, I report the effects on firm-level FXD positions by the sign of net FXD positions of firms. This is because the net FXD positions rather than export sales are what matter for constrained banks. I define firms with negative net FXD positions as exporters and those with positive FXD positions as non-exporters.[37] Table 8 reports the full sample results. Columns (1) and (2) show that exposed exporters reduced firm-level FXD hedging 40–45% relative to non-exposed firms, given that the pre-shock average scaled FXD position for exporters was −16%.[38] In contrast, there was almost no effect on non-exporters. Results for the subsample of fully disclosed firms using the continuous variable, *Exposure*, in Table B.6 are similar.

Overall, the results suggest that switching bank relationships in the FXD market is costly for firms. Some plausible reasons are related to the facts that FXDs are customized products and that banks typically bundle their services. In my sample, contracts are often customized to meet firm-specific hedging demand in terms of maturity and payoff structure. In addition, for a given firm, its main bank in terms of FXD contracts typically coincides with its main bank in terms of loans. Another reason could be that unconstrained banks were reserving the remaining capacity for the future needs of their existing customers. In light of previous work showing the importance of bank-borrower relationships in the credit market (Beck et al. (2018), Liberti and Sturgess (2018), Nakashima and Takahashi (2018), and others), it is

[36]The pre-shock average scaled FXD position is presented in Table 4.

[37]Based on this classification, a firm with non-zero export sales may be classified as "non-exporter" if, for instance, the firm holds a large amount of FC debt and its main purpose of hedging is to address the FC debt exposure. Nonetheless, the correlation between export sales and net FXD position is 0.95.

[38]The pre-shock average scaled FXD position of exporters is presented in Table IA.E.3.

plausible that the relationships are playing a key role in the FXD market as well.

The natural questions arising from the firm-level reduction in FXD hedging regard alternative hedging tools that firms can use. First, firms may enter FXD contracts with an offshore bank. However, I find that almost none of the firms that fully disclosed their counterparty banks switched to deal with an offshore entity. This is likely related to the reasons why firms were not able to substitute constrained banks with unconstrained banks within Korea: high degree of FXD product customization and bundling of FXD products with loan products. Another plausible explanation is the cost for foreign institutions to acquire information about Korean firms. It can be costly for a foreign entity to perform due diligence on Korean firms, especially smaller firms, to assess the credit risks associated with the FXD contracts. My finding that the firm-level hedging of small firms was affected by much more than that of large firms is consistent with this explanation. Furthermore, hedging KRW-involving-FXD entails investment in KRW-denominated bonds, which imposes administrative costs on a foreign entity.[39] Second, firms may use other financial instruments. For instance, exporters may borrow USD and invest in KRW-denominated bonds to replicate the cash flows of a short position in USD forwards. I am not able to directly test the hypothesis because detailed data on firm FC borrowing and security holdings are not available. Yet, it is unlikely, given my finding that the exposed firms did not even substitute their forwards with futures. It suggests that firms tend to prefer dealing FXD with banks to dealing directly in the market, likely due to their limited knowledge and capacity regarding FXD trading. Third, firms may adjust their risk exposure with nonfinancial instruments, such as operational hedging. One example of it is matching income currency and cost currency. Although I am not able to test this due to data limitations, either switching invoice currency to KRW or building plants in foreign countries is not likely a low-cost alternative means of hedging.

Main Result: Impact on Firm Exports

Provided that the reduction in bank hedging supply primarily affected exporters (net FXD sellers), I confine the sample to exporters and examine the effect of the shock on their exports.[40] I hypothesize that the impact would be larger for firms with higher export hedge

[39]For instance, investment procedure involves registration and setting up a custodian account. Moreover, income accrued from this investment is subject to withholding tax and capital gains tax.

[40]All exporters are better off when the USD appreciates and the main result focuses on exporters only. Therefore, exchange rate is not a confounding factor, as long as export sales sensitivity to exchange rate is

ratios, and use the following specification to estimate the impact on exports:

$$\Delta Y_j = \beta_E \; Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls + \varepsilon_j \quad (9)$$

The outcome variable is change in log export sales. $Exposure_j$ is the weighted average shock of firm j's counterparty banks. $HighHedge_j$ is an indicator variable that takes the value 1 if firm j sold FXD equaling more than 10% of its export sales and is 0 otherwise. With this definition, about two thirds of FXD-selling firms that fully disclosed their counterparties are classified as high-hedge firms ($HighHedge = 1$). The results are robust to the choice of threshold, 10%. I show that the results get even stronger if I use a continuous variable: the hedge ratio itself. Still, I use the dummy variable to ensure that the results are not driven by outliers.[41] The firm controls are the same as those in the previous regressions.

Table 9 presents the results. The top panel specification uses the dummy variable, High Hedge, and the bottom panel specification uses the continuous variable, Export Hedge Ratio. The impact of the regulation shock on exports is substantial. Column (1) shows that for a one-standard-deviation increase in $Exposure$, firm exports fall 17.1% for high-hedge firms and rise 5.7% for low-hedge firms. Therefore the differential effect is 22.8%.[42] Column (2) adds firm controls and the differential result is largely unchanged. The bottom panel shows that the results are robust to replacing High Hedge variable with Export Hedge Ratio, which is defined as the amount of FXD sold divided by export sales.[43]

Additionally, I test whether the firms with high export hedge ratios reduce their firm-level FXD hedging given that they are more exposed to the regulation shock. Table 10 shows that the change in the net FXD position for high-hedge firms was indeed large. The net FXD position moved up 6–6.7% more for high-hedge firms than for low-hedge firms, for a one-

controlled. I control for the heterogeneous export sensitivity to exchange rate by including pre-shock FX derivatives position.

[41] If a firm receives export orders for the next few years and enters a FXD contract to hedge the exposure, its export-hedge ratio may exceed 1, as unearned revenues are not captured in sales. It is valid to classify such a firm as a $HighHedge$ firm, as it relies heavily on FXD hedging. However, the hedge ratio itself may not be a perfect measure of the ratio of hedging to the full underlying exposure.

[42] In the sample period, between 2009 and 2010, the USD appreciated against KRW, and even with this favorable exchange rate movement for exporters, my results show that the exports fell for the firms that were more exposed to the regulatory shock and more relying on FXD before the regulation.

[43] I winsorize the top 2% and bottom 2% of the Export Hedge Ratio to ensure that the results are not driven by outliers.

standard-deviation increase in *Exposure*. These translate into 50–56% reduction in hedging, given the pre-shock average net FXD position of -12% among fully disclosed exporters.[44]

Further, as a placebo test to confirm that my results reflect the impact of the FXD supply shock, I estimate the impact on firm domestic sales. If the result on export sales is driven by a systemic relationship between troubled firms and constrained banks, one expects those troubled firms to experience declines in both domestic and export sales. However, in Table 11, I show that the change in domestic sales is small and insignificant, unlike that in export sales. This result confirms that the decline in exports is caused by the reduction in the supply of hedging instruments rather than by a systemic firm-bank relationship.

Impact on Firm Profitability

Additionally, I estimate the impact of the FXD supply shock on firm profitability using specifications (7), (8), and (9), where the outcome variable is the gross profit margin. I find evidence that the regulation shock negatively affects exporter profitability. Table 12 shows the results for the full sample, including the partially disclosed firms, by net FXD position. Columns (3) and (4) show that the gross profit margin of exposed exporters decreased approximately 10% more than that of non-exposed exporters, given a pre-shock average gross profit margin of 20%. Columns (5) and (6) show that the impact on importers was muted. I find similar, yet slightly weaker, results when I focus on fully disclosed firms and use the continuous variable, *Exposure* (Table B.7). Interestingly, the effect on profitability is not strongly concentrated among the high hedge firms, in contrast with the effect on exports (Table B.8).

Mechanism

The decrease in the supply of hedging leading to a substantial reduction in exports may look surprising in a few respects. First, the importance of hedging for these firms may look surprising compared with that for U.S. or European firms. While it is known that U.S. and European firms' use of FX derivatives is low, FX hedging is essential for Korean exporters. This is because invoice currency is predominantly in USD, and Korean exporters are mostly manufacturers without market power often leaving thin net profit margins. Without FX

[44] The pre-shock average net FXD/Asset is shown in Table IA.E.5.

derivatives, Korean exporters are critically exposed to FX risk.

Second, one may wonder if it is possible for a firm to adjust exports in the short term. While it may be difficult for firms to alter the contracts that have already been made, they can still choose to reduce new export contracts going forward. Therefore, export sales can fall without the non-fulfillment of existing contracts.

Third, the fact that it is optimal for a firm to reduce exports when hedging supply falls, especially in a short horizon, may be puzzling. However, this is not surprising in the context of Froot et al. (1993). Firms make short-term and long-term decisions, and export decisions tend to be of a shorter horizon than investment decisions. It would thus be natural for firms to internalize the effect of export outcomes on long-term decisions when making export decisions. Specifically, export outcomes will determine the size of internal funds available for future investment opportunities, and they are exposed to exchange rate risk. If internal funds fall short, firms would have to rely on external financing with convex cost. Then, they would face higher expected external financing costs when the volatility of the internal funds is higher. Therefore, they have incentives to lower the volatility of internal funds by using hedging instruments or lowering export quantity. When hedging becomes less available, it is optimal for firms to reduce export quantity to reduce the volatility of internal funds. In other words, a fall in exports is a result of firms' active risk management to lower the volatility of internal funds in order to make better investment decisions in the future. It is not a result of lower investment following a failure in risk management. In the internet appendix C, I present this mechanism in more detail and present a numerical example.[45]

Following from the mechanism a la Froot et al. (1993), when hedging becomes less available, high cash firms are expected to reduce exports by more than low cash firms would. This is because high cash firms can ensure through hedging that they always have enough internal funds for future investments even in a state with an unfavorable exchange rate. Therefore, they would reduce exports rather than maintaining unhedged exports and risk a shortfall of internal funds for future investment. On the other hand, low cash firms would be willing to be exposed to FX risk rather than foregoing exports because they would never have enough internal funds without taking some risk. In other words, they would prefer to forego hedging so that they have enough internal funds at least in a state with a favorable

[45]Figure C.1 plots export quantity and hedging quantity as a function of hedging friction. Figure C.2 plots expected firm value as a function of hedging friction.

exchange rate. Built on the numerical example, Figure C.3 plots exports with respect to the magnitude of hedging friction for high cash firms compared with low cash firms.

Based on the result of Figure C.3, I hypothesize that firms more exposed to the regulation, as well as higher cash balances and higher hedge ratios before the regulation, would reduce exports to a greater extent. I use the following specification to test the hypothesis:

$$\begin{aligned}\Delta Y_j = {} & \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_c Cash_j \\ & + \beta_{Eh} Exposure_j \times HighHedge_j + \beta_{Ec} Exposure_j \times Cash_j + \beta_{hc} HighHedge_j \times Cash_j \\ & + \beta_{Ehc} Exposure_j \times HighHedge_j \times Cash_j + FirmControls + \varepsilon_j \qquad (10)\end{aligned}$$

where $Cash_j$ is cash and cash equivalent balance scaled by total assets before the regulation. Consistent with the proposed mechanism, Table 13 shows that β_{Ehc} is negative, which implies that firms with higher cash and a high hedge ratio (before shock) reduced export sales by more. Furthermore, those firms switched to the domestic market to a greater extent, which corroborates that high cash firms have greater incentives to avoid FX risk exposure coming from exports when hedging becomes less available. In robustness analysis, I show that high cash is not a substitute for hedging and confirm that the main result is driven by the hedging channel.

5 Robustness Results

To ensure that my results reflect the impact of the regulation shock and not other shocks, I conduct several additional robustness checks.

First, one potential concern is a confounding effect of non-random sorting of firm-bank relationships. Although firm-bank sorting is non-random, Table 4 shows that key firm characteristics are not significantly different across exposed firms and non-exposed firms. This holds for the subset of firms that fully disclose their counterparty information as well as the subset of firms with net negative FXD positions.[46] Figure A.5 shows low correlations between firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure to the regulation shock. Nevertheless, I control for a large number of bank, firm, and contract characteristics to ensure that the results are not confounded by the

[46] See Table IA.E.2–Table IA.E.5.

differences in these characteristics throughout my analyses.

To corroborate that the results are not confounded by potentially systemic firm-bank relationships, I conduct an analysis using coarsened exact matching (CEM) (See Blackwell et al. (2009)) based on FC liability share, the dimension along which the exposed and non-exposed firms differ with statistical significance. I coarsen the sample into five bins, considering the trade-off between keeping observations and the post-match similarity of FC liability share for the treatment and control groups. The top panel of Table B.9 shows that the results remain similar. The interaction term is negative and significant for change in log exports, positive and significant for change in the net FXD position (scaled by assets), and small and insignificant for change in log domestic sales. The bottom panel of Table B.9 shows that the results are robust even after matching firms on export share, profitability, and FC liability share.[47] I include export share as a matching variable to address an alternative hypothesis that exporters predominantly traded with foreign banks, which represent the majority of constrained banks. I also include profitability as a matching variable to address an alternative hypothesis that troubled firms predominantly traded with constrained banks.

Second, one may be concerned about the difference in business models between foreign and domestic banks. Almost by construction, it is likely that foreign banks would suffer more from the regulation because they are more active in the FXD business than domestic banks. In fact, a few foreign banks closed in 2017, after the regulation was imposed.[48] However, it is noteworthy that only half (14 out of 29) the foreign banks in my sample were constrained when the regulation was imposed, I find stronger results in the bank-level analysis when I restrict my sample to foreign banks (Table B.10a).[49] This suggests that my results are not driven by the differences in characteristics between foreign and domestic banks. In addition, the strong result within foreign banks suggests that my bank-level results are unlikely to be mainly driven by the GFC, which cannot explain the variation within foreign banks.

Third, one could worry that the result is confounded by a credit supply shock. Specifically, an alternative hypothesis is that constrained banks were in trouble during the GFC and

[47]I coarsen the sample into three bins per matching variable.

[48]Royal Bank of Scotland, Barclays, Goldman Sachs International Bank, and UBS

[49]The bottom table of Table B.10 suggests that constrained domestic banks reduced their capital bases compared with unconstrained domestic banks. This result is driven by domestic banks with smaller FXD market shares. When the observations are weighted by bank FXD positions, domestic banks' adjustments in *LogCapital* are not significant (Table IA.H.2b).

therefore were more likely to suffer from the credit supply shock. However, the results that the constrained bank share of FC lending was not significant for the full sample (Table B.11), for foreign banks (Table B.12), and for domestic banks (Table B.13) corroborate that the mechanism at work is through the hedging channel rather than the credit channel.[50]

Fourth, one may be concerned that holding high cash balance is a substitute for hedging and the main result is driven by cash balance rather than hedging. However, when the high hedge dummy variable is replaced with the high cash dummy variable in specification (9), the coefficient on the interaction term is not significant (Table B.14). This is consistent with the mechanism that high cash firms have an incentive to hedge to ensure that they have enough cash even in a state with an unfavorable exchange rate. That cash alone fails to explain the decline in exports supports the hedging channel.

Lastly, I document additional suggestive evidence that the reduction in the FXD position was driven by a reduction in supply as opposed to a reduction in demand, by looking at the FXD pricing. If the reduction in the FXD position was driven by a reduction in supply, one would expect to see an increase in the price of FXD hedging. An increase in FXD hedging cost from the perspective of exporters corresponds to a decrease in USD forward prices since exporters are *sellers* of USD forwards. Put differently, constrained banks would lower forward prices to reduce their long positions. Since I do not observe firm-specific pricing on derivatives, I am not able to directly show that constrained banks lowered USD forward prices relative to unconstrained banks. Nevertheless, I show suggestive evidence that firms' forwards hedging costs increased after the regulation by comparing short-term and long-term CIP deviations. I define CIP deviation for maturity n at time t, $x_{t,t+n}$, as the difference between the USD rate ($y^{\$}_{t,t+n}$) and the USD rate implied by forward price ($f_{t,t+n}$), spot exchange rate (s_t)[51], and KRW rate ($y^{₩}_{t,t+n}$):

$$x_{t,t+n} = y^{\$}_{t,t+n} - \left(y^{₩}_{t,t+n} - \frac{1}{n}(f_{t,t+n} - s_t) \right) \tag{11}$$

CIP deviation, $x_{t,t+n}$, would likely fall or, equivalently, increase in magnitude as banks lower forward prices to reduce their long positions. Since forward positions are subject to the FXD position limit while synthetic forward positions are not, the shadow cost of the constraint

[50]For this analysis, closed banks are excluded due to data unavailability.
[51]Value of 1 USD in terms of KRW; higher s_t means USD appreciation.

would widen the wedge between the price of forwards and the price of synthetic forwards. In the cross-section of tenors of CIP, the regulation would likely affect long-term CIP deviation more than the short-term because bank long positions in USD forwards are concentrated in longer tenors. Figure A.6 plots three-month and three-year CIP deviations. It shows that the three-year CIP deviation fell relative to the three-month CIP deviation, particularly after the first two announcements.

6 Conclusion

In this paper, I examine the real effects of FXD hedging. I exploit a quasi-natural experiment in South Korea at the bank level that can be traced through firms. By using cross-bank variation in the regulation's tightness, I show that it causes a reduction in the supply of FXD, resulting in a substantial decline in exports among the firms that heavily relied on FXD hedging. These results provide causal evidence that a negative FXD supply shock can trigger a decline in exports, and regulations aiming to curtail financial intermediary risk-taking can have detrimental effects on the real economy. I offer a mechanism in which imbalances in hedging demand, banks' costly equity financing, firms' costly switching of banking relationships, and firms' costly external financing play key roles in explaining the empirical findings.

Looking beyond this paper, I expect literature to expand to studying the long-term effects of FXD supply shocks and macroprudential FX regulations. A question that arises from my analysis is whether the regulation affected other financial and operational hedging of firms. Whether and to what extent firms facing a supply shock in derivatives can turn to alternative hedging options in the long term is an important question for future research. Another question concerns welfare implications. While I show that the regulation caused a reduction in exports, my analysis does not include an overall welfare evaluation of the regulation. While welfare analysis is an interesting question, it is beyond the scope of this paper because it would involve a general equilibrium model of multiple economies that requires understanding the preferences of the regulator and interactions with other macroprudential measures.

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Figures

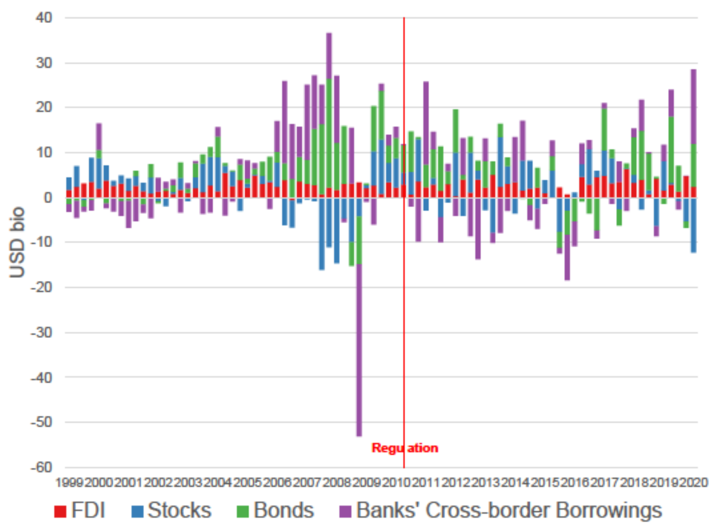


Figure 1: **Gross Foreign Capital Inflows** Korea's gross foreign capital inflows. The vertical line indicates the imposition of the regulation.

Firms (Exporters)			Banks		
Long FC:	*Short FC:*		*Long FC:*	*Short FC:*	
FC Receivables	**FX Derivatives**	→	**FX Derivatives**	**FC Borrowing**	<- Cross-
(Long-term)	(Long-term)		(Long-term)	(Short-term)	border
	FC Loans		FC Loans	FC Deposits	

Figure 2: **FX Positions of Exporters and Banks before the Regulation** The left panel illustrates the structure of the exporter FX position and the right panel illustrates the structure of the bank FX position prior to the regulation. Exporters had a long position in foreign currency (due to export sales) and hedged the exposure by taking short positions in FXD. As banks are firms' FXD counterparties, banks had a long position in foreign currency due to the FXD. Banks hedged the long exposure by foreign currency borrowing.

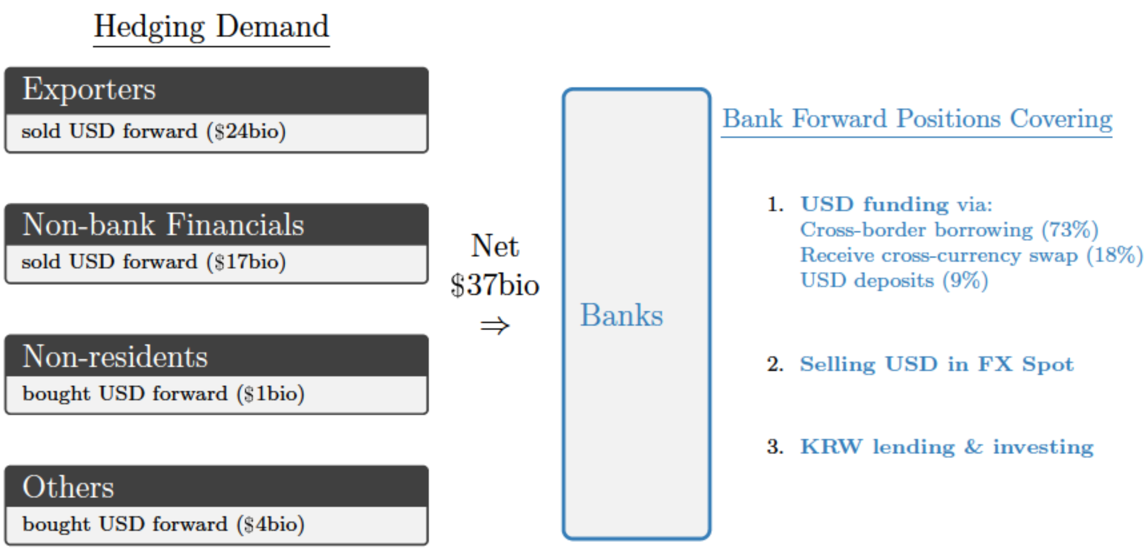
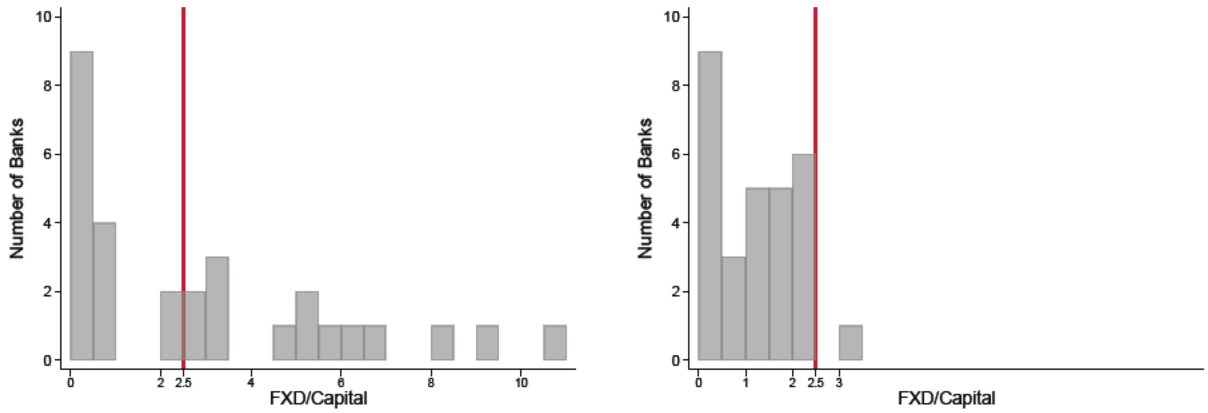
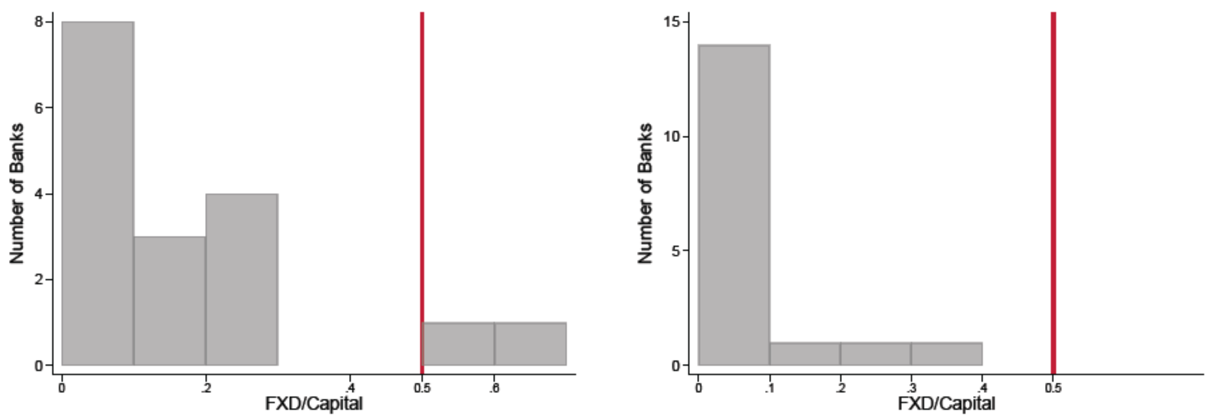


Figure 3: **FX Forward Hedging Demand and Bank Positions Covering** The left panel shows the amount of USD forwards each non-bank sector purchased from or sold to banks during the first three quarters of 2007. The right panel shows how banks covered the net long position of 37 billion USD in forwards. Source: Bank of Korea (2008)



(a) Before Regulation (2009 Dec) (b) After Regulation (2010 Dec)

Figure 4: **FXD Position to Capital Ratio, Before and After the Regulation (Foreign Banks)** The histogram of the FXD position to the capital (DPTC) ratio of foreign banks, six months before and six months after the first announcement of regulation. The vertical line indicates the regulatory cap on the DPTC ratio.



(a) Before Regulation (2009 Dec) (b) After Regulation (2010 Dec)

Figure 5: **FXD Position to Capital Ratio, Before and After the Regulation (Domestic Banks)** The histogram of the FXD position to the capital (DPTC) ratio of domestic banks, six months before and six months after the first announcement of regulation. The vertical line indicates the regulatory cap on the DPTC ratio.

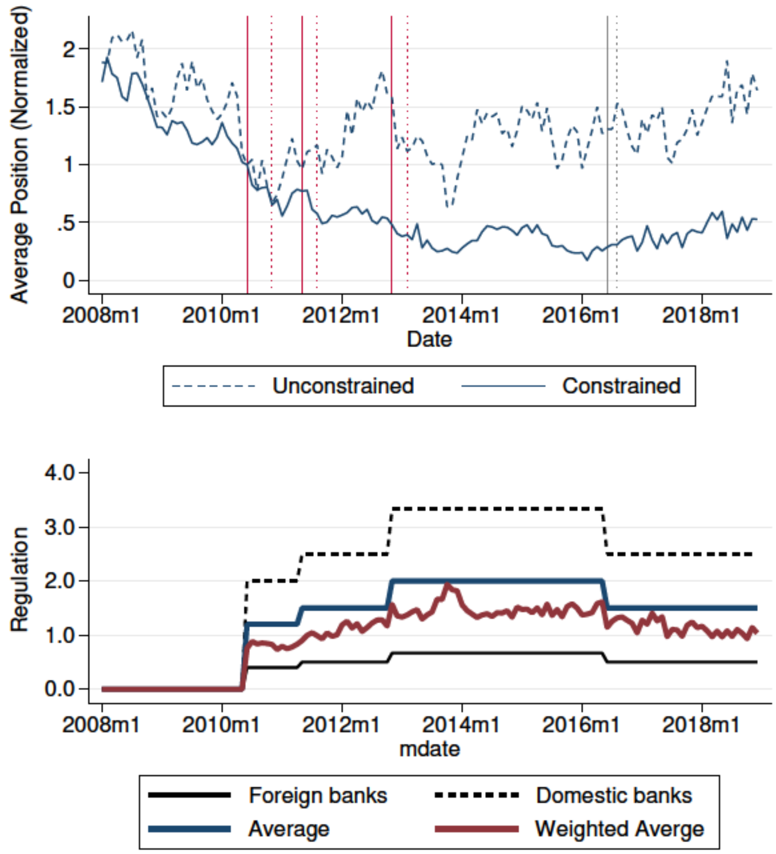


Figure 6: **FXD Position by Treatment** The top panel plots the normalized average FXD position of constrained (solid) and unconstrained (dotted) banks. The average FXD positions are normalized such that they are 1 at the imposition of the regulation. The vertical solid (dotted) lines indicate the announcement (effective) dates of the changes in the minimum FXD capital requirement. The bottom panel plots the minimum FXD capital requirements. The blue line is the simple average and the red line is the weighted average minimum FXD capital requirements where the weight is FXD position.

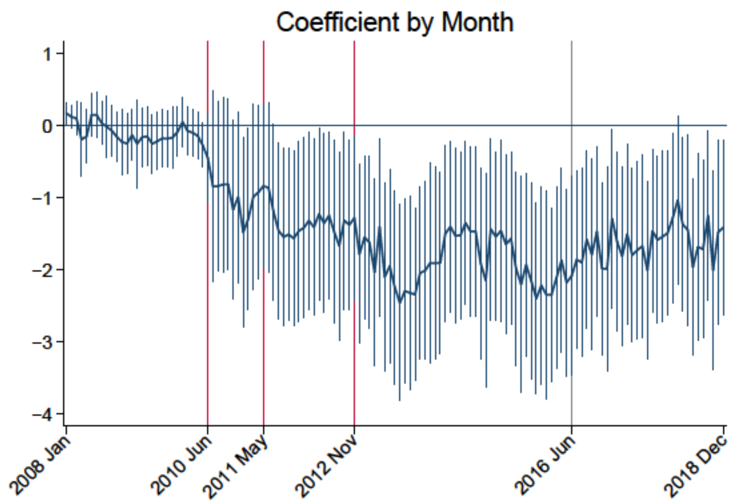


Figure 7: **Coefficient by Month** Plot of λ_t over time in the following specification: $Y_{it} = \beta_0 + \beta_1 Constrained_i + \beta_2 Post_t + \sum_t \lambda_t Constrained_i \times \gamma_t + \varepsilon_{it}$ where $Post$ takes the value of 1 for the time period after the regulation (June 2010) and 0 otherwise. γ_t is the time dummy variable for each month. The vertical lines correspond to the adjustments of the regulatory cap. The first three vertical lines (in red) indicate tightening adjustments and the last vertical line (in grey) indicates a loosening adjustment.

Tables

Announced on	June 13, 2010	May 19, 2011	Nov 27, 2012	June 16, 2016	March 18, 2020
Effective from	Oct 31, 2010	July 31, 2011	Jan 31, 2013	July 31, 2016	March 19, 2020
Foreign Banks	250%	200%	150%	200%	250%
Domestic Banks	50%	40%	30%	40%	50%

Table 1: **FXD Position Limits over Time** The top two rows show the announcement dates and effective dates. The regulation was first announced on June 13, 2010. The bottom two rows show the historical changes in the regulatory cap on the ratio of FXD to capital. 250% means that a bank's FXD position is required to be lower than 2.5 times its capital.

	Full Sample		Constrained		Unconstrained		Difference	
	mean	sd	mean	sd	mean	sd	b	t
FXD (mio USD)	1,348	1,467	2,385	1,421	796	1,178	-1,589***	(-3.8)
Capital (mio USD)	2,726	4,317	971	1,275	3,662	5,046	2,691**	(2.8)
Asset (mio USD)	33,708	55,924	13,602	15,845	44,432	66,190	30,830*	(2.4)
FXD/Assets (%)	14	19	31	21	5	8	-26***	(-4.8)
Loans/Assets (%)	40	29	18	19	52	27	34***	(5.1)
Deposits/Assets (%)	20	28	10	20	26	30	16*	(2.1)
Equity/Assets (%)	7	4	5	2	7	4	2*	(2.3)
FC Loan Share (%)	44	41	67	40	34	38	-33*	(-2.2)
FC Liab Share (%)	18	23	13	16	20	26	8	(1.2)
Observations	46		16		30		46	

Table 2: **Bank Summary Statistics** All variables are computed as of December 2009 and are defined in the Appendix.

	Full Sample		Constrained		Unconstrained		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Notional Net (USD mio)	18.0	77	30.1	92	10.2	64	-20	(-1.9)
FXDNet/Assets (%)	-2.9	9	-3.0	9	-2.9	8	0	(0.1)
Direction: Firm sells FC (%)	51.4	49	41.4	48	57.7	49	16*	(2.6)
Pair: USD-KRW (%)	86.2	32	95.5	17	80.2	37	-15***	(-4.4)
Pair: JPY-KRW (%)	11.4	30	1.5	11	17.8	36	16***	(5.3)
Pair: EUR-KRW (%)	1.8	10	1.6	8	2.0	11	0	(0.3)
Type: Forwards (%)	52.8	49	38.2	47	62.1	48	24***	(3.9)
Type: Swaps (%)	39.0	48	48.4	49	32.9	47	-16*	(-2.5)
Type: Options (%)	7.9	26	13.4	33	4.3	20	-9*	(-2.4)
Type: Futures (%)	0.4	6	0.0	0	0.7	8	1	(1.0)
Observations	251		98		153		251	

Table 3: **FXD Contract Summary Statistics** All variables are computed as of December 2009 and are defined in the Appendix. I define contract as a firm-bank pair.

	Full Sample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	2,371.130	6422.07	2,673.585	8728.05	2,202.391	4719.67	-471.19	(-0.36)
FXDNet/Assets	-0.082	0.19	-0.065	0.18	-0.091	0.20	-0.03	(-0.79)
Sales (USD mio)	1,936.725	4648.93	1,801.008	4534.04	2,012.440	4733.92	211.43	(0.27)
FXDNet/Sales	-0.097	0.28	-0.061	0.26	-0.118	0.30	-0.06	(-1.23)
Number of Banks	2.385	2.41	2.472	2.08	2.337	2.58	-0.13	(-0.35)
Log Size	26.804	1.83	26.836	1.76	26.786	1.87	-0.05	(-0.16)
Leverage	0.487	0.18	0.511	0.16	0.474	0.19	-0.04	(-1.26)
Gross Profit Margin	0.211	0.17	0.210	0.19	0.211	0.15	0.00	(0.02)
FC Asset Share	0.096	0.11	0.088	0.11	0.101	0.11	0.01	(0.66)
FC Liab Share	0.197	0.19	0.240	0.19	0.173	0.20	-0.07*	(-2.05)
Export Share	0.473	0.31	0.425	0.32	0.502	0.30	0.08	(1.38)
Export Hedge Ratio	0.409	0.71	0.435	0.72	0.393	0.71	-0.04	(-0.31)
FCL Hedge Ratio	0.485	2.11	0.803	3.41	0.300	0.50	-0.50	(-1.07)
Observations	148		53		95		148	

Table 4: **Firm Summary Statistics** All variables are computed as of December 2009 and are defined in the Appendix. Summary statistics of sub-samples are included in the Internet Appendix.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.913***	-0.967***	0.0268	0.0262	-3.383***	-3.377***
	(-3.18)	(-3.28)	(0.33)	(0.34)	(-5.13)	(-5.17)
Constrained=1	5.341***		-0.646		6.505***	
	(3.92)		(-1.52)		(5.40)	
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	5906	5906	5885	5885	5886	5886
Adj RSqr	0.109	0.802	0.0550	0.915	0.409	0.497

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Based on Simple Average FXD Capital Requirement

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-1.207***	-1.292***	0.0203	0.0152	-4.398***	-4.388***
	(-3.05)	(-3.17)	(0.19)	(0.15)	(-5.16)	(-5.21)
Constrained=1	5.312***		-0.631		6.326***	
	(3.91)		(-1.49)		(5.44)	
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	5906	5906	5885	5885	5886	5886
Adj RSqr	0.109	0.803	0.0550	0.915	0.404	0.492

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Based on Weighted Average FXD Capital Requirement

Table 5: **Impact on Bank FXD Position and Capital** The regressions in this table examine the impact of the regulation shock on the bank FXD position. The top panel uses $Regulation_t^{Avg}$, which takes 0 before the regulation and the **simple average** of foreign bank and domestic bank minimum FXD capital requirements. The bottom panel uses $Regulation_t^{WAvg}$, which is the **weighted average** of the minimum FXD capital requirements, where the weight is the FXD position in each month. In either case, a higher value indicates tighter constraint. Columns (2), (4), and (6) add bank fixed effects. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Constrained	0.0529***	0.0374**	0.00189	0.00317**	0.0228**	0.0129*
	(3.66)	(2.52)	(1.00)	(2.09)	(2.28)	(1.70)
Type Swaps		0.0114		-0.00114		0.00511
		(0.59)		(-0.15)		(1.13)
Type Options		0.0862***		0		0.0992***
		(4.48)		(.)		(6.38)
Type Futures		0.0111		0		0.00293
		(0.54)		(.)		(0.34)
Pair EURKRW		0.0661		0		0.0469
		(1.20)		(.)		(1.45)
Pair JPYKRW		-0.0188		0.00658**		0.00104
		(-1.29)		(2.17)		(0.15)
Pair XXXKRW		-0.00541		-0.00207		-0.000744
		(-0.43)		(-0.18)		(-0.13)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	129	129	122	122	251	251
RSqr	0.0964	0.353	0.00419	0.125	0.0371	0.315

t statistics in parentheses

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

Table 6: **Transmission of Regulation Shock to FXD Hedging at the Contract Level** The regressions in this table examine the impact of the regulation shock on firm FXD contracts. I define contract as a firm-bank pair. The dependent variable is the change in net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $\mathbf{Constrained_i}$ is 1 if the contract is dealt with a constrained bank and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Small	(4) Small	(5) Large	(6) Large
Exposed	0.0352**	0.0385**	0.0608**	0.0716**	0.00838	0.00910
	(2.13)	(2.43)	(2.50)	(2.49)	(0.40)	(0.52)
Constant	-0.00329	0.0265	-0.00167	-0.180	-0.00487	-0.260
	(-0.28)	(0.17)	(-0.10)	(-0.24)	(-0.28)	(-0.98)
FirmControls	N	Y	N	Y	N	Y
N	148	148	74	74	74	74
RSqr	0.0253	0.0771	0.0743	0.186	0.00151	0.0237

t statistics in parentheses

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

Table 7: **Impact on Firm-level FXD Position by Firm Size, Full Sample** The regressions in this table examine the impact of the regulation on firm-level FXD positions. The outcome variable is change in firm j's net FXD position scaled by assets. Independent variable *Exposed* is 1 if the firm's main FXD counterparty bank is constrained. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Exporter	(2) Exporter	(3) Non-exporter	(4) Non-exporter
Exposed	0.0640**	0.0728***	-0.00226	-0.00229
	(2.48)	(2.72)	(-0.39)	(-0.41)
Constant	-0.00302	-0.0811	-0.00380	0.0451
	(-0.17)	(-0.27)	(-1.24)	(0.84)
FirmControls	N	Y	N	Y
N	92	92	56	56
RSqr	0.0510	0.113	0.00307	0.0798

t statistics in parentheses

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

Table 8: **Impact on Firm-level FXD Position by Net FXD Position, Full Sample** The regressions in this table compare the impact of the regulation on the firm-level FXD positions of exporters and non-exporters. A firm is classified as an exporter (non-exporter) if it holds a negative (positive) net FXD position. The outcome variable is the change in firm j's net FXD position scaled by assets. Independent variable *Exposed* is 1 if the firm's main FXD counterparty bank is constrained. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) LogExport	(2) LogExport
High Hedge=1 × Exposure	-0.228*	-0.189*
	(-1.94)	(-1.81)
Exposure	0.0571	0.0956
	(0.77)	(1.55)
High Hedge=1	0.136	0.0217
	(1.30)	(0.24)
Constant	0.212***	-1.615
	(2.66)	(-1.22)
FirmControls	N	Y
N	74	74
RSqr	0.0817	0.324

t statistics in parentheses

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

(a) High Hedge vs. Low Hedge Firms

	(1) LogExport	(2) LogExport
Exposure × Export Hedge Ratio	-0.196***	-0.237**
	(-3.96)	(-2.24)
Exposure	-0.0557	-0.0530
	(-0.99)	(-0.83)
Export Hedge Ratio	0.0808	0.153**
	(1.29)	(2.12)
Constant	0.299***	-1.663
	(6.14)	(-1.31)
FirmControls	N	Y
N	74	74
RSqr	0.228	0.464

t statistics in parentheses

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

(b) Continuous Hedge Ratio

Table 9: **Impact on Export Sales** The regressions in this table examine the impact of the regulation on exports. The outcome variable is the change in log export sales. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. The top panel uses $HighHedge_j$, which takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. The bottom panel uses $ExportHedgeRatio_j$, which is firm j's sold amount of FXD divided by export sales. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) FXD/Asset	(2) FXD/Asset
High Hedge=1 × Exposure	0.0594***	0.0667***
	(2.70)	(2.84)
Exposure	0.0124	0.0124
	(1.22)	(1.16)
High Hedge=1	0.0418**	0.0433**
	(2.13)	(2.15)
Constant	-0.00820	-0.124
	(-1.01)	(-0.56)
FirmControls	N	Y
N	74	74
RSqr	0.215	0.319

t statistics in parentheses

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

Table 10: **Impact on Firm-level FXD Position** The regressions in this table examine the impact of the regulation on the firm-level FXD position. The outcome variable is the change in firm j's net FXD notional scaled by assets. All variables are defined in the Appendix.

	(1) LogDomesticSales	(2) LogDomesticSales
High Hedge=1 × Exposure	-0.0372	-0.00911
	(-0.37)	(-0.09)
Exposure	-0.00754	0.000967
	(-0.09)	(0.01)
High Hedge=1	0.127	0.0932
	(1.44)	(0.95)
Constant	0.0885	0.315
	(1.24)	(0.35)
FirmControls	N	Y
N	74	74
RSqr	0.0353	0.118

t statistics in parentheses

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

Table 11: **Impact on Domestic Sales as a Placebo Test** The regressions in this table examine the impact of the regulation on domestic sales. The outcome variable is the change in firm j's log domestic sales. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Exporter	(4) Exporter	(5) Non-exporter	(6) Non-exporter
Exposed	-0.00508	-0.00843	-0.0202*	-0.0241*	0.0129	0.0112
	(-0.42)	(-0.71)	(-1.74)	(-1.93)	(0.56)	(0.74)
Constant	0.00545	-0.200**	0.00250	-0.358***	0.0110	-0.0658
	(0.81)	(-2.36)	(0.32)	(-2.99)	(0.86)	(-0.57)
FirmControls	N	Y	N	Y	N	Y
N	148	148	92	92	56	56
RSqr	0.00129	0.0710	0.0274	0.225	0.00618	0.672

t statistics in parentheses

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

Table 12: **Impact on Profitability by Net FXD Position, Full Sample** The regressions in this table examine the impact of the regulation on firm profitability. The outcome variable is the change in gross profit margin. Independent variable *Exposed* is 1 if the firm's main FXD counterparty bank is constrained. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) LogExport	(2) ExpShare
High Hedge=1 × Exposure × Cash	-3.789**	-1.478***
	(-2.09)	(-3.68)
High Hedge=1 × Exposure	0.0885	0.0665**
	(0.64)	(2.22)
High Hedge=1 × Cash	-1.847	-1.025***
	(-1.39)	(-3.37)
Exposure × Cash	2.506	0.953**
	(1.63)	(2.54)
Exposure	-0.0177	-0.0224
	(-0.21)	(-0.93)
High Hedge=1	0.0876	0.0422
	(0.66)	(1.63)
Cash	2.931**	1.055***
	(2.42)	(3.61)
Constant	-2.553**	-0.625**
	(-2.19)	(-2.60)
FirmControls	Y	Y
N	74	74
RSqr	0.421	0.525

t statistics in parentheses

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

Table 13: **Role of Internal Funds on Export Sales and Export Share** The regressions in this table examine the impact of the regulation, hedge ratio, and internal funds (cash balance) on export sales and share of export sales. The outcome variable is export sales or share of export sales. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. $Cash_j$ is firm's pre-shock cash and cash equivalent balance scaled by total assets. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

Appendix

A Additional Figures

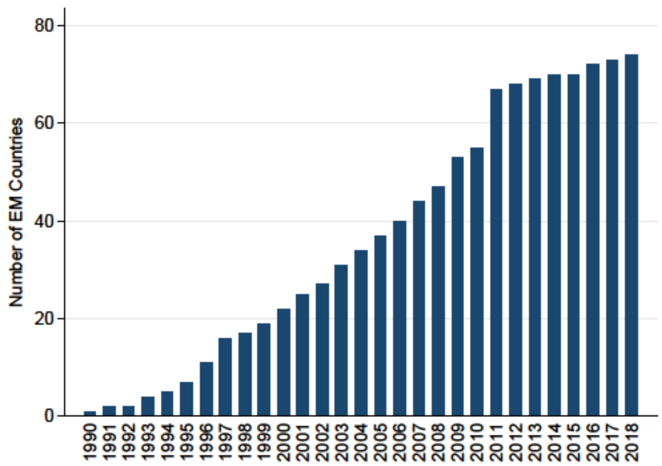


Figure A.1: **Number of Countries using Macroprudential FX Regulations** The number of emerging market and developing economy countries using macroprudential FX regulations. Source: IMF integrated Macroprudential Policy Database.

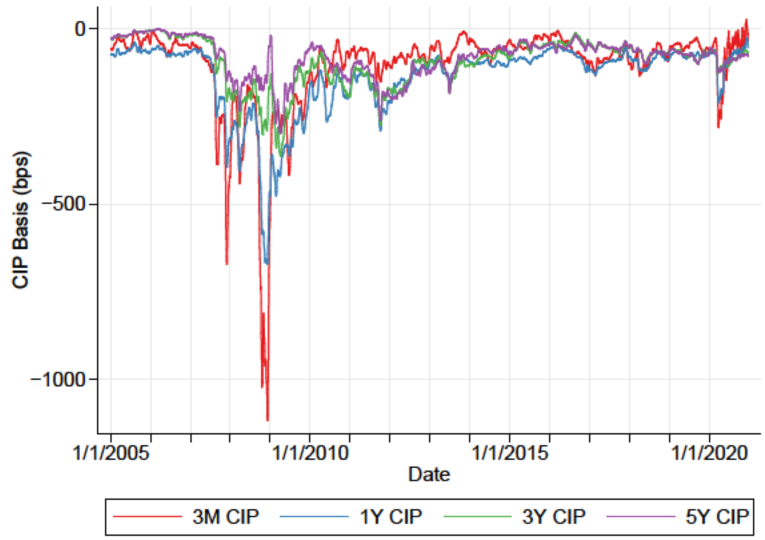


Figure A.2: **CIP Bases** 10-day moving average of daily CIP bases for different maturities. CIP basis at time t for maturity n is defined in equation (11).

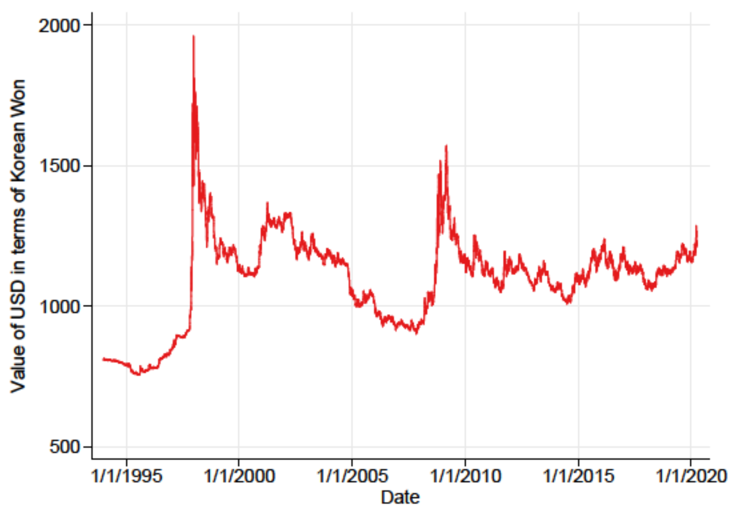


Figure A.3: **Korean Won Exchange Rate** The exchange rate is defined as the value of 1 USD in Korean Won (KRW). A higher exchange rate indicates depreciation of the KRW.

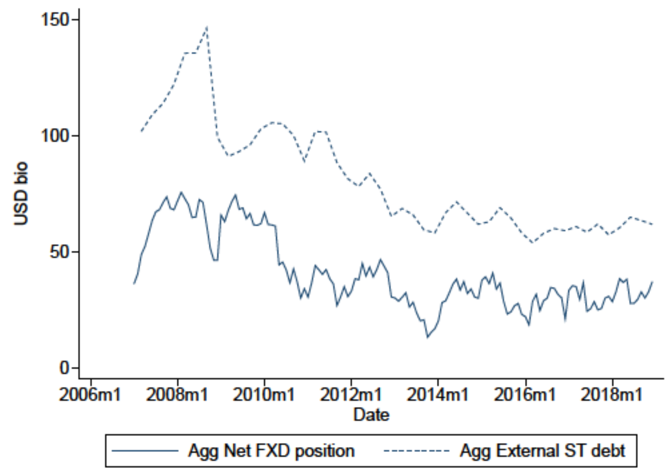


Figure A.4: **FXD Position and External Short-term Borrowings** The dotted line is the aggregate external short-term debt and the solid line is the aggregate net FXD position of the banking sector.

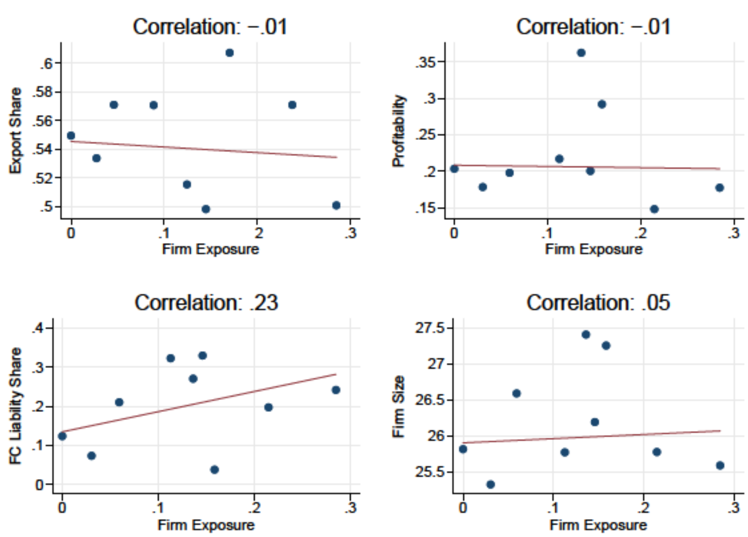


Figure A.5: **Correlations between Firm Characteristics and Firm Exposure** Binned scatter plots of firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure to the regulation.

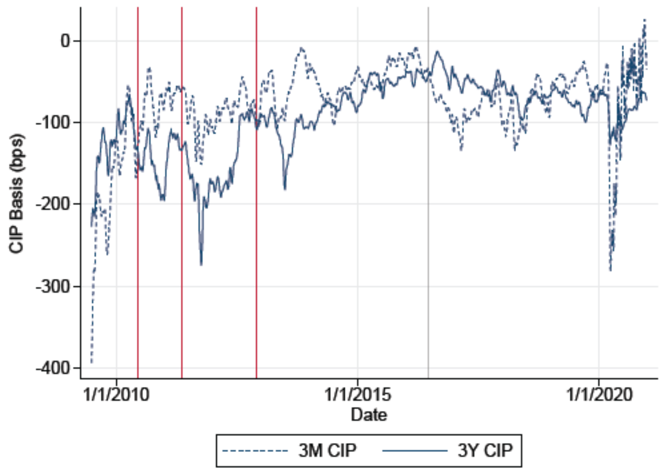


Figure A.6: **CIP Deviations: Short-term and long-term** 10-day moving average of 3-year (solid) and 3-month (dotted) USD-KRW CIP deviations where CIP deviation is defined in equation (11). The first three red vertical lines indicate tightening adjustments while the last grey vertical line indicates a loosening adjustment.

B Additional Tables

Variable	Definition
	Bank-level Variables
FXD	FXD position
Capital	Total bank capital
Asset	Total bank assets
FXD/Assets	FXD position as a share of assets
Loans/Assets	Bank loans as a share of assets
Deposits/Assets	Bank deposits as a share of assets
Equity/Assets	Bank equity as a share of assets
FC Loan Share	Bank's foreign currency loans as a share of loans
FC Liab Share	Bank's foreign currency borrowings as a share of borrowings
LogFXD	Natural logarithm of total FXD position
LogCapital	Natural logarithm of total capital
FXD/Capital	FXD position as a share of capital
$Constrained_i$	Indicator variable equal to one if bank i is constrained and zero otherwise
$Regulation^{Avg}$	Simple average regulatory capital requirement (Blue solid line in Figure 6)
$Regulation^{WAvg}$	Weighted average regulatory capital requirement (Red solid line in Figure 6)
	FXD Contract-level Variables
Notional Net	FXD position at the contract (firm-bank pair) level
FXDNet/Assets	Net FXD as a share of assets from the firm's perspective
Direction	FXD that firm sells to banks as a share of FXD
Pair: USD-KRW	FXD that involves USD-KRW as a share of FXD
Pair: JPY-KRW	FXD that involves JPY-KRW as a share of FXD
Pair: EUR-KRW	FXD that involves EUR-KRW as a share of FXD
Type: Forwards	FX forwards as a share of FXD
Type: Swaps	FX swaps as a share of FXD
Type: Options	FX options as a share of FXD
Type: Futures	FX futures as a share of FXD
$Constrained_{ij}$	Indicator variable equal to one if bank i is constrained and zero otherwise
$Shock_i$	Percentage of bank i's FXD position that needed to be reduced on imposition of the regulation
	Firm-level Variables
Assets	Total firm assets
FXDNet/Assets	Firm's net FXD position as a share of assets
Leverage	Firm liabilities as a share of assets
Gross Profit Margin	Firm gross profit as a share of liabilities
FC Asset Share	Firm's foreign currency assets as a share of assets
FC Liab Share	Firm's foreign currency liabilities as a share of liabilities
Export Share	Firm's export sales as a share of sales
Export Hedge Ratio	Amount of FXD that firm sold as a share of its export sales
FCL Hedge Ratio	Amount of FXD that firm bought as a share of its foreign currency liabilities
Exposed	Indicator variable equal to one if the firm's main bank is constrained and zero otherwise
Exposure	Weighted average shock of the firm's FXD counterparty banks
HighHedge	Indicator variable equal to one if the firm's export hedge ratio is higher than 10%, zero otherwise
Cash	Firm's cash and cash equivalent as a share of assets

Table B.1: **Variable Definitions**

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Shock	0.0306***	0.0220***	0.00100*	0.00161*	0.00765	0.00482
	(2.95)	(3.00)	(1.73)	(2.03)	(1.46)	(1.51)
Type Swaps		0.0159		-0.000985		0.00598
		(0.85)		(-0.13)		(1.36)
Type Options		0.0865***		0		0.100***
		(4.49)		(.)		(6.63)
Type Futures		0.00914		0		0.00298
		(0.45)		(.)		(0.34)
Pair EURKRW		0.0562		0		0.0460
		(1.06)		(.)		(1.43)
Pair JPYKRW		-0.0200		0.00680*		-0.000960
		(-1.31)		(1.93)		(-0.13)
Pair XXXKRW		-0.00860		0.00465		0.00317
		(-0.76)		(0.45)		(0.44)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	129	129	122	122	251	251
RSqr	0.0820	0.350	0.00650	0.127	0.0174	0.313

t statistics in parentheses

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

Table B.2: **Transmission of Regulation Shock to FXD Hedging at Contract Level using continuous variable, Shock** The regressions in this table examine the impact of the regulation shock on firm FXD contracts. I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $\mathbf{Shock_i}$ is the percentage of bank i's FXD position that needed to be reduced when the regulation was imposed. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Constrained	0.0259*	0.0296*	0.00192	0.00326*	0.0121**	0.00927
	(1.96)	(2.06)	(0.99)	(2.00)	(2.12)	(1.28)
Type Swaps		-0.000369		-0.00110		0.00325
		(-0.02)		(-0.14)		(0.65)
Type Options		0		0		0
		(.)		(.)		(.)
Type Futures		0.0193		0		0.00604
		(0.85)		(.)		(0.72)
Pair EURKRW		0.0218		0		0.0218*
		(0.70)		(.)		(1.91)
Pair JPYKRW		-0.0182		0.00662**		-0.000000735
		(-1.08)		(2.17)		(-0.00)
Pair XXXKRW		0.000695		-0.00265		0.00137
		(0.05)		(-0.23)		(0.25)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	111	111	122	122	233	233
RSqr	0.0270	0.125	0.00415	0.125	0.0144	0.0566

t statistics in parentheses

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

Table B.3: **Transmission of Regulation Shock to FXD Hedging, Excluding Option Contracts (1)** The regressions in this table examine the impact of the regulation shock on firm FXD contracts when **I exclude all option contracts from the data.** I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $Constrained_i$ is 1 if the contract is dealt with a constrained bank and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Shock	0.0168**	0.0183**	0.00103*	0.00169*	0.00509**	0.00363
	(2.34)	(2.88)	(1.71)	(2.03)	(2.11)	(1.25)
Type Swaps		0.00435		-0.000947		0.00391
		(0.21)		(-0.12)		(0.78)
Type Options		0		0		0
		(.)		(.)		(.)
Type Futures		0.0171		0		0.00602
		(0.75)		(.)		(0.71)
Pair EURKRW		0.0141		0		0.0210*
		(0.48)		(.)		(1.96)
Pair JPYKRW		-0.0187		0.00687*		-0.00135
		(-1.07)		(1.91)		(-0.17)
Pair XXXKRW		-0.00287		0.00427		0.00421
		(-0.20)		(0.41)		(0.58)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	111	111	122	122	233	233
RSqr	0.0287	0.124	0.00638	0.127	0.0109	0.0551

t statistics in parentheses

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

Table B.4: **Transmission of Regulation Shock to FXD Hedging, Excluding Option Contracts (2)** The regressions in this table examine the impact of the regulation shock on firm's FXD contracts when **I exclude all option contracts from the data.** I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $Shock_i$ is the percentage of bank i's FXD position that needed to be reduced at the imposition of the regulation. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Small	(4) Small	(5) Large	(6) Large
Exposure	0.0270***	0.0304***	0.0367***	0.0379***	0.0174**	0.0195***
	(3.45)	(3.86)	(2.83)	(3.13)	(2.27)	(2.73)
Constant	0.0105	0.146	0.0190	-0.153	0.00289	0.222
	(1.39)	(1.26)	(1.45)	(-0.23)	(0.37)	(1.12)
FirmControls	N	Y	N	Y	N	Y
N	132	132	66	66	66	66
RSqr	0.0687	0.164	0.0888	0.465	0.0537	0.154

t statistics in parentheses

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

Table B.5: **Impact on Firm-level FXD Position by Firm Size, Fully Disclosed Firms** The regressions in this table examine the impact of regulation on firm-level FXD positions when I restrict the sample to firms that fully disclosed their FXD counterparty information. The outcome variable is the change in firm j's net FXD position scaled by assets. Independent variable *Exposure* is the weighted average shock of the firm's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Exporter	(2) Exporter	(3) Non-exporter	(4) Non-exporter
Exposure	0.0513***	0.0582***	0.00151	0.000738
	(3.95)	(4.22)	(0.45)	(0.19)
Constant	0.0246**	0.0183	-0.00564**	0.0591
	(2.10)	(0.08)	(-2.05)	(0.88)
FirmControls	N	Y	N	Y
N	82	82	50	50
RSqr	0.140	0.245	0.00502	0.0851

t statistics in parentheses

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

Table B.6: **Impact on Firm-level FXD Position by Net FXD Position, Fully Disclosed Firms** The regressions in this table compare the impact of regulation on the firm-level FXD positions of exporters and non-exporters when I restrict the sample to firms that fully disclosed their FXD counterparty information. The outcome variable is the change in firm j's net FXD position scaled by assets. A firm is classified as an exporter (non-exporter) if it holds a negative (positive) net FXD position. Independent variable *Exposure* is the weighted average shock of the firm's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Exporter	(4) Exporter	(5) Non-exporter	(6) Non-exporter
Exposure	-0.00142	-0.00336	-0.00671	-0.0119*	0.00120	0.00828
	(-0.25)	(-0.49)	(-1.12)	(-1.72)	(0.13)	(0.85)
Constant	0.00236	-0.151	-0.00824	-0.349	0.0185	-0.0227
	(0.38)	(-1.16)	(-1.33)	(-1.48)	(1.47)	(-0.15)
FirmControls	N	Y	N	Y	N	Y
N	132	132	82	82	50	50
RSqr	0.000302	0.0801	0.00886	0.173	0.000174	0.674

t statistics in parentheses

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

Table B.7: **Impact on Profitability by Net FXD Position, Fully Disclosed Firms** The regressions in this table examine the impact of the regulation on firm profitability when I restrict the sample to firms that fully disclosed their FXD counterparty information. The outcome variable is the change in gross profit margin. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Profitability	(2) Profitability
High Hedge=1 × Exposure	-0.00592	-0.00557
	(-0.49)	(-0.48)
Exposure	-0.00374	-0.00863
	(-0.40)	(-0.78)
High Hedge=1	-0.0110	-0.00597
	(-0.86)	(-0.51)
Constant	0.000841	-0.365
	(0.09)	(-1.50)
FirmControls	N	Y
N	74	74
RSqr	0.0240	0.202

t statistics in parentheses

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

Table B.8: **Impact on Profitability** The outcome variable is the change in firm j's gross profit margin. All variables are defined in the Appendix Table B.1.

	LogExport	FXD/Asset	LogDomesticSales
Firm_highHR=1 × Exposure	-0.178*	0.0697**	-0.197
	(-1.95)	(2.08)	(-1.54)
Exposure	0.125**	0.0141	0.136
	(2.49)	(0.68)	(1.17)
Firm_highHR=1	0.0495	0.0411	0.336**
	(0.61)	(1.06)	(2.41)
Constant	-0.295	-0.548	1.532
	(-0.17)	(-1.55)	(1.37)
FirmControls	Y	Y	Y
N	68	68	68
RSqr	0.286	0.454	0.252

t statistics in parentheses

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

(a) Matching Based on FC Liability Share

	LogExport	FXD/Asset	LogDomesticSales
Firm_highHR=1 × Exposure	-0.191*	0.0614***	-0.0317
	(-1.73)	(2.66)	(-0.29)
Exposure	0.0746	0.0165	-0.000762
	(1.27)	(1.49)	(-0.01)
Firm_highHR=1	0.0695	0.0291	0.104
	(0.71)	(1.58)	(1.02)
Constant	-1.474	-0.112	0.705
	(-1.07)	(-0.48)	(0.80)
FirmControls	Y	Y	Y
N	72	72	72
RSqr	0.312	0.323	0.0790

t statistics in parentheses

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

(b) Matching Based on FC Liability, Export Share, and Profitability

Table B.9: **Firm-level Impacts on Exporters after Coarsened Exact Matching** The top panel shows results after matching firms based on FC liability share only. The bottom panel shows results after matching firms based on FC liability share, export share, and gross profit margin. All variables are defined in the Appendix Table B.1.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-4.318***	-4.551***	-0.0418	-0.0156	-11.23***	-11.23***
	(-2.88)	(-2.99)	(-0.14)	(-0.05)	(-5.66)	(-5.73)
Constrained=1	6.341***		0.123		6.959***	
	(3.08)		(0.30)		(5.87)	
Constant	16.11***	21.04***	26.22***	25.81***	5.936***	12.27***
	(8.07)	(50.75)	(66.20)	(179.85)	(3.65)	(5.38)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	3698	3698	3694	3694	3694	3694
Adj RSqr	0.155	0.760	0.0528	0.835	0.474	0.532

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Foreign Banks

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.105	-0.126	-0.0659**	-0.0663**	-0.107***	-0.107***
	(-0.61)	(-0.72)	(-2.51)	(-2.39)	(-9.28)	(-9.34)
Constrained=1	4.401**		0.357		0.471***	
	(2.38)		(0.86)		(10.39)	
Constant	17.24***	19.02***	28.60***	28.25***	0.224***	0.252***
	(9.07)	(30.50)	(69.51)	(370.80)	(3.85)	(4.82)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	2208	2208	2191	2191	2192	2192
Adj RSqr	0.0528	0.875	0.0243	0.934	0.535	0.647

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Domestic Banks

Table B.10: **Impact on Bank FXD Position and Capital of Foreign and Domestic Banks** The regressions in this table examine the impact of the regulation shock on the bank FXD position. The top panel is the result when I restrict the data to foreign banks. The bottom panel is the result when I restrict the data to domestic banks. Columns (2), (4), and (6) add bank fixed effects. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

	(1)	(2)	(3)	(4)
	FCLoanShr	FCLoanShr	FCLiabShr	FCLiabShr
Constrained=1 x Regulation	-0.0509	-0.0495	-0.0150	-0.00923
	(-1.50)	(-1.52)	(-0.45)	(-0.29)
Constrained=1	0.299**		-0.0253	
	(2.22)		(-0.36)	
Constant	0.344***	0.980***	0.292***	0.408***
	(4.69)	(23.57)	(5.11)	(12.94)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	1523	1523	1680	1680
Adj RSqr	0.132	0.884	0.0886	0.787

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.11: **Impact on Bank FC Loans and FC Liabilities** The regressions in this table examine the impact of the regulation shock on the foreign currency shares of bank lending and borrowing. Columns (2) and (4) add bank fixed effects. The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) FCLiabShr
Constrained=1 x Regulation	-0.165	-0.117	0.0304	0.0565
	(-1.45)	(-1.03)	(0.28)	(0.53)
Constrained=1	0.211*		-0.130	
	(1.72)		(-1.31)	
Constant	0.582***	1.007***	0.456***	0.456***
	(6.72)	(15.87)	(5.24)	(11.36)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	914	914	1071	1071
Adj RSqr	0.154	0.785	0.173	0.782

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.12: **Impact on Bank FC Loans and FC Liabilities, Foreign Banks** The regressions in this table examine the impact of regulation on the banks' foreign currency share of bank lending and borrowing, when I restrict the sample to foreign banks. All variables are defined in the Appendix Table B.1.

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) FCLiabShr
Constrained=1 x Regulation	-0.00821	-0.00859	-0.00877*	-0.00906*
	(-0.82)	(-0.86)	(-1.89)	(-1.99)
Constrained=1	0.0243		0.0272	
	(0.58)		(1.06)	
Constant	0.0666**	0.0598***	0.0746***	0.0700***
	(2.58)	(5.59)	(3.69)	(12.30)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	609	609	609	609
Adj RSqr	0.160	0.895	0.143	0.940

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.13: **Impact on Bank FC Loans and FC Liabilities, Domestic Banks** The regressions in this table examine the impact of regulation on the bank foreign currency share of lending and borrowing when I restrict the sample to domestic banks. All variables are defined in the Appendix Table B.1.

	(1) LogExport	(2) ExpShare
Exposure	-0.00635	0.0109
	(-0.11)	(1.08)
HighCash=1	0.242**	0.0344
	(2.15)	(1.52)
HighCash=1 × Exposure	0.00683	-0.0233
	(0.06)	(-0.89)
Constant	-1.616	-0.365
	(-1.32)	(-1.13)
FirmControls	Y	Y
N	74	74
RSqr	0.357	0.287

t statistics in parentheses

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

Table B.14: **Placebo Test of Impact of Internal Funds on Export Sales and Export Share** The regressions in this table examine the impact of the regulation and internal funds (cash balance) on export sales and share of export sales. The outcome variable is export sales or share of export sales. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. $HighCash_j$ takes value of 1 if the firm's pre-shock cash and cash equivalent balance scaled by total assets is in the top 50 percentile. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

C Export Hedging Mechanism

Consider the model of Froot et al. (1993) where a firm faces a two-period investment and financing decision.

1. In period zero, firm chooses export quantity q and size of hedging q_H.
2. The firm enters the first period with internal funds w (in local currency) at hand, and chooses investment expenditure I and external financing need $e = I - w$ to maximize the net expected profits:
$$P(w) = \max_I F(I) - C(e)$$
   (a) w is exposed to FX risk because export sales proceed is in foreign currency.
$$w = R(q) - C^q(q) + (\epsilon_0 - \epsilon)q_H - H(q_H)$$
      - $R(q) = pq\epsilon$ is revenue function. Assume that all sales are export sales. p is in USD and ϵ is exchange rate (1 USD= ϵ Won). $pq\epsilon$ is export sales converted to local currency.
      - C^q is convex product cost function such that marginal cost increases in q. ($C'' > 0$).
      - $(\epsilon_0 - \epsilon)q_H$ is cash flow from hedging contract with linear payoff (e.g. forward). Consider exporter selling q_H USD forwards at the forward price of ϵ_0 per USD. Then the firm receives $\epsilon_0 q_H$ Won and pays q_H USD ($= \epsilon q_H$ in Won). If firm hedges full exposure from export sales, $q_H = pq$.
      - H is hedging cost. Assume that marginal hedging cost increases in the size of hedging q_H.

   (b) On the investment side, net present value of investment expenditure is given by:
$$F(I) = f(I) - I$$
   where $f' > 0, f'' < 0$.

   (c) On the financing side, there are deadweight costs $C(e)$ to the firm of external finance. $C_e \geq 0$
3. In the second period, the output from the investment is realized and outside investors are repaid.

Numerical Example

With a numerical example, I can show that firm chooses to reduce exports when the hedging supply falls. Consider:

$$
\begin{aligned}
C^q(q) &= \frac{c}{2}q^2 \\
H(q_H) &= \frac{h}{2}q_H^2 \\
F(I) &= I^{1/2} \\
C(e) &= \frac{k}{2}e^2
\end{aligned}
$$

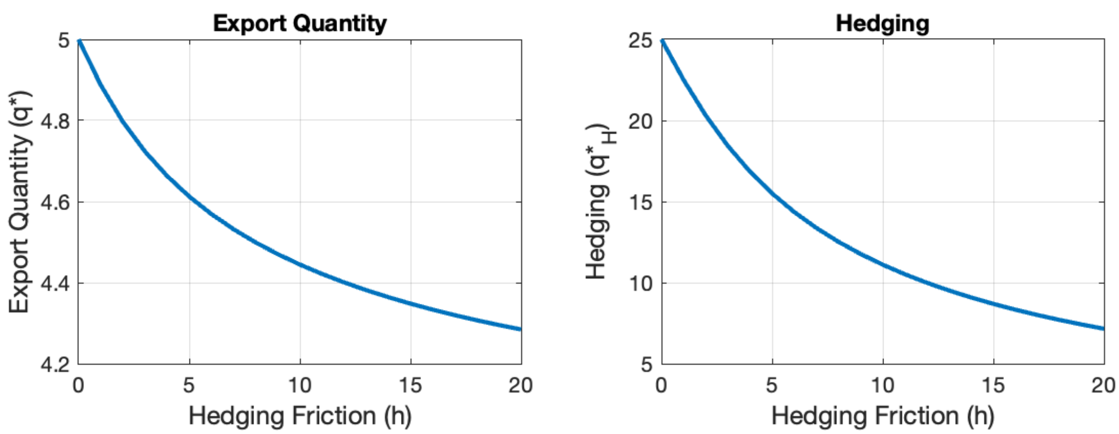


Figure C.1: **Export Quantity and Hedging Quantity as a Function of Hedging Friction**

When the supply of hedging falls, marginal cost is the same (at a given level of quantity) but the marginal benefit of producing a unit of exports goes down because of the FX risk exposure from the export sales. Therefore, it is optimal for the firm to reduce exports.

I can also show that the firm value (net expected profits, $E[P(w)]$) also falls as the hedging cost rises:

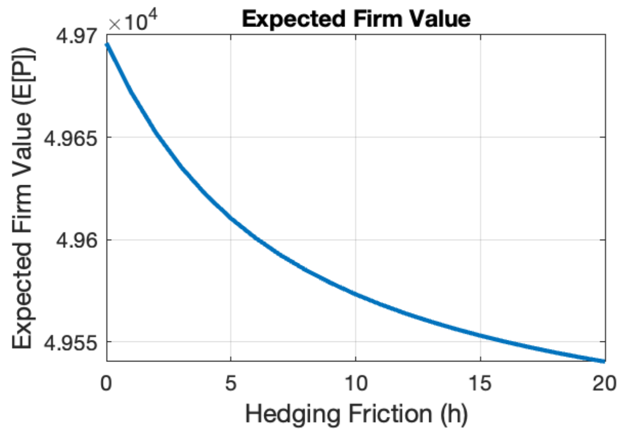


Figure C.2: **Expected Firm Value as a Function of Hedging Friction**

Comparing high cash firms and low cash firms, high cash firms are expected to reduce exports to a greater extent as the magnitude of hedging friction rises:

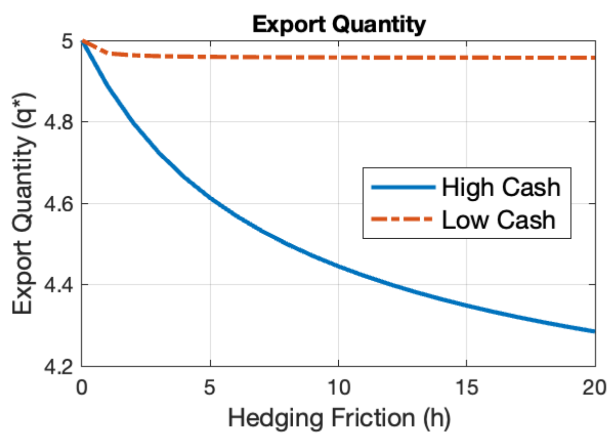


Figure C.3: **Reduction in Exports: High Cash Firms vs. Low Cash Firms**

Internet Appendix to
"The Real Consequences of Macroprudential FX Regulations"

Hyeyoon Jung

IA.A Background

This section presents the plots of Korea's balance of payments, total external debt, short-term external debt, FX reserves, and FX liquidity.

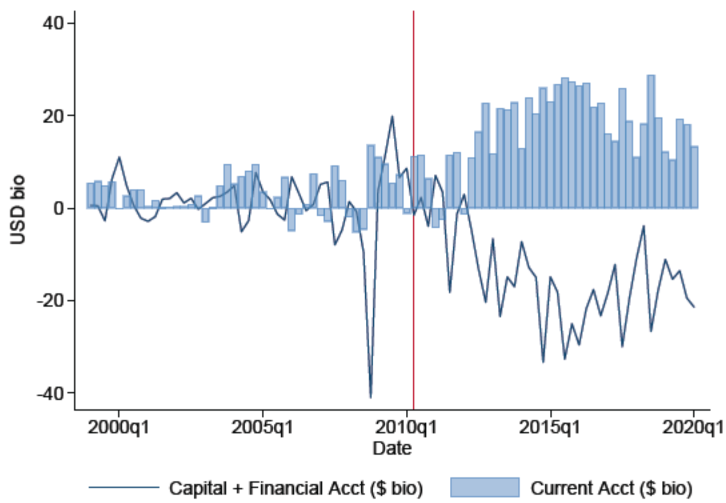


Figure IA.A.1: **Balance of Payments** Korea's balance of payments. The vertical line indicates the imposition of the regulation.

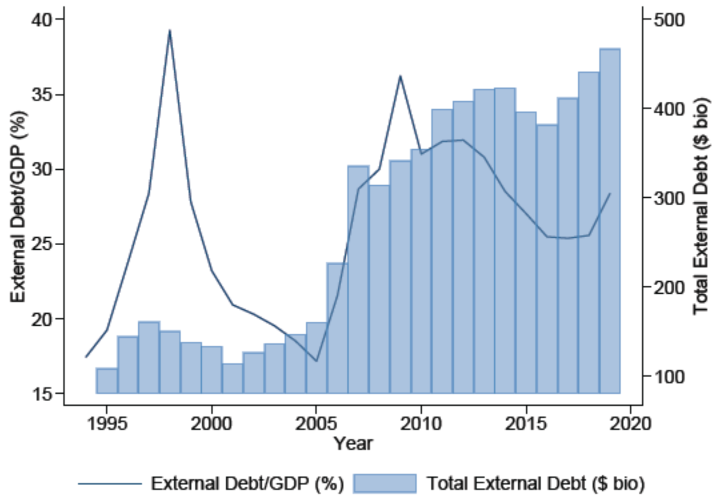


Figure IA.A.2: **Total External Debt** Korea's total external debt in billions of USD (bar) and external debt as a percentage of GDP (line).

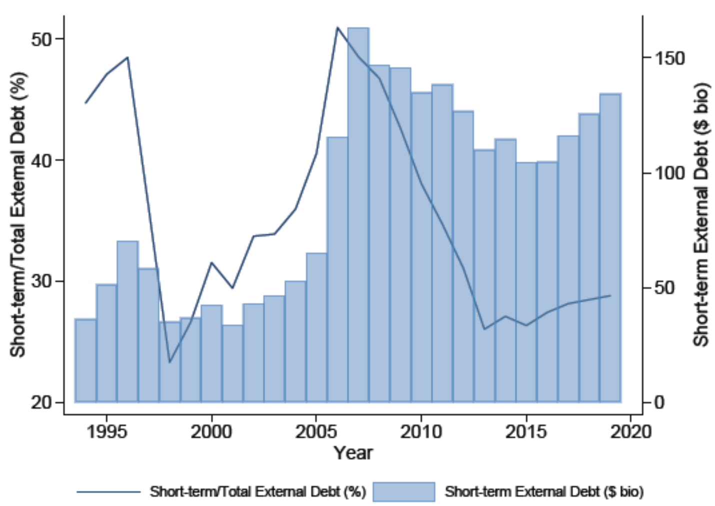


Figure IA.A.3: **Short-term External Debt** Korea's total short-term external debt in billions of USD (bar) and share of short-term external debt in percentage (line).

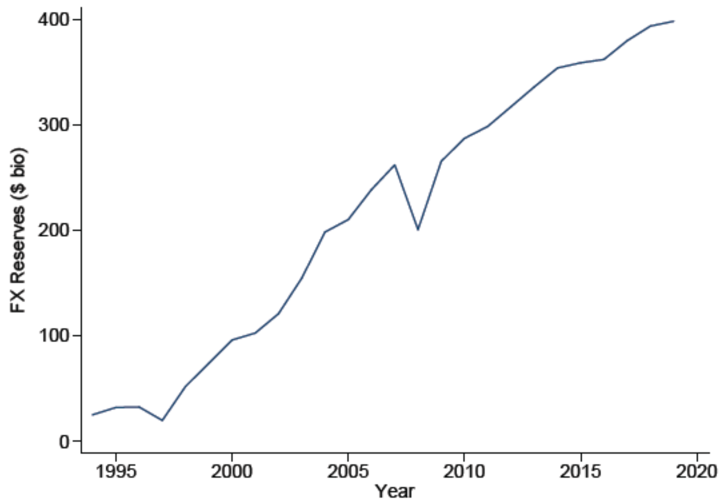


Figure IA.A.4: **FX Reserves** Bank of Korea's FX reserves in USD billion.

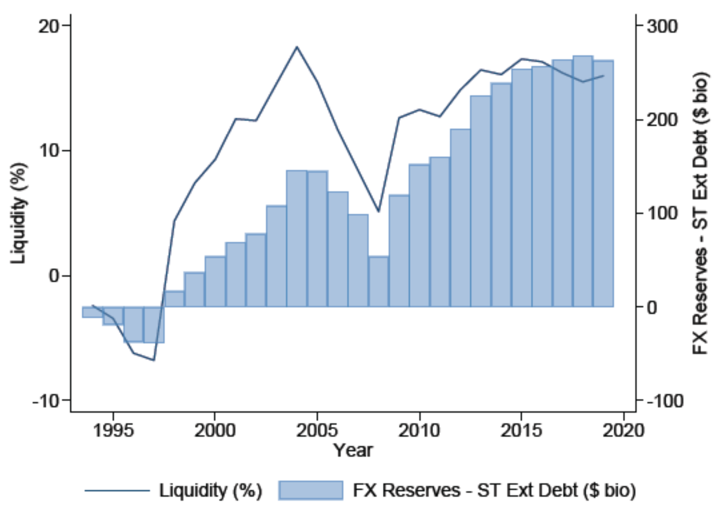


Figure IA.A.5: **FX Liquidity** Korea's FX reserves less short-term external debt in billions of USD (bar), and liquidity (line), defined as (FX Reserves - Short-term External Debt)/GDP.

IA.B Cash Flow Illustration

This section illustrates the cash flows from: an exporter's export sales in USD, FX forward contract between the exporter and a bank, and bank's trades to square the FX forward position.

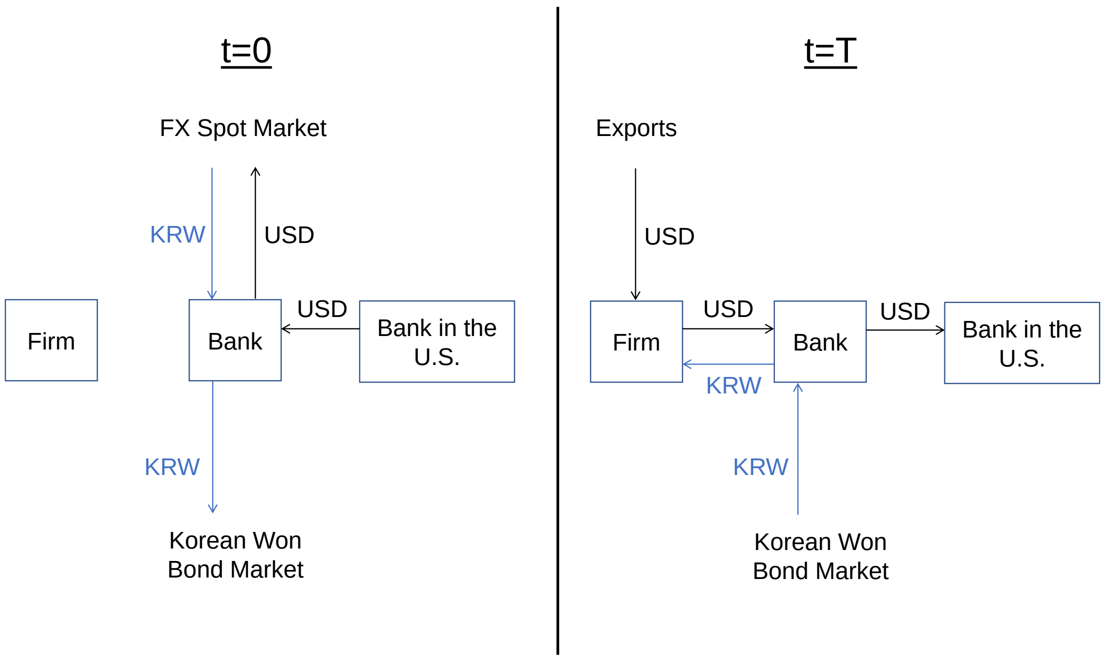


Figure IA.B.1: **Cash Flow Illustration** Consider the following transactions: (1) On $t = 0$ date, a firm (exporter) sells USD forward with maturity T to a bank. This does not involve any cash flows on $t = 0$ as it is a forward contract. On the same date, the bank borrows USD from its parent bank in the U.S., converts USD into KRW in the spot market, and buys KRW-denominated bonds. (2) At maturity $t = T$, the firm receives USDs from export sales and matches the USD amount of the forward contract. From the forward contract, the firm pays the USD and receives KRW. From the bank's perspective, it receives KRW from its investment in KRW-denominated bonds and pays KRW to the firm. The bank receives USD from the firm and pays USD back to its lender. If the maturity of bank's USD loan is T, then the bank is perfectly hedged.

IA.C Bank Names

	Bank	Full Name	Parent Country	Note
1	ANZ	Australia and New Zealand Bank	Australia	
2	BankComm	Bank of Communications	China	
3	BNP	BNP Paribas	France	
4	BNYMellon	BNY Mellon	US	
5	BOA	Bank Of America	US	
6	BOC	Bank Of China	China	
7	CCBC	China Construction Bank	China	
8	CIG	Credit Agricole Corporate and Investment Bank	France	
9	CS	Credit Suisse	Swiss	
10	DB	Deutsche Bank	Germany	
11	DBS	DBS	Singapore	
12	HSBC	HSBC	GB	
13	ICBC	Industrial and Commercial Bank of China	China	
14	ING	ING	Netherlands	
15	JPM	JP Morgan Chase	US	
16	Mellat	Mellat Bank	Iran	
17	MitsuiSumitomo	Mitsui Sumitomo	Japan	
18	Mizuho	Mizuho Bank	Japan	
19	MorganStanley	Morgan Stanley	GB	
20	MUFG	Mitsubishi UFJ	Japan	
21	Scotia	Scotia Bank	Canada	
22	SocGen	Societe Generale	France	
23	StateStreet	State Street	US	
24	UOB	United Overseas Bank	Singapore	
25	Yamaguchi	Yamguchi	Japan	
26	ABNRBS*	Royal Bank of Scotland	UK	RBS acquired ABN Amro in 2007 and RBS closed in 2014.
27	Barclays*	Barclays	UK	Closed in 2017.
28	GS*	Goldman Sachs International Bank	UK	Closed in 2017.
29	UBS*	UBS	Switzerland	Closed in 2017.
30	Busan	Busan Bank	Korea	
31	Citi	Cit bank Korea	Korea	
32	Daegu	Daegu Bank	Korea	
33	IBK	Industrial Bank of Korea	Korea	
34	Jeju	Jeju Bank	Korea	
35	Jeonbuk	Jeonbuk Bank	Korea	
36	KB	Kookmin Bank	Korea	
37	KDB	Korea Development Bank	Korea	
38	KEBHana	KEB Hana Bank	Korea	Hana bank before acquiring KEB in Feb 2012.
39	Kwangjoo	Kwangjoo Bank	Korea	
40	Kyongnam	Kyongnam Bank	Korea	
41	NH	Nonghyup Bank	Korea	
42	SH	Suhyup Bank	Korea	
43	Shinhan	Shinhan Bank	Korea	
44	StandChar	Standard Chartered Bank Korea	Korea	
45	Woori	Woori Bank	Korea	
46	KEB*	Korea Exchange Bank	Korea	Hana bank (KEBHana) acquired KEB in Feb 2012.

Table IA.C.1: **Full Name of Sample Banks**

IA.D Bank FXD Position before Regulation

Bank	Foreign	Assets	DerivPosition	Capital	DPTCRatio	DerivExceeded	Constrained	Shock	DPTARatio	CTARatio	DerivPosShare
UOB	1	1,601,133	1,292,500	122,000	11	987,500	1	0.76	0.81	0.08	0.02
Barclays*	1	11,670,373	2,525,772	277,580	9	1,831,821	1	0.73	0.22	0.02	0.04
StateStreet	1	2,077,924	823,084	102,148	8	567,715	1	0.69	0.4	0.05	0.01
CS	1	5,860,097	4,252,749	610,104	7	2,727,490	1	0.64	0.73	0.1	0.07
BNP	1	12,355,659	4,450,664	709,914	6	2,675,879	1	0.6	0.36	0.06	0.07
DBS	1	3,917,999	1,810,170	304,008	6	1,050,151	1	0.58	0.46	0.08	0.03
ANZ	1	4,190,502	1,185,243	220,920	5	632,943	1	0.53	0.28	0.05	0.02
BOA	1	7,201,784	1,796,047	358,225	5	900,485	1	0.5	0.25	0.05	0.03
MorganStanley	1	5,489,824	1,413,215	309,701	5	638,963	1	0.45	0.26	0.06	0.02
CIG	1	13,270,216	2,485,735	715,450	3	697,110	1	0.28	0.19	0.05	0.04
HSBC	1	20,617,534	5,994,277	1,972,932	3	1,061,948	1	0.18	0.29	0.1	0.1
ABNRBS*	1	7,155,556	1,470,707	489,208	3	247,686	1	0.17	0.21	0.07	0.02
ING	1	13,996,040	2,311,018	836,297	3	220,275	1	0.1	0.17	0.06	0.04
UBS*	1	5,095,065	1,141,340	443,393	3	32,857	1	0.03	0.22	0.09	0.02
Citi	0	44,900,564	2,982,505	4,264,960	1	850,025	1	0.29	0.07	0.09	0.05
StandChar	0	58,232,404	2,220,717	3,792,562	1	324,436	1	0.15	0.04	0.07	0.04
DB	1	9,893,187	1,942,116	821,928	2	−112,705	0	0	0.2	0.08	0.03
SocGen	1	6,284,281	1,211,031	563,549	2	−197,842	0	0	0.19	0.09	0.02
CCBC	1	1,276,478	160,987	168,333	1	−259,846	0	0	0.13	0.13	0
MUFG	1	8,464,476	912,865	986,416	1	−1,553,176	0	0	0.11	0.12	0.01
BNYMellon	1	1,124,330	103,472	142,688	1	−253,248	0	0	0.09	0.13	0
Scotia	1	1,008,951	61,785	113,939	1	−223,063	0	0	0.06	0.11	0
JPM	1	14,655,266	5,150,490	10,387,546	0	−20,818,374	0	0	0.35	0.71	0.08
Yamaguchi	1	117,378	20,306	54,831	0	−116,770	0	0	0.17	0.47	0
KEBHana	0	116,057,552	2,086,478	7,703,450	0	−1,765,247	0	0	0.02	0.07	0.03
KEB*	0	82,483,816	1,651,937	6,241,667	0	−1,468,896	0	0	0.02	0.08	0.03
Busan	0	26,102,380	403,293	1,804,721	0	−499,067	0	0	0.02	0.07	0.01
Woori	0	186,484,800	2,348,102	11,717,465	0	−3,510,631	0	0	0.01	0.06	0.04
KDB	0	104,773,424	2,529,950	12,961,896	0	−3,950,998	0	0	0.02	0.12	0.04
KB	0	219,698,320	2,071,910	15,240,589	0	−5,548,385	0	0	0.01	0.07	0.03
IBK	0	129,253,992	1,125,675	10,421,005	0	−4,084,828	0	0	0.01	0.08	0.02
Shinhan	0	168,008,736	1,098,607	11,709,110	0	−4,755,948	0	0	0.01	0.07	0.02
MitsuiSumitomo	1	4,826,040	79,700	1,045,047	0	−2,532,917	0	0	0.02	0.22	0
NH	0	156,517,472	832,138	11,855,901	0	−5,095,813	0	0	0.01	0.08	0.01
Daegu	0	23,864,670	40,901	645,505	0	−281,852	0	0	0	0.03	0
GS*	1	2,304,765	−5,726	187,500	0	−463,024	0	0	0	0.08	0
Kyongnam	0	17,481,136	32,240	1,238,000	0	−586,760	0	0	0	0.07	0
Kwangjoo	0	13,614,953	9,186	940,000	0	−460,814	0	0	0	0.07	0
SH	0	16,038,712	2,793	704,286	0	−349,350	0	0	0	0.04	0
Mizuho	1	5,995,878	−240	634,977	0	−1,587,202	0	0	0	0.11	0
Jeonbuk	0	6,192,970	0	229,462	0	−114,731	0	0	0	0.04	0
Jeju	0	2,526,683	0	180,000	0	−90,000	0	0	0	0.07	0
Mellat	1	2,615,603	0	82,812	0	−207,030	0	0	0	0.03	0
ICBC	1	2,110,354	0	582,500	0	−1,456,250	0	0	0	0.28	0
BankComm	1	1,763,835	0	253,333	0	−633,333	0	0	0	0.14	0
BOC	1	1,406,988	0	230,390	0	−575,974	0	0	0	0.16	0

Table IA.D.1: **Bank FXD Positions (As of December 2009)** *Foreign* is 1 if the bank is a foreign bank branch and 0 if otherwise. *Assets*, *DerivPosition*, and *Capital* are in 1,000 USD. *DPTCRatio* is derivatives-position-to-capital ratio. *DerivExceeded* is *DerivPosition* less the size (in 1,000 USD) of the derivatives position the bank is allowed to take. *Constrained* is 1 if the bank needs to reduce its DPTC ratio and 0 if otherwise. *Shock* is *DerivExceeded*/*DerivPosition*. *DPTARatio* is derivatives-position-to-assets ratio. *CTARatio* is capital-to-assets ratio. *DerivPosShare* is market share. * indicates closed banks. Full names and parent bank's country are listed in Table IA.C.1.

IA.E Summary Statistics of Subsamples

This section reports the summary statistics of subsamples.

	Full Sample		Constrained		Unconstrained		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Notional Net (USD mio)	-19.8	41	-27.0	39	-16.6	41	10	(1.4)
FXDNet/Assets (%)	-7.9	10	-10.2	11	-6.9	9	3	(1.7)
Direction: Firm sells FC (%)	98.7	7	98.5	8	98.8	6	0	(0.2)
Pair: USD-KRW (%)	86.3	30	91.0	25	84.3	31	-7	(-1.3)
Pair: JPY-KRW (%)	9.3	25	2.6	16	12.3	28	10*	(2.5)
Pair: EUR-KRW (%)	3.5	14	3.9	13	3.4	15	-1	(-0.2)
Type: Forwards (%)	80.9	38	66.0	46	87.5	32	21**	(2.7)
Type: Swaps (%)	3.1	16	1.2	8	3.9	19	3	(1.1)
Type: Options (%)	15.3	35	32.7	46	7.5	25	-25**	(-3.3)
Type: Futures (%)	0.8	9	0.0	0	1.1	11	1	(1.0)
Observations	129		40		89		129	

Table IA.E.1: **FXD Contracts Summary Statistics (Exporters' Contracts)** Subsample of FXD contracts of the firms with negative net FXD position. All variables are computed as of Dec 2009 and are defined in Table B.1. I define contract as firm-bank pair.

	Full Sample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,619.693	5947.10	2,277.264	8795.78	1,231.489	3287.01	-1045.78	(-0.80)
FXDNet/Assets	-0.056	0.14	-0.052	0.15	-0.058	0.13	-0.01	(-0.25)
Sales (USD mio)	1,208.244	3400.29	1,500.800	4455.40	1,035.530	2601.87	-465.27	(-0.67)
FXDNet/Sales	-0.058	0.21	-0.037	0.21	-0.071	0.21	-0.03	(-0.88)
Number of Banks	2.288	2.21	2.531	2.14	2.145	2.25	-0.39	(-0.98)
Log Size	26.471	1.61	26.623	1.63	26.381	1.60	-0.24	(-0.83)
Leverage	0.467	0.17	0.500	0.16	0.448	0.18	-0.05	(-1.74)
Gross Profit Margin	0.218	0.17	0.213	0.19	0.222	0.16	0.01	(0.29)
FC Asset Share	0.099	0.12	0.091	0.12	0.103	0.11	0.01	(0.56)
FC Liab Share	0.198	0.20	0.246	0.19	0.169	0.21	-0.08*	(-2.20)
Export Share	0.455	0.31	0.427	0.32	0.473	0.30	0.05	(0.79)
Export Hedge Ratio	0.357	0.68	0.385	0.67	0.339	0.70	-0.05	(-0.34)
FCL Hedge Ratio	0.295	0.46	0.314	0.45	0.283	0.47	-0.03	(-0.38)
Observations	132		49		83		132	

Table IA.E.2: **Firm Summary Statistics (Fully disclosed Firms)** Subsample of firms that fully disclosed their FXD counterparties. These firms' contracts are analyzed in the contract-level analysis (subsection 4.2). All variables are computed as of Dec 2009 and are defined in Table B.1.

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,378.542	3554.30	1,325.730	3535.54	1,404.095	3591.85	78.37	(0.10)
FXDNet/Assets	-0.163	0.20	-0.164	0.18	-0.162	0.21	0.00	(0.06)
Sales (USD mio)	1,082.764	2722.87	1,071.161	2615.15	1,088.378	2794.43	17.22	(0.03)
FXDNet/Sales	-0.208	0.30	-0.184	0.25	-0.219	0.32	-0.03	(-0.58)
Number of Banks	1.859	1.14	1.833	1.05	1.871	1.19	0.04	(0.15)
Log Size	26.343	1.66	26.376	1.54	26.327	1.72	-0.05	(-0.14)
Leverage	0.487	0.19	0.500	0.17	0.481	0.20	-0.02	(-0.45)
Gross Profit Margin	0.199	0.14	0.210	0.19	0.194	0.12	-0.02	(-0.44)
FC Asset Share	0.131	0.12	0.124	0.12	0.135	0.12	0.01	(0.42)
FC Liab Share	0.166	0.21	0.205	0.19	0.148	0.21	-0.06	(-1.29)
Export Share	0.563	0.27	0.522	0.28	0.586	0.27	0.06	(1.00)
Export Hedge Ratio	0.595	0.79	0.661	0.81	0.558	0.79	-0.10	(-0.57)
FCL Hedge Ratio	0.413	2.69	1.011	4.55	0.103	0.48	-0.91	(-1.09)
Observations	92		30		62		92	

Table IA.E.3: **Firm Summary Statistics (Exporters)** Subsample of firms with negative net FXD position. It *includes* the firms that do not fully disclose their FXD counterparties. All variables are computed as of Dec 2009 and are defined in Table B.1.

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,487.513	3745.06	1,325.730	3535.54	1,580.850	3891.48	255.12	(0.30)
FXDNet/Assets	-0.162	0.20	-0.164	0.18	-0.161	0.22	0.00	(0.08)
Sales (USD mio)	1,160.832	2869.75	1,071.161	2615.15	1,212.566	3030.44	141.41	(0.22)
FXDNet/Sales	-0.208	0.30	-0.184	0.25	-0.221	0.33	-0.04	(-0.57)
Number of Banks	1.817	1.03	1.833	1.05	1.808	1.03	-0.03	(-0.11)
Log Size	26.361	1.70	26.376	1.54	26.353	1.79	-0.02	(-0.06)
Leverage	0.477	0.19	0.500	0.17	0.464	0.19	-0.04	(-0.86)
Gross Profit Margin	0.204	0.14	0.210	0.19	0.200	0.12	-0.01	(-0.29)
FC Asset Share	0.130	0.12	0.124	0.12	0.134	0.12	0.01	(0.36)
FC Liab Share	0.178	0.22	0.205	0.19	0.163	0.23	-0.04	(-0.89)
Export Share	0.564	0.27	0.522	0.28	0.588	0.27	0.07	(1.04)
Export Hedge Ratio	0.597	0.80	0.661	0.81	0.560	0.80	-0.10	(-0.54)
FCL Hedge Ratio	0.457	2.84	1.011	4.55	0.118	0.53	-0.89	(-1.07)
Observations	82		30		52		82	

Table IA.E.4: **Firm Summary Statistics (Fully Disclosed Exporters)** Subsample of firms with negative net FXD position. It *excludes* the firms that do not fully disclose their FXD counterparties. All variables are computed as of Dec 2009 and are defined in Table B.1.

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	541.577	1589.81	529.287	1357.29	549.057	1730.51	19.77	(0.05)
FXDNet/Assets	-0.120	0.13	-0.141	0.14	-0.106	0.12	0.03	(1.08)
Sales (USD mio)	481.355	1218.33	521.483	1483.71	456.929	1041.86	-64.55	(-0.20)
FXDNet/Sales	-0.144	0.19	-0.146	0.15	-0.142	0.21	0.00	(0.10)
Number of Banks	1.878	1.05	1.893	1.07	1.870	1.05	-0.02	(-0.09)
Log Size	25.972	1.26	26.101	1.17	25.895	1.32	-0.21	(-0.70)
Leverage	0.454	0.18	0.482	0.16	0.437	0.19	-0.05	(-1.11)
Gross Profit Margin	0.210	0.15	0.218	0.19	0.206	0.12	-0.01	(-0.29)
FC Asset Share	0.134	0.13	0.127	0.13	0.137	0.13	0.01	(0.33)
FC Liab Share	0.183	0.22	0.215	0.20	0.164	0.24	-0.05	(-1.01)
Export Share	0.546	0.27	0.518	0.28	0.562	0.27	0.04	(0.67)
Export Hedge Ratio	0.519	0.78	0.574	0.75	0.486	0.80	-0.09	(-0.47)
FCL Hedge Ratio	0.097	0.44	0.143	0.47	0.067	0.43	-0.08	(-0.69)
Observations	74		28		46		74	

Table IA.E.5: **Firm Summary Statistics (Export Sales Analysis)** Subsample of firms with negative net FXD position. It *excludes* the firms that do not fully disclose their FXD counterparties and also excludes firms with missing export sales value in either 2009 or 2010. All variables are computed as of Dec 2009 and are defined in Table B.1.

IA.F Net FXD Buying Firms and Selling Firms

This section presents the details of full sample 148 firms, grouped by the sign of net FXD position.

No	Stock	Firm	FullDisc	Industry
1	036460	KoreaGas	0	Gas and Electricity
2	030200	KT	1	IT and Tele-communication
3	096770	SKInnov	0	Manufacturing
4	004170	SSG	1	Retail
5	015760	Kepco	1	Gas and Electricity
6	023530	LotteShop	1	Retail
7	004990	LotteHoldings	1	Science and Technology
8	011170	LotteChem	1	Manufacturing
9	097950	CJCheil	0	Manufacturing
10	071320	KoreaHeat	1	Gas and Electricity
11	051910	LGChem	0	Manufacturing
12	069960	HyundaiDept	1	Retail
13	010950	SOil	1	Manufacturing
14	000210	Daelim	1	Construction
15	001120	LGIntl	1	Retail
16	009830	HanhwaSol	1	Manufacturing
17	011780	Kumho	1	Manufacturing
18	003490	KoreanAir	1	Transportation and Shipping
19	011930	Shinsung	1	Manufacturing
20	069620	Daewoong	1	Manufacturing
21	007070	GSRetail	1	Retail
22	006280	GreenCross	1	Manufacturing
23	003030	SeahSteel	1	Science and Technology
24	001790	DaehanSugar	1	Manufacturing
25	004000	LotteFineChem	1	Manufacturing
26	002350	NexenTire	1	Manufacturing
27	000070	Samyang	0	Science and Technology
28	006120	SKDiscovery	0	Science and Technology
29	009200	Moorim	1	Manufacturing
30	010060	OCI	1	Manufacturing
31	058650	SeahHoldings	1	Manufacturing
32	049770	DongwonFB	1	Manufacturing
33	090350	NorooPaint	1	Manufacturing
34	001810	MoorimSP	1	Manufacturing
35	084010	DaehanSteel	1	Manufacturing
36	006840	AKHoldings	1	Science and Technology
37	004140	Dongbang	1	Transportation and Shipping
38	117580	DaesungEnergy	1	Gas and Electricity
39	014190	Wonik	1	Retail
40	002840	Miwon	1	Manufacturing
41	005990	MaeilHoldings	1	Manufacturing
42	067830	Savezone	1	Retail
43	000320	Noroo	1	Science and Technology
44	060540	SAT	1	Manufacturing
45	004710	HansolTech	1	Manufacturing
46	155660	DSR	1	Manufacturing
47	014160	Daeyoung	1	Manufacturing
48	010660	Hwacheon	1	Manufacturing
49	166090	HanaMaterials	1	Manufacturing
50	059090	MiCo	1	Manufacturing
51	003160	DI	1	Manufacturing
52	084870	TBH	1	Manufacturing
53	041650	Sangsin	1	Manufacturing
54	033320	JCHyun	1	Retail
55	013520	Hwaseung	1	Manufacturing
56	049480	Openbase	1	IT and Tele-communication

Table IA.F.1: **Net FXD Buyers ("Non-exporters")** The list of name, stock ticker, and industry of the firms with *positive* net FXD position as of December 2009. *FullDisc* is 1 if the firm fully disclosed its FXD counterparties.

No	Stock	Firm	FullDisc	Industry
1	9540	HyundaiHeavy	0	Manufacturing
2	10140	SamsungHeavy	0	Manufacturing
3	42660	DaewooShip	0	Manufacturing
4	42670	DoosanInfra	0	Manufacturing
5	10620	HyundaiMipo	0	Manufacturing
6	34020	DoosanHeavy	0	Manufacturing
7	82740	HSDEngine	0	Manufacturing
8	6360	GSCons	0	Construction
9	77970	STXEngine	0	Manufacturing
10	36890	JinSungTEC	1	Manufacturing
11	97230	HanjinHeavy	0	Construction
12	21050	Seowon	1	Manufacturing
13	660	SKHynix	1	Manufacturing
14	720	HyundaiCons	1	Construction
15	83650	BHI	1	Manufacturing
16	10120	LS	1	Manufacturing
17	10130	KoreaZinc	1	Manufacturing
18	5850	SL	1	Manufacturing
19	53660	Hyunjin	1	Manufacturing
20	4060	Segye	1	Retail
21	12800	Daechang	1	Manufacturing
22	54950	JVM	1	Manufacturing
23	13570	DY	1	Science and Technology
24	68790	DMS	1	Manufacturing
25	150	Doosan	1	Science and Technology
26	91090	SewonCellon	1	Manufacturing
27	11790	SKC	1	Manufacturing
28	9440	KCGreen	1	Science and Technology
29	65130	TopEngi	1	Manufacturing
30	79960	DongyangENP	1	Manufacturing
31	23810	Infac	1	Manufacturing
32	5950	IsuChem	1	Manufacturing
33	122900	IMarket	1	Retail
34	27580	Sangbo	1	Manufacturing
35	35150	Baiksan	1	Manufacturing
36	95500	MiraeNano	1	Manufacturing
37	34730	SK	1	Science and Technology
38	16800	Fursys	1	Manufacturing
39	14830	Unid	1	Manufacturing
40	37070	Paseco	1	Manufacturing
41	47310	PowerLogics	1	Manufacturing
42	89030	TechWing	1	Manufacturing
43	11300	Seongan	1	Manufacturing
44	11760	HyundaiCorp	1	Retail
45	43150	Vatech	1	Manufacturing
46	44340	Winix	1	Manufacturing
47	53620	Taeyang	1	Manufacturing
48	9160	Simpac	1	Manufacturing
49	67310	HanaMicron	1	Manufacturing
50	78890	KaonMedia	1	Manufacturing
51	79950	Invenia	1	Manufacturing
52	36930	Joosung	1	Manufacturing
53	109740	DSK	1	Manufacturing
54	29460	KC	1	Manufacturing
55	7630	PolusBioPharm	1	Retail
56	66110	Hanp	1	Manufacturing
57	7860	Seoyon	1	Science and Technology
58	79980	Huvis	1	Manufacturing
59	86450	DongkookPharm	1	Manufacturing
60	49830	Seungil	1	Manufacturing
61	19490	Hitron	1	Manufacturing
62	20150	IljinMaterials	1	Manufacturing
63	27970	Seha	1	Manufacturing
64	46310	BGTNA	1	Manufacturing
65	54540	SamyoungMT	1	Manufacturing
66	66310	QSI	1	Manufacturing
67	33530	Sejong	1	Manufacturing
68	8970	DongyangPipe	1	Manufacturing
69	99320	Satrec	1	Manufacturing
70	43340	EssenTech	1	Manufacturing
71	53450	Sekonix	1	Manufacturing
72	1250	GSGlobal	1	Retail
73	5670	Foodwell	1	Manufacturing
74	49550	Inktec	1	Manufacturing
75	31980	PSK	1	Manufacturing
76	30720	DongwonFish	1	Agriculture and Fishing
77	51360	Tovis	1	Manufacturing
78	500	GaonCable	1	Manufacturing
79	92460	HanlaIMS	1	Manufacturing
80	23960	SCEngi	1	Construction
81	45100	HanyangENG	1	Science and Technology
82	7980	Pacific	1	Manufacturing
83	24800	YoosungTnS	1	Transportation and Shipping
84	41910	Estech	1	Manufacturing
85	52710	Amotech	1	Manufacturing
86	70590	HansolInticube	1	IT and Tele-communication
87	65950	Welcron	1	Manufacturing
88	19540	IljiTech	1	Manufacturing
89	92600	NCN	1	Manufacturing
90	105740	DKLok	1	Manufacturing
91	59100	Icomponent	1	Manufacturing
92	18880	Hanon	1	Manufacturing

Table IA.F.2: **Net FXD Sellers ("Exporters")** The list of name, stock ticker, and industry of the firms with *negative* net FXD position as of December 2009. *FullDisc* is 1 if the firm fully disclosed its FXD counterparties.

IA.G Bank-level OLS: Impact on Bank Security Holdings

This section measures the impact of regulation on banks' government bond holdings. KTB is long-term Korean government bonds with maturities: 3, 5, 10, 20, 30 years. MSB is issued by Bank of Korea and the maturities are: 91 days, 1 year, 2 years. In Table IA.G.1, columns (1) and (2) show that the impact on KTB holdings is insignificant; however, columns (3) and (4) show that the constrained banks reduced their MSB holdings relative to unconstrained banks.

These results suggest that the government bonds used in constructing the synthetic short USD forward positions had been MSBs rather than KTBs prior to the regulation. Table IA.G.2 shows that the results of the weighted least squares estimation (where the weight is pre-shock FXD position) are similar.

	(1) KTB/Asset	(2) KTB/Asset	(3) MSB/Asset	(4) MSB/Asset
Constrained=1 x Regulation	0.00950	0.0105	-0.0626***	-0.0595***
	(0.62)	(0.70)	(-2.90)	(-3.02)
Constrained=1	0.0361		0.145***	
	(0.97)		(2.96)	
BankFE	N	Y	N	Y
TimeFE				
N	1692	1692	1692	1692
Adj RSqr	0.114	0.737	0.241	0.756

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IA.G.1: **Impact on Bank Security Holdings** $Y_{it} = \beta_0 + \beta_1 Constrained_i \times Regulation_t^{WAvg} + \delta_i + \gamma_t + \varepsilon_{it}$ The outcome variables are KTB holdings and MSB holdings scaled by assets.

	(1) KTB/Asset	(2) KTB/Asset	(3) MSB/Asset	(4) MSB/Asset
Constrained=1 x Regulation	0.00147	0.00159	-0.0414***	-0.0407***
	(0.07)	(0.07)	(-2.87)	(-2.97)
Constrained=1	0.0498		0.0980**	
	(0.92)		(2.27)	
BankFE	N	Y	N	Y
TimeFE				
N	1692	1692	1692	1692
Adj RSqr	0.0916	0.779	0.157	0.780

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IA.G.2: **Impact on Bank Security Holdings (Weighted LS)** $Y_{it} = \beta_0 + \beta_1 Constrained_i \times Regulation_t^{WAvg} + \delta_i + \gamma_t + \varepsilon_{it}$ **Weighted least squares model** where the weight is FXD position as of Dec 2009.

IA.H Bank-level OLS: Weighted Least Squares Models

This section reports the results of weighted least squares estimation. The weight is pre-shock FXD position.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.475***	-0.470***	0.0321	0.0352	-3.013***	-2.996***
	(-4.26)	(-4.09)	(0.35)	(0.40)	(-4.29)	(-4.28)
Constrained=1	0.499*		-2.151***		5.744***	
	(1.93)		(-5.49)		(4.44)	
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	5906	5906	5885	5885	5886	5886
Adj RSqr	0.191	0.400	0.490	0.893	0.410	0.502

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Based on Simple Average FXD Capital Requirement

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.662***	-0.656***	0.0254	0.0312	-3.936***	-3.915***
	(-3.71)	(-3.58)	(0.20)	(0.25)	(-4.33)	(-4.32)
Constrained=1	0.517*		-2.133***		5.602***	
	(1.80)		(-5.54)		(4.48)	
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	5906	5906	5885	5885	5886	5886
Adj RSqr	0.192	0.402	0.490	0.893	0.408	0.500

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Based on Weighted Average FXD Capital Requirement

Table IA.H.1: **Adjustments in FXD Position and Capital (Full Sample)** The results are based on a weighted least square model where the weight is pre-shock FXD position. The top panel uses $Regulation_t^{Avg}$, which takes 0 before the regulation and takes a **simple average** of foreign bank and domestic bank minimum FXD capital requirements. The bottom panel uses $Regulation_t^{WAvg}$, which is the **weighted average** of the minimum FXD capital requirements, where the weight is the FXD position in each month. In either case, a higher value indicates tighter constraint. Columns (2), (4), and (6) add bank fixed effects. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in Table B.1.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-1.483***	-1.491***	-0.184	-0.182	-9.680***	-9.641***
	(-2.85)	(-2.80)	(-0.45)	(-0.46)	(-4.22)	(-4.21)
Constrained=1	0.271		-1.723**		5.818***	
	(0.72)		(-2.28)		(3.99)	
Constant	21.62***	20.23***	28.39***	25.87***	6.510***	11.91***
	(59.65)	(106.95)	(40.12)	(158.57)	(3.14)	(4.36)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	3698	3698	3694	3694	3694	3694
Adj RSqr	0.246	0.424	0.369	0.815	0.480	0.542

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Foreign Banks

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.128	-0.124	-0.0272*	-0.0201	-0.0980***	-0.0983***
	(-1.01)	(-0.98)	(-1.97)	(-1.48)	(-8.94)	(-9.02)
Constrained=1	0.513**		-0.892***		0.424***	
	(2.28)		(-6.06)		(9.79)	
Constant	20.86***	18.70***	29.85***	28.35***	0.275***	0.267***
	(44.30)	(53.35)	(185.87)	(459.87)	(3.04)	(3.11)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	2208	2208	2191	2191	2192	2192
Adj RSqr	0.171	0.481	0.592	0.972	0.680	0.745

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Domestic Banks

Table IA.H.2: **Adjustments in Derivatives Position and Capital (Foreign Banks vs. Domestic Banks)** The results are based on a weighted least square model where the weight is pre-shock FXD position. The top panel is the result when I restrict the data to foreign banks. The bottom panel is the result when I restrict the data to domestic banks. Columns (2), (4), and (6) add bank fixed effects. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in Table B.1.

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) FCLiabShr
Constrained=1 x Regulation	-0.102*	-0.108**	-0.0589***	-0.0579***
	(-1.97)	(-2.11)	(-3.08)	(-3.04)
Constrained=1	0.353**		0.0995**	
	(2.43)		(2.42)	
Constant	0.168**	0.924***	0.212***	0.456***
	(2.67)	(22.08)	(5.64)	(13.27)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	1523	1523	1680	1680
Adj RSqr	0.183	0.838	0.238	0.732

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IA.H.3: **Impact on Bank FC Loans and FC Liabilities (All banks)** The results are based on a weighted least square model where the weight is pre-shock FXD position. Columns (2) and (4) add bank fixed effects. The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank. All variables are defined in Table B.1.

When the observations are weighted by the pre-shock FXD position, constrained banks reduced both FC loan share and FC liability share relative to unconstrained banks. The decrease in FC loan share could be due to the second macroprudential measure, the levy on non-core FC liabilities, which raises the effective cost of FC funding.

The second measure, effective since August 2011, was to impose a levy on the banking sector's non-core FC denominated liabilities. This measure is designed to induce banks to cut their FC borrowings by increasing their funding costs. The levy is higher for FC borrowings with shorter maturities.[52] The proceeds of the levy flow into the Foreign Exchange Stabilization Fund, which is separate from government revenue and can be used as a buffer in financial crises. Banks constrained by the FXD position limit are likely to be more affected by the macroprudential stability levy. My main results on firm exports are based on 2009 and 2010, which is *before* the introduction of this measure.

[52]The levy is 20 basis points per year for nondeposit FC liabilities of up to 1-year maturity and lower for longer maturities: 10 bps for up to 3-year maturity, 5 bps for up to 5-year maturity, and 2 bps for longer than 5-year maturity.

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) FCLiabShr
Constrained=1 x Regulation	-0.474***	-0.469***	-0.138**	-0.133**
	(-4.00)	(-3.91)	(-2.51)	(-2.42)
Constrained=1	0.402*		0.137**	
	(2.02)		(2.79)	
Constant	0.221	0.922***	0.236***	0.508***
	(1.67)	(17.11)	(4.68)	(13.23)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	914	914	1071	1071
Adj RSqr	0.204	0.779	0.306	0.739

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Foreign Banks

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) FCLiabShr
Constrained=1 x Regulation	-0.00264	-0.00369	-0.00738	-0.00860
	(-0.21)	(-0.30)	(-1.36)	(-1.74)
Constrained=1	-0.0166		-0.0102	
	(-0.26)		(-0.24)	
Constant	0.124*	0.0839***	0.122**	0.0789***
	(2.12)	(3.72)	(2.81)	(7.01)
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	609	609	609	609
Adj RSqr	0.207	0.901	0.202	0.947

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Domestic Banks

Table IA.H.4: **Impact on Bank FC Loans and FC Liabilities (Foreign Banks vs. Domestic Banks** The results are based on a weighted least square model where the weight is pre-shock FXD position. The top panel is the result when I restrict the data to foreign banks. The bottom panel is the result when I restrict the data to domestic banks. Columns (2) and (4) add bank fixed effects. The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank. All variables are defined in Table B.1.

IA.I FXD Contract Level OLS: FXD Scaled by Sales

This section reports the results of the contract level analysis when the outcome variable is scaled by sales instead of by assets.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Constrained	0.0649***	0.0344**	0.00718	0.00437	0.0291***	0.00807
	(4.68)	(2.17)	(1.51)	(1.22)	(2.86)	(1.10)
Type Swaps		0.0106		-0.000135		0.00255
		(0.50)		(-0.01)		(0.33)
Type Options		0.137***		0		0.150***
		(3.69)		(.)		(4.66)
Type Futures		0.0253		0		0.0208*
		(1.10)		(.)		(2.01)
Pair EURKRW		0.0511*		0		0.0276*
		(1.96)		(.)		(1.76)
Pair JPYKRW		-0.0505*		0.0104		-0.0123
		(-2.12)		(1.05)		(-0.95)
Pair XXXKRW		0.0105		0.0315**		0.0111
		(0.58)		(2.36)		(1.30)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	129	129	122	122	251	251
RSqr	0.0841	0.461	0.0162	0.449	0.0333	0.435

t statistics in parentheses

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

Table IA.I.1: **FXD Contract level OLS** $\Delta FXD_{i,j} = \alpha + \beta\ Constrained_b + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$ The dependent variable is the change in the net FXD notional dealt between firm j and bank b, **scaled by sales**. $Bind_b$ is 1 if the contract is dealt with a binding bank. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank b's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Exporters	Exporters	Non-exporters	Non-exporters	Full Sample	Full Sample
Constrained	0.0272*	0.0281*	0.00442	0.00329	0.0146***	0.00722
	(1.94)	(1.76)	(0.97)	(0.88)	(3.12)	(1.05)
Type Swaps		-0.00475		-0.00635		-0.00582
		(-0.21)		(-0.56)		(-0.73)
Type Options		0		0		0
		(.)		(.)		(.)
Type Futures		0.0275		0		0.0179**
		(1.54)		(.)		(2.68)
Pair EURKRW		0.0487		0		0.0317***
		(1.54)		(.)		(2.97)
Pair JPYKRW		-0.0296		0.0152		-0.00292
		(-1.25)		(1.65)		(-0.28)
Pair XXXKRW		0.00655		0.0181		0.00329
		(0.37)		(1.19)		(0.40)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	111	111	122	122	233	233
RSqr	0.0290	0.109	0.00719	0.322	0.0186	0.0714

t statistics in parentheses

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

Table IA.I.2: **FXD Contract level OLS** $\Delta FXD_{i,j} = \alpha + \beta Constrained_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$ **FX Options contracts are excluded.** The dependent variable is change in net FXD notional **scaled by sales**.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Shock	0.0360***	0.0179**	0.00252	0.000285	0.00894	0.000922
	(3.07)	(2.15)	(1.63)	(0.18)	(1.54)	(0.26)
Type Swaps		0.0136		-0.0000924		0.00318
		(0.66)		(-0.01)		(0.41)
Type Options		0.138***		0		0.151***
		(3.69)		(.)		(4.77)
Type Futures		0.0244		0		0.0212*
		(1.07)		(.)		(2.00)
Pair EURKRW		0.0418		0		0.0272*
		(1.58)		(.)		(1.84)
Pair JPYKRW		-0.0522*		0.00739		-0.0159
		(-2.10)		(0.77)		(-1.27)
Pair XXXKRW		0.00906		0.0374**		0.0145
		(0.54)		(2.64)		(1.59)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	129	129	122	122	251	251
RSqr	0.0654	0.458	0.0111	0.447	0.0131	0.434

t statistics in parentheses

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

Table IA.I.3: **FXD Contract Level OLS** $\Delta FXD_{i,j} = \alpha + \beta_{Shock} Shock_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$ The dependent variable is the change in the net FXD notional dealt between firm j and bank b, **scaled by sales**. $Shock_b$ is the percentage of bank b's FXD position that needed to be reduced at the imposition of the regulation. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and foreign bank indicator variable. Contract controls include bank b's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level.

	(1) Exporters	(2) Exporters	(3) Non-exporters	(4) Non-exporters	(5) Full Sample	(6) Full Sample
Shock	0.0182**	0.0177**	0.00156	0.000781	0.00612***	0.00199
	(2.61)	(2.36)	(1.01)	(0.46)	(2.86)	(0.65)
Type Swaps		-0.0000793		-0.00627		-0.00527
		(-0.00)		(-0.54)		(-0.67)
Type Options		0		0		0
		(.)		(.)		(.)
Type Futures		0.0253		0		0.0181**
		(1.44)		(.)		(2.66)
Pair EURKRW		0.0414		0		0.0309***
		(1.41)		(.)		(3.07)
Pair JPYKRW		-0.0300		0.0139		-0.00494
		(-1.23)		(1.54)		(-0.46)
Pair XXXKRW		0.00289		0.0235		0.00592
		(0.15)		(1.45)		(0.67)
FirmControls	N	Y	N	Y	N	Y
BankControls	N	Y	N	Y	N	Y
N	111	111	122	122	233	233
RSqr	0.0331	0.109	0.00481	0.321	0.0141	0.0699

t statistics in parentheses

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

Table IA.I.4: **FXD Contract level OLS** $\Delta FXD_{i,j} = \alpha + \beta_{Shock} Shock_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$ **FX Options contracts are excluded.** The dependent variable is the change in the net FXD notional dealt between firm j and bank b, **scaled by sales**.

IA.J Knock-in Knock-out (KIKO) Options

This section shows an example of KIKO option contract. A typical contract is structured as follows:

- If the exchange rate (value of 1 USD in KRW) never trades above 930 during a window of time, typically a month, the option expires.
- If the exchange rate ever goes above 930 during the window:
  - If FX at maturity is between 930 and 945, option buyer has a right to sell **$0.5** at 945.
  - If FX at maturity is above 945, option buyer has an obligation to sell **$1** at 945.

The range of the exchange rate during 2007 was 900–950.

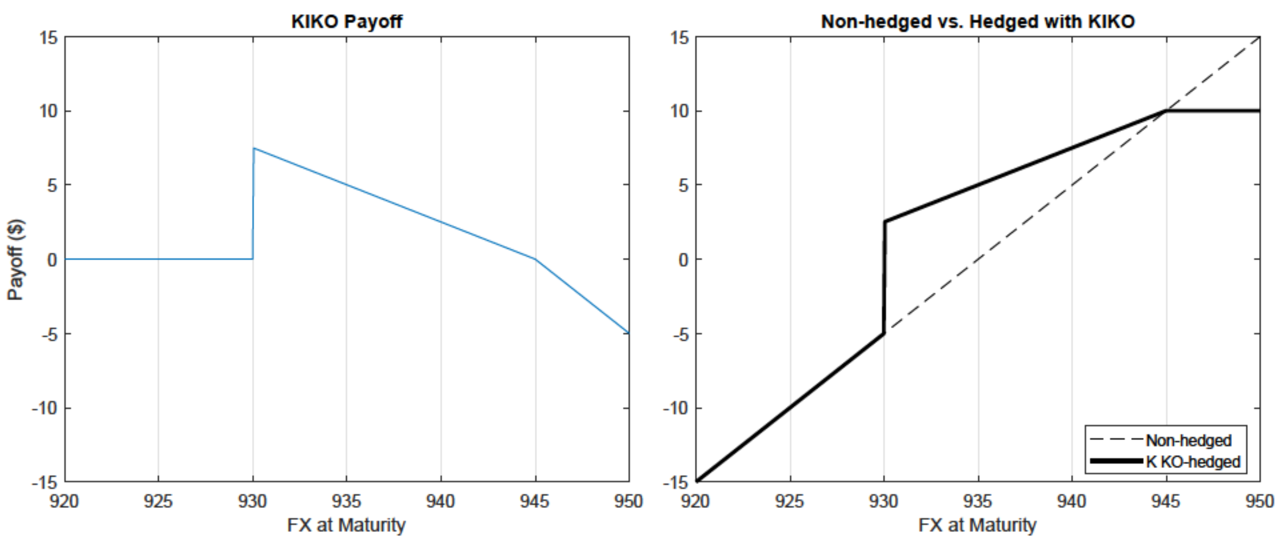


Figure IA.J.1: **Knock-in Knock-out (KIKO) Option Payoff** The left panel plots KIKO payoff as a function of exchange rate at maturity. The right panel compares non-hedged payoff with KIKO-hedged payoff.