The Real Consequences of Macroprudential FX Regulations

Hyeyoon Jung*

First draft: September 2020
This draft: November 18, 2020

Click **HERE** for the latest version.

Abstract

I examine the real effects of macroprudential foreign exchange (FX) regulations designed to reduce risk-taking by financial intermediaries. I exploit a natural experiment in South Korea at the bank-level that can be traced through firms. The regulation limits the banks' ratio of FX derivatives positions to capital. By using cross-bank variation in the tightness of the regulation, I show that the regulation causes a reduction in the supply of FX derivatives. Controlling for hedging demand, I find that exporting firms reduce hedging with constrained banks by 47% relative to unconstrained banks. Further, I show that the reduction in the banks' supply of hedging instruments results in a substantial decline in firm exports. For a one-standard-deviation increase in a firm's exposure to the regulation shock transmitted by banks, exports fall by 17.1% for high-hedge firms and rise by 5.7% for low-hedge firms, resulting in a differential effect of 22.8%. Collectively, my results provide causal evidence that regulations aiming to curtail risk-taking behaviors of financial intermediaries can affect the real side of the economy.

*Stern School of Business, New York University. E-mail: hjung@stern.nyu.edu. I am deeply grateful to my advisors—Robert Engle (Co-chair), Philipp Schnabl (Co-chair), Ralph Koijen, Alexi Savov, and Joel Hasbrouck—for their unwavering support and guidance. I additionally thank Viral Acharya, Robert Richmond, Toomas Laarits, Holger Mueller, Bruce Tuckman, David Yermack, Shan Ge, Yakov Amihud, Richard Levich, and participants at NYU Stern Finance department seminar, Federal Reserve Board pre-job market conference, and SoFiE seminar for helpful suggestions and comments. I thank the Center for Global Economy and Business, NYU Stern, for research funding. All errors are my own.

1 Introduction

Global financial shocks can severely destabilize the financial and macroeconomic states of emerging markets (EM) through volatile capital flows. A surge in capital inflow can contribute to excessive credit expansions and a buildup of systemic risk, and a sudden reversal of capital inflow can lead to an increased vulnerability to crises. Therefore, managing the volatility of capital flows is a significant concern to many EM economies. EM economies have commonly adopted two types of measures to address vulnerability to external shocks: capital controls that are designed to limit capital flows directly and macroprudential foreign exchange (FX) regulations that are designed to mitigate financial-stability risks associated with capital flows.

Although previous studies have largely focused on the role of capital controls, a growing number of countries have adopted a macroprudential approach in the form of FX-related measures that limit net or gross open FX positions, FX exposures, FX funding, or currency mismatches. Figure 1 plots the number of EM economies that use macroprudential FX regulations, based on the International Monetary Fund's (IMF) integrated Macroprudential Policy database compiled by Alam et al. (2020). As of 2018, 74 out of 98 EM economies are using macroprudential FX regulations. Figure 2 shows that macroprudential FX regulations have substantially tightened, especially since the global financial crisis (GFC). A growing body of literature has documented the effectiveness of using macroprudential FX regulations.[1] However, little consideration has been given to analyzing their real implications.

In this paper, I examine whether macroprudential FX regulations imposed on financial intermediaries have real effects on non-financial sectors. Specifically, I study how a regulation that limits banks' ratios of FX derivatives positions to equity capital affects the supply of FX derivatives and firms' exports. By exploiting a natural experiment in South Korea at the bank-level, which can be traced through firms, I show that the regulation caused a reduction

[1] Bergant et al. (2020) show that tighter regulation reduces the sensitivity of gross domestic product growth to VIX movements and capital flow shocks. Ostry et al. (2012) find that countries with stronger regulation were more resilient during the GFC.

in the supply of FX derivatives, and it in turn induced firms to reduce their exports. 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, due to a shortage of FX hedging instruments. Importantly, this implies that macroprudential regulations can have a negative effect on real economic outcomes for non-financial firms, even if they mitigate vulnerabilities to the financial sector.

How do macroprudential FX regulations affect firms' exports? I answer this question in two steps. First, how do the macroprudential FX regulations cause a reduction in the supply of FX derivatives? Second, how does a reduction in the supply of FX derivatives lead to a decline in exports?

The first question relates to the imbalance between the hedging demand of exporters versus importers and costly equity financing by banks. If the exporters' and importers' hedging demands were balanced, banks could simply match the two sides of offsetting demand, and the leverage-based FX regulatory constraint would not bind. Similarly, if it were costless for banks to raise equity capital, banks could raise equity to meet the requirement, and there would be no reduction in the supply of FX derivatives. However, I show that banks chose to reduce their FX derivatives position instead of raising capital to meet the requirement. This is an optimal choice for banks if it is costly to raise equity. In fact, the two factors—the imbalance in the hedging demands and the intermediary constraint—are not confined to the emerging market context. Du et al. (2018) finds that the interaction between the two factors, global imbalance in investment demand versus funding supply and intermediaries' balance sheet constraints, has resulted in covered interest rate parity (CIP) deviations in the currencies of developed markets. This has occurred in the context of tightened capital requirements in the post-GFC period.

The second question relates to export decline and can be answered by considering the inability of firms to find alternative sources of hedging to ease the regulation shock transmitted by the banks. Even if a fraction of banks reduced the supply of FX derivatives following the regulation, firms could substitute part of their hedging toward banks that are less constrained by the regulation. However, I show that this is not the case. The firms' hedging with constrained banks fell compared to their hedging with unconstrained banks, and total firm-level hedging also fell. These results suggest that the firms' inability to offset the liquidity shock transmitted by banks by borrowing from alternative sources is not limited to the credit market and can be extended to the derivatives market. The unavailability of FX hedging instruments, resulting in a decline in exports, implies that FX derivatives are crucial risk management tools for firms with exposure to FX risk.

A natural experiment in Korea provides a suitable setting to study the real effects of macroprudential regulation for several reasons. First, it offers a setting in which the exposure to the regulation shock varies across banks. When the regulation was imposed in Korea, only a subset of banks was constrained, and this allows me to estimate a bank-specific tightness of the regulation. This cross-bank heterogeneity in the strictness of regulation provides an identification strategy for my empirical analysis. Second, data on the details of FX derivatives contracts at the firm-bank pair level are available for analysis. This allows me to isolate banks' hedging supply from firms' 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 the change in hedging demand. Third, firm-level FX derivatives holdings and export sales are observable. Therefore, I can evaluate the real outcomes at the firm level by comparing the firms that traded with constrained banks and those that did not.

To understand how the regulation shock to the banks propagates to firms, I proceed in three steps. First, I conduct a bank-level analysis to evaluate the banks' responses following the regulatory imposition. The regulation requires all banks located in Korea to maintain their ratio of FX derivatives 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 FX derivatives to capital exceeded the regulatory cap when the regulation was introduced. I compare their responses with those from the banks whose regulatory constraint was not binding. Using the difference-in-differences specification, I find that the constrained banks' FX derivatives position is reduced more than that of the unconstrained banks. I find that the gap between the two groups' FX derivatives positions decreases as the regulations are tightened. This result suggests that it is costly for banks to raise equity capital, and therefore banks cut down their FX derivatives position.

For the second step, I use contract-level data for FX derivatives, observed during the six months before and after the regulation was imposed. With these data I estimate the transmission of regulation shock from banks to firms. I control for changes in hedging demand by examining the hedging with constrained banks and the 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 that the net FX derivatives position of contracts with constrained banks increased by 45% relative to that with unconstrained banks. The increase in the net FX derivatives position implies a contraction in hedging for the exporters and an expansion in hedging for the non-exporters, including the importers and the firms hedging their exposure to FX risk from the foreign currency debt. Both cases help loosen the banks' regulatory constraint, as their long foreign currency position in FX derivatives would decrease. I find that the effect on hedging is much stronger for exporters than for non-exporters. The exporters' hedging with constrained banks declined by 47% more than their hedging with unconstrained banks. These results suggest that regulation causes a reduction in the supply of FX derivatives.

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

Based on my analyses, I argue that macroprudential FX regulation can cause a reduction in FX derivatives, which can lead to a reduction in exports by affected firms. My findings imply that the regulation achieves its goal of reducing the aggregate-level FX maturity mismatch, but only at the expense of reducing exports. This finding is important, especially for the firms that have been actively using FX derivatives to mitigate their exposure to FX risk. Further, the muted effect on the importers combined with the negative effect on the exporters has an important macroeconomic implication: the regulation could adversely affect the trade balance. It is concerning that a macroprudential regulation could destabilize what it intended to stabilize. Although my analysis does not involve an overall welfare assessment, the findings here demonstrate that macroprudential policies can have adverse effects. These effects should be carefully considered in future policy development.

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 and including bank, firm, and contract characteristics as control variables in the contract-level and firm-level analyses. Second, I analyze changes in FX derivatives separately for foreign banks and confirm that the relative reduction in FX derivatives of the constrained banks was large and significant even within foreign banks. This suggests that the result is not driven by the difference in business models between foreign and domestic banks. Third, I estimate the impact of regulation on banks' foreign currency lending to test a potentially confounding effect of credit shock. I find no significant change in the share of foreign currency lending of the constrained banks compared to unconstrained banks. Fourth, I estimate the impact on firms' domestic sales as a placebo test and find that the effect is small and insignificant. This result implies that the decrease in export sales is indeed caused by a regulatory shock as opposed to a systemic relationship between troubled firms and constrained banks.

The conclusions of this paper apply to other emerging market economies as well as developed economies. The leverage-based cap on banks' net position of FX spot or (and) derivatives position is common. Globally, approximately three out of four countries, including developed economies, have limits on their financial sector's open FX positions as of 2018.[2] Therefore, the implications of my results may extend to countries with similar regulations.

Related Literature

This paper relates to various strands of literature. The main contribution of this paper is to an actively growing body of literature concerning the effects of macroprudential regulations in the context of international finance. Studies including Bruno et al. (2017) and Ostry et al. (2012) show the effectiveness of the regulations in achieving their goals. Bruno and Shin (2014) studied the same Korean macroprudential FX policies that are analyzed in this paper and found that the sensitivity of incoming capital flows to global conditions decreased in Korea following the introduction of the regulations.[3] However, Aiyar et al. (2014), Cerutti et al. (2015), Reinhardt and Sowerbutts (2015), and Keller (2019) document leakages and unintended consequences of macroprudential regulations or capital controls. 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 closely related to that of Keller (2019), who analyzes a similar setting in Peru to identify the capital control shock transmitted through loans, which resulted in risk-shifting

[2]Based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, 147 out of 192 countries have imposed limits on the financial sector's open FX positions as of 2018. (AREAER) Of these, 27 are advanced economies.

[3]See Choi (2014) as well.

from banks to firms. In my paper, the transmission channel is through FX derivatives rather than loans, and I focus on the real effects that arise from the shortage of firms' hedging instruments. Another closely related paper is that of Ahnert et al. (2020), who evaluate the effectiveness and unintended consequences of macroprudential FX regulations using cross-country panel data. Unlike their work, 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.

There is a large body of literature on the effect of financial shocks on the real economy. Theoretical work from Bernanke and Blinder (1988), Bernanke and Gertler (1989), Holmstrom and Tirole (1997), and Stein (1998) shows that 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. Paravisini et al. (2014) study the effect of credit on exporting firms and find that credit shortages reduce exports by raising the variable cost of production. Here, I add to this body of literature by documenting evidence that is similar to the bank lending channel and the firm borrowing channel in the derivatives market. In my setting, banks face a regulatory shock rather than a liquidity shock related to financial crises. The macroprudential FX regulation, combined with costly external financing, leads to a market imperfection for the banks. The market imperfection for the firms is that they are not able to offset the shock by switching across banks, which suggests that switching across banks 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.

My paper also relates to the effects of frictions in financial intermediation on asset prices and real outcomes. In an FX market context, Gabaix and Maggiori (2015) and Du et al. (2019) apply intermediary-based asset pricing models to the exchange rate literature. On the empirical side, 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.[4] Ivashina et al. (2015) explain how regulatory capital constraints may lead to the violation of CIP. I contribute to the field by documenting that FX macroprudential regulation can cause financial intermediation to be costly and that the regulation can have real consequences.

My work here builds on the literature concerning the real implications of derivatives hedging. Empirical studies from Allayannis and Weston (2015), Carter et al. (2006), Jin and Jorion (2006), Campello et al. (2011), and Gilje and Taillard (2017) find that hedging is associated with an increase in firm values. Here, I highlight the importance of FX derivatives 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 FX derivatives.

My empirical results add to the growing body of literature studying the implications of bank capital regulations on banks' behaviors. Greenwood et al. (2017) show that both the aggregate level of activity and the distribution of activity across banks will be distorted by having multiple competing capital requirements. Duffie (2018) finds that 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 the 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 banks' FX derivative positions as opposed to leverage, it takes the form of imposing a leverage-based cap. I find that banks choose to shrink their balance sheet exposure rather than raising equity to meet the FX derivative capital requirement, which is consistent with the model of Admati et al. (2018).

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

Outline of the Paper

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

2 The Setting

2.1 Background

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

From 2000 to 2007, prior to the GFC, Korea had had twin surpluses in the balance of payments and a surge in capital inflows (Figure 3). The surge in capital inflow was primarily driven by the banking sector's borrowings, which subsequently had a dramatic reversal during the GFC (Figure 4). The outflow during the fourth quarter of 2008 was close to $40 billion, which is about 4% of the country's annual GDP.

In terms of external debt, Figure 5 shows that Korea's external debt had increased throughout the 2000s prior to the GFC, and Figure 6 shows that the short-term component of the external debt rose substantially. Even after taking the huge accumulation of foreign exchange (FX) reserves (Figure 7) into account, liquidity defined as FX reserves less short-term debt, scaled by GDP, had been deteriorating from 2005 (Figure 8).[5]

The surge in the banking sector's short-term borrowings was closely related to the increase in exporters' hedging demand (relative to importers' hedging demand) and banks' position covering practices. During 2006–2007, the high global demand lead exporters to have long-term US Dollar (USD) receivables, and exporters sold a large amount of USD forwards

[5] A measure of liquidity by Acharya and Krishnamurthy (2019)

to banks in order to hedge FX exposure from the USD receivables.[6] The left panel of Figure 9 presents the structure of firms' FX position. Because banks purchased USD forwards from exporters, they were long USD forwards. Had there been importer's hedging demand matching that of exporters', banks could have covered the long position by selling USD forwards to the importers. However, importers' hedging demand fell far short of exporters' hedging demand for several reasons. First, importers' FX liabilities are typically short-term and easier to predict. Second, it could be optimal for importers to not hedge when central bank aggressively accumulates FX reserves, in an anticipation that the reserves would be used to reduce currency depreciation (Acharya and Krishnamurthy (2019)). Third, the main importing sector in Korea is energy sector with market power, which allows them to pass the FX risk to their customers through pricing. (Kim (2010))

In the shortage of natural USD forward buyers, banks needed to cover the long position in USD forwards by constructing a short position in synthetic forwards. A short position in synthetic forwards is constructed by borrowing USD, converting USD to Korean Won (KRW) in FX spot market, and investing in risk-free KRW-denominated bonds. In this process, foreign bank branches typically used short-term external USD borrowing from their parent banks.[7] The structure of banks' FX position is illustrated in the right panel of Figure 9.

As a result, although its firms and banks hedged their FX mismatches, Korea was left with a substantial *maturity* mismatch which made the financial system vulnerable. Korea suffered severely from USD funding liquidity crisis during the GFC, as the banks were not able to roll over the short-term external debt. As shown in Figure 10, the average KRW CIP basis, a measure of FX funding liquidity, during 2007–2009 had been -300bps[8]. KRW also depreciated rapidly and Korea was close to suffering a currency crisis.[9] Figure 11 shows

[6] McCauley and Zukunft (2008), Ree et al. (2012) and others

[7] The domestic banks' maturity mismatch was not as severe as the foreign bank branches. (Ree et al. (2012))

[8] The average for G10 currencies during the same period was -20.8bps with maximum deviation of -63.1bps for Danish Krone. (Du et al. (2018))

[9] International Monetary Fund (2012)

that USD appreciated by 34% during 2008.

2.2 Policy Measures

To address the vulnerabilities, Korea introduced two main macroprudential measures to improve resilience against capital flow volatility through the banking sector.[10]

FX Derivatives Position Limit

The first measure, announced in June 2010, was to limit banks' FX derivatives (FXD) position relative to their capital:

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

The FXD position is defined as monthly average of daily net aggregate delta-adjusted notional value of all FXD contracts including FX forwards, swaps, and options that the bank holds.[11] Since the net FXD position is aggregated across all currencies, banks' FXD position in a currency pair that does not involve KRW (e.g. EUR-USD pair) has no effect on the constraint. The equity capital base is defined as the sum of Tier 1 capital (paid-in capital) and Tier 2 capital (including long-term, longer than a year, borrowing from its parent bank) in all currencies. The exchange rate to convert KRW-denominated capital base to USD is the average of the exchange rate used for the previous year's calculation and previous year's average exchange rate.

The limit (1) is placed on each bank; the FXD position of a bank must be within 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 banks and domestic banks. The regulation was tightened in the first three changes and loosened in the last two. For my

[10]International Monetary Fund (2012), Bruno and Shin (2014)

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

empirical analysis, the last change in 2020 is not included due to lack of data availability. According to the regulator's statements, the main underlying factors that led the regulator to adjust the limit is banking sector's aggregate short-term external debt and the USD funding liquidity condition.

The policy seeks to limit the short-term FC borrowings of banks by requiring them to put up more equity capital as they increase their FXD position. The link between banks' FXD position and short-term borrowing lies on the exporters' hedging demand in excess of the hedging demand of the opposite side, such as importers. Due to the imbalance in the hedging demand, banks hedged their forwards positions with offsetting positions in synthetic forwards by using cash instruments. In addition, foreign bank branches' accessibility to USD funding from their parent banks facilitated the hedging of derivatives by using cash. Figure 12 shows the co-movement between the aggregate net FXD position and the aggregate external short-term FC borrowings of banking sector.

Macroprudential Stability Levy

The second measure, effective since August 2011, was to impose levy on the non-core FC denominated liabilities of the banking sector. This measure is designed to induce banks to cut down their FC borrowings by increasing their funding costs. The proceeds of the levy flow into the Foreign Exchange Stabilization Fund, which is separate from the revenue of the government and can be used as a buffer in the event of financial crises.

The levy is 20 basis points per year for non-deposit FC liabilities of up to 1 year maturity, and it is lower for longer-maturity: 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.

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. Banks' FXD position data is hand-collected from the banks' financial statements and the rest of banks' financial data is downloaded from Korean Financial Statistics Information System[12] managed by Korea's financial regulator, Financial Supervisory Service. FXD contract data of all listed non-financial firms is hand-collected from firms' financial statements published on Korean Data Analysis, Retrieval and Transfer (DART) System[13]. DART is the repository of Korea's corporate filings where the disclosure filings of all Korean firms subject to external audit (including listed and non-listed) can be downloaded. The data source for firm-level financial data is TS2000, a commercial data aggregator managed by Korea Listed Companies Association. The 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 limit. Among them, 29 are foreign banks and 17 are domestic banks. The list of banks' full names are included in Appendix (Table 25). Banks' on-balance sheet FX position, defined as FC assets less FC liabilities, FXD position, and the FX derivatives-position-to-capital (DPTC) ratio are observed on a monthly basis. Other financial variables of banks are observed on a quarterly basis. The sample period is from 2008 to 2018.

Aggregate Data

[12] http://efisis.fss.or.kr/fss/fsiview/indexw.html
[13] https://englishdart.fss.or.kr/

The mean DPTC ratio peaked at 16.9 in 2007 for foreign banks and at 0.4 in 2008 for domestic banks.[14] As of December 2009, the last reporting period before the regulation, the average DPTC ratio of foreign banks was 2.9, which exceeded the regulatory cap of 2.5. Figure 13 shows that 14 foreign banks had DPTC ratio exceeding the regulatory cap, and all of them except one reduced their DPTC ratio below the regulatory cap six months after the first announcement. On the other hand, the average DPTC ratio of domestic banks was 0.17 as of December 2009, which was below the regulatory cap of 0.5. Figure 14 shows that the 2 domestic banks with DPTC ratio above the regulatory cap reduced their DPTC ratio below the cap six months after the first announcement.

The top panel of Figure 15 plots the gross aggregate FXD position of banks with the announcement dates of changes in the minimum FXD capital requirement. The bottom panel plots the minimum FXD capital requirement (inverse of regulatory cap) for foreign banks and domestic banks. The gross aggregate FXD position decreased after the imposition of the regulation, and it fell further following subsequent tightening adjustments.

Bank-specific Data

To study the effect of the FXD position limit on banks, I exploit the heterogeneity in the tightness of the regulation across banks. Table 2 reports banks' asset, derivatives position ($DerivPosition$), capital, DPTC ratio, size of derivatives positions in excess of the limit ($DerivExceeded$), size of shock defined as $DerivExceeded/DerivPosition$ if the constraint was binding. The heterogeneity in DPTC ratio comes from both numerator and denominator, but more driven by the numerator.[15] Among the 46 sample banks, the regulatory constraint was binding for 16 banks as of Dec 2009, prior to the first announcement of the regulation. The constrained foreign banks had to reduce DPTC ratio below 2.5 and the constrained domestic banks had to reduce the DPTC ratio below 0.5.

The constrained banks in aggregate needed to reduce about 13 billion USD of their FXD

[14] Figure 20 in Appendix plots the time series of mean, 10-percentile and 90-percentile of DPTC ratio for foreign banks and those of domestic banks, overlaid with the regulatory cap.

[15] The standard deviation of DPTA is 0.19 and that of CTA is 0.12

position. Table 3 is bank summary statistics by whether the bank was constrained (treated) or not (control). The constrained banks consist mostly of foreign banks. They are, on average, smaller, had lower loans to assets ratio, and more leveraged. The differences in these characteristics are statistically significant, and therefore I control for the differences in my empirical analysis. I also run separate analyses for foreign banks and domestic banks.

Figure 16 compares the average FXD position of constrained banks with that of unconstrained banks. It shows that the constrained banks reduced their FXD positions after the imposition of regulation, relative to unconstrained banks. In terms of FXD market share, Figure 17 shows that the constrained banks' share fell while foreign banks' share is relatively stable. This is because unconstrained foreign banks took over a part of constrained foreign banks' share.

3.3 FXD Contract Data

All non-financial firms in Korea have been required to disclose the details of their existing financial derivatives contracts in disclosure since 1999.[16] I hand-collected the details of FXD contracts for years 2009 and 2010. Among approximately 300 firms that had been using FXD as of 2009, I focus on 148 firms that continued to use FXD in 2010. 132 of them fully disclosed their counterparty information, while 16 firms disclosed only the main counterparty.[17] Although I am not able to include the 16 firms (with large FXD market shares) in the contract-level analysis, I include them in firm-level analysis.

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

[16] Ban and Kim (2004)

[17] The top 10 firms' market share of FXD usage (sum of FXD assets and FXD liabilities) is 88%, yet none of them reports the full list of counterparties. This is because the regulator does allow 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 such that profit and losses from the contracts would be predictable, given the future movements in the exchange rate. When firms report at the aggregate level, they typically do not disclose the full list of counterparties.

contracts for the firm-bank pair. A positive net FXD position indicates a long position in USD, or USD equivalent amount for non-USD foreign currency such as Euro. While the delta of forwards, futures and swaps is 1, the delta of each option needs to be calculated. For the regulatory purpose, Black-Scholes model is used to calculate 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 delta of forwards. This assumption is conservative; using Black-Scholes delta would only make the results stronger.[18] To illustrate the calculation of net FXD position, suppose that an exporting firm A sold USD forward with notional of \$100 and wrote 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 make a loss from its FXD trades with bank B in case USD appreciates.

The sample contains 251 contracts between 132 firms and 33 banks[19]. Table 4 is the contract-level summary statistics by exposure. The contracts that do not involve KRW and the contracts without directional (buy or sell) information are excluded.[20] In terms of the direction of contracts, roughly half of the contracts are firms taking long position in foreign-currency. In terms of pairs, USD-KRW pair is most common (86%). All contracts that involve KRW, but not USD, JPY or EUR are categorized as one group. In terms of type, forwards are most common (53%).

A contract is "Exposed" if the firm dealt with a constrained bank, a bank that was required to reduce its DPTC ratio at the end of year 2009. 40% of the contracts are exposed and 60% are non-exposed. The contract characteristics (size, side, pair and type) of exposed firms are statistically significantly different from those of non-exposed firms, and therefore I control for the contract characteristics in my analysis.

[18]Most of the options are exotic options with Black-Scholes delta in the range between 0.7 and 0.9.

[19]13 banks in the bank data set do not have any FXD contract with sample firms.

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

3.4 Firm Data

The contract-level data are aggregated at the firm-level. Table 5 provides summary statistics on firm-level data by exposure. A firm is classified as "Exposed" if its main FXD counterparty bank (in terms of notional) is constrained. The exposed and non-exposed firms are similar in terms of all characteristics except FC liability share. The full-sample average net FXD position of firms is -8% of assets (similar in terms of sales), which means that firms on average make loss equal to 8% of assets in case USD appreciates by 1 Won. This translates into approximately 20% in terms of export hedge ratio; firms hedge one fifth of their export sales using FXD. To take a concrete example, suppose that an exporter's total sales is $100 worth and the share of export sales is 50%. Suppose that the export sales are all account receivables and therefore the firm has $50 to receive in the future. If the firm hedges $10 worth of USD forwards, 20% of the export sales is hedged. For completeness, in Appendix (Table 27), I show summary statistics of the subsample excluding the 16 firms that disclosed only the main counterparty.

I categorize firms into net FXD buyers and net FXD sellers.[21] The net FXD buyers are the firms with positive net FXD position. These firms profit from their FXD trades in case foreign currency appreciates, and they are typically importers or firms with FC borrowings. They mostly use swaps that match the exact cash flows of their FC loans or FC bonds they issued. Their median FC liability hedge ratio, defined as FXD bought amount divided by FC liabilities, is 0.56. The correlation between FC liabilities and net FXD position is 0.78.

The FXD sellers are the firms with negative net FXD position, and they are typically exporters. They primarily use forwards to hedge their export sales. Their median export hedge ratio, defined as FXD sold amount divided by export sales is 0.68. The hedge ratio of FXD sellers is not so informative about whether firms used FXDs for hedging or speculating purpose, because unearned revenues are not captured in sales. To be specific, a manufacturing firm "JinSungTEC" had export hedge ratio of 9.95, which may look like its FXD

[21] Tables 36 – 38 in Appendix provide the list of firms with information on their hedging practices.

position serves a speculating purpose. However, the firm received export orders for the next ten years and its FXD was for hedging the future USD cash inflows. Since the orders flow into the unearned revenue account until the 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, strong correlation (-0.93) between export sales and net FXD position suggests that the primary purpose of holding FXD was to hedge rather than to speculate.

4 Empirical Methodology and Results

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

4.1 Impact of Regulations on Banks

This section studies the impact of the regulations on banks' FXD positions, capital, FC liabilities and FC loans.

Banks' Adjustments of FX Derivatives Positions and Capital

Since the regulation is enforced in terms of the DPTC ratio, banks may manage the ratio by adjusting their derivatives position or their capital bases (or both). I show that the banks mostly adjusted the former, using the following base-line 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 derivatives holdings ($LogDeriv$), 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 DPTC ratio); it is 0 before the imposition of the regulation, and higher value indicates tighter regulation. The bottom panel of Figure 16 plots the $Regulation_t$. 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 the official announcement dates rather than the effective dates (presented in Table 1) whenever the minimum FXD capital requirement is adjusted, as banks may preemptively react to the regulation upon the announcements before the effective dates.[22] 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 derivatives position as of Dec 2009. For some specifications, I add bank fixed effects δ_i to control for differences in time-invariant factor 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.

[22] The first news article mentioning that the regulators are considering introducing a regulation related to banks' FX derivatives positions came out about two weeks earlier (on 27 May 2010). My results are robust to changing the imposition date from the official announcement date (13 June 2010) to the first news date (27 May 2010).

DiD specification requires parallel-trends assumption. The Figure 16 which plots the aggregate FXD position (top panel) and the normalized average FXD position by treatment (middle panel) shows that the trends had indeed been parallel. It would be a concern 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.

Table 6 reports the 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 and it is expected to have a negative sign for $LogFXD$, because the constrained banks' FXD position relative to unconstrained banks' is expected to decrease as the regulation gets tighter (higher $Regulation_t$). The estimated β_1 coefficients in columns (1) and (2) imply that the constrained banks' FXD position is reduced by 60[23]-62% more than unconstrained banks' per unit increase in $Regulation_t$. β_1 remains negative and significant when bank fixed effects are added (column (2)), and estimated under the weighted least squares models where the weight is pre-shock FXD position (Table 29 in Appendix). Columns (3) and (4) 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 the constrained banks, and therefore they reduced their DPTC ratios after the regulation.

In sum, the results suggest that the constrained banks chose to reduce their FXD position instead of increasing their capital. These results are robust to using weighted average minimum FXD capital requirement, $Regulation_t^{WAvg}$, as reported in the bottom panel of Table 6. While it is not surprising to find that 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 DPTC ratio by cutting down the FXD position along with the short-term

[23] $1 - \exp(-0.913)$

external borrowing from the parent banks, rather than to increase their equity capital.

To ensure that the results are not driven by differences in characteristics or differential exposure to the GFC across foreign banks and domestic banks, I run the same analyses separately for foreign banks and domestic banks. Tables 7 and 8 are results for foreign banks and domestic banks, respectively. They suggest that the full-sample results are driven by the foreign banks. In other words, even among foreign banks, constrained banks reduced more of their FXD positions. This could not have been driven by the GFC, which cannot explain the variation within foreign banks.

Impact on FX Derivatives Pricing

If the reduction in FXD position was driven by the shift in supply as opposed to demand, I expect to see an increase in the mark-up on FXD contracts. An increase in mark-up corresponds to decrease in USD forwards prices as 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 (mark-up) on derivatives, I am not able to directly show that the constrained banks lowered USD forward prices relative to the unconstrained banks. Yet, I show suggestive evidence that the mark-up of USD forwards increased after the regulation by comparing short-term and long-term covered interest rate parity (CIP) deviations.

Define CIP deviation for maturity n at time t ($x_{t,t+n}$) as 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)[24], and KRW rate ($y^{₩}_{t,t+n}$):

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

CIP deviation would likely fall (increase in terms of magnitude) as firms raise mark-up by lowering forward prices. Because banks' long positions in USD forwards are concentrated

[24]Value of 1 USD in terms of KRW; higher s_t means USD appreciation.

in the longer tenor, regulation would likely affect the long-term CIP deviation than the short-term one. Figure 18 plots 3-month and 3-year CIP deviations. It shows that the 3-year CIP deviation fell relative to 3-month CIP deviation, particularly after the first two announcements. (The last vertical line indicates loosening of the regulation as opposed to a tightening.)

Impact on Banks' Foreign Currency (FC) Liabilities and FC Loans[25]

Figure 19 shows that banks' FX positions are reasonably hedged; their on-balance sheet FC positions offset off-balance sheet FX derivatives positions. As banks need to match their FC assets and FC liabilities, a reduction in the net long FXD positions would lead to either a decrease in FC liabilities or an increase in FC assets (or both). To understand how the regulations affect banks' FX balance sheets, I estimate the same specification (2) with the outcome variables: FC loans share and FC liabilities share.

Table 9 shows that the impacts on FC loan share and FC liability share are insignificant. This suggests that the transmission of regulatory shock on banks to firms is through the hedging channel (FXD contract relationship), rather than the credit channel (loan relationship). Furthermore, my findings imply that similar regulations could have very different consequences, depending on whether the banking sector's FC liability is primarily used for funding domestic loans or FXD positions. For instance, Keller (2019) finds that a similar regulation by Peru that limits local banks' holdings of forward contracts results in inducing banks to increase FC loan share. On the other hand, in case of an export-driven economy, it is FXD hedging that is very important for the exporters. Therefore, before the regulation, banks' FC borrowing had been predominantly used for banks to fund their FXD positions dealt with exporters.

In Appendix (Table 32), I show the results under that weighted models. When the observations are weighted by the pre-shock FXD position, the constrained banks reduced

[25]For this analysis, the closed banks are excluded due to data availability.

both FC loan share and FC liability share relative to unconstrained banks. The decrease in FC loan share could be due to the other macroprudential measure, the levy on the non-core FC liabilities, which raises the effective cost of FC funding.

Impact on Banks' Security Holdings

Although it is not the main focus of this paper, banks' adjustments of security holdings following the regulations suggest that the government bonds used in constructing the synthetic short USD forward positions were short-term government bonds rather than long-term ones. Table 12 shows this result. Korea Treasury Bonds (KTBs) are long-term (3-year to 30-year) government bonds, and Monetary Stabilization Bonds (MSBs) are short-term (91-day to 2-year) bonds issued by Bank of Korea. Columns (3) and (4) in Table 12 show that the constrained banks reduced their short-term government bond holdings, as they reduced their long USD position in forwards.

All of the main results on banks' adjustments of FX derivatives positions, capital, FC liabilities, FC loans and security holdings are robust to excluding three banks that were unconstrained but became constrained at a point in time after the regulation.[26] (Appendix Table 39–41)

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 the hedging demand and the hedging supply; the observed relative reduction in hedging by firms that traded with constrained banks could be due to an increase in hedging demand of firms that traded with unconstrained banks, as opposed to a decrease in 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

[26] Deutche Bank, Goldman Sachs, and Mizuho

exporting opportunities were impaired during the GFC, the exporting firms that traded with constrained banks may demand 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 the 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 choose OLS specification with controls for firm characteristics:

$$\Delta FXD_{i,j} = \alpha + \beta\, Constrained_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j} \tag{4}$$

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

The outcome variable is change in net FXD position of firm j with bank i (scaled by firm j's asset) between year 2009 and 2010. I winsorize the extreme 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 value of 1 if the contract is dealt with a constrained bank and 0 if otherwise. Firm controls include log size, scaled net FXD position before the shock, FC liability share, and 7 industry dummies. I also include contract and bank characteristics to make sure that the results are not confounded by pre-shock differences in contract or bank characteristics. Bank controls include log size, loans to assets ratio, leverage ratio, and 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 that are classified as forwards, swaps, options, and futures. Similarly, currency pair is the percentage of FXDs that are categorized as USD-KRW pair, JPY-KRW pair, EUR-KRW pair and other pairs involving KRW. I cluster standard errors at the bank level.

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

Table 13 show the results. Column (1) reports the result for the exporters' contracts. The scaled net FXD position of the contracts dealt with constrained banks increased by 5.3% after the shock, compared to the contracts with unconstrained banks. Given that the pre-shock average scaled net FXD position of the exporters' contracts was -8%, the change translates into 67%[27] reduction in hedging. Column (2) adds firm controls, bank controls, and contract controls, and it shows that the relative reduction in hedging is by 47%, which is economically significant. I further find that the net option positions increase by 8.6% relative to forwards. As the 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 firms' 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 regulatory shock did not affect the non-exporters' hedging. This is likely related to the reasons why importers' hedging demand had been weak; potential reasons include central bank put, market power of Korea's importing sector, and importers' cash flows being relatively easier to predict (than exporters' cash flows). I report

[27] (-8+5.3)/(-8)-1

the full sample results in columns (5) and (6) for completeness.

Since the bank-specific tightness of regulation ($Shock$) is observed, I also use the following specification by replacing binary variable $Constrained_i$ in (4) with $Shock_i$:

$$\Delta FXD_{i,j} = \beta + \beta_{Shock} Shock_i + FirmControls + BankControls + ContractControls + \varepsilon_{i,j} \tag{5}$$

$Shock_i$ is the percentage of bank i's FXD position that banks were required to reduce at the imposition of the regulation, presented in Table 2.

Table 14 presents the results. Columns (1) and (2) show that the impact on exporters' contracts remain large and significant. Column (2) shows that one standard deviation increase[28] in $Shock$ leads to 2% increase in scaled net FXD position (which is decrease in hedging by 28%[29]) for exporters' contracts. Columns (3) and (4) show that the non-exporters' contracts were not affected. The full sample results, columns (5) and (6) are weaker than those under the specification (4).

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.

Relation to Exotic Options Crisis

Most of the options in the sample are Knock-In Knock-out (KIKO) exotic options that many small and medium-sized enterprises entered before the financial crisis.[30] Typical payoff structure of exotic options is presented in Appendix (Figure 22). The continued appreciation trend of KRW with low volatility triggered the popularity of the exotic options and many firms presumably entered into the contracts without having a good understanding of the risks. Some firms sued banks for not fully informing them of the potential risks, after making large

[28] Standard deviation of $Shock$ is 11.8%.

[29] (-8+2.2)/(-8)-1

[30] About 500 SMEs were holding Knock-In Knock-Out (KIKO) exotic options contracts in June 2008, and the number decreased to about 300 SMEs at the end of 2008.

losses during the financial crisis. The case of non-financial firms suffering from exotic FX derivatives positions is not unique to Korea; many EM countries had similar experience.[31]

To test whether the 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 15 presents the results for specification (4), and Table 16 shows the results for specification (5). The results of exporters' contracts are still significant after excluding the options. Column (1) of Table 15 shows that the scaled net FXD position of sell contracts with constrained banks increased by 2.6% (which is reduction in hedging by 33%). Column (1) of Table 16 shows that one standard deviation increase in *Shock* leads to 1.7% increase in the scaled net FXD position (which is reduction in hedging by 22%).

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 exporters' contracts. Exporters' hedging with constrained banks decreased considerably, by 47%, compared to their hedging with unconstrained banks.

4.3 Impact on Real Outcomes of Firms

This section uses firm-level data to estimate the impact of changes in FXD position of banks on real outcomes of firms.

Firm-level Reduction in Hedging

To estimate the impact of the regulation shock on firm-level FX derivatives hedging, I use the following OLS specification:

$$\Delta Y_j = \beta_E \, Exposed_j + FirmControls + \varepsilon_j \tag{6}$$

[31] Korea, Sri Lanka, Japan, Indonesia, China, Brazil, Mexico and Poland (See Dodd (2009))

for the full sample (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 the firm j's main bank is constrained and 0 if otherwise. The main bank is defined as the firm's counterparty bank with the largest FXD position. The firm control variables are same as those in the contract-level regression. The identification assumption is that the change in hedging demand is uncorrelated with the bank exposure, conditional on observables.

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

$$\Delta Y_j = \beta_{\overline{E}}\, Exposure_j + FirmControls + \varepsilon_j \tag{7}$$

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

First, I report the effect on firm-level FXD position by firm size. Table 17 presents the result for the full sample. Columns (1) and (2) show that the net FXD position of exposed firms shifted up by 43–47% relative to non-exposed firms, given that the pre-shock average scaled FXD position was -8.2%. Columns (3)–(6) show that the effects are large for small firms, but small and insignificant for large firms. The results for the subsample with complete disclosure of counterparties in Table 18 corroborates that firms were not able to offset the regulation shock transmitted by banks, and small firms in particular had difficulty finding an alternative source of FXD hedging. These results are analoguos to the evidence in the credit market (Khwaja and Mian (2008), for example).

Second, I report the effect on firm-level FXD position by the sign of net FXD position of firms. I define firms with negative net FXD position as exporters and those with positive FXD position as non-exporters.[32] Table 19 reports the full sample result. Columns (1) and (2) show that the exporters moved up their net short FXD position by 40–45% relative to

[32]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.

non-exposed firms, given that the pre-shock average scaled FXD position for exporters was 16%. In contrast, there was almost no effect on non-exporters. Results for the fully disclosed firms in Table 20 are similar.

Overall, the results suggest that switching bank relationship in FX derivatives market is costly for firms. Some plausible reasons are related to the facts that the FX derivatives are customized products and that banks typically bundle their services. In my sample, contracts are often customized to meet firm's specific hedging demand, in terms of maturity and payoff structure. In addition, for a given firm, its main bank in terms of FX derivatives contracts typically coincides with its main bank in terms of loans.

Main Result: Impact on Firms' Exports

Provided that the reduction in banks' hedging supply primarily affected exporters (net FXD sellers), I confine sample to exporters and examine the impact of the shock on their exports. I hypothesize that the impact would be larger for the firms with high export hedge ratio, and use the following specification to estimate the impact on exports:

$$\Delta Y_j = \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls + \varepsilon_j \tag{8}$$

$Exposure_j$ is the weighted average shock of firm j's counterparty banks. $HighHedge_j$ is an indicator variable that takes 1 if firm j sold FXD more than 10% of its export sales, and 0 if otherwise. With this definition, about 75% of FXD selling firms are classified as high-hedge firm ($HighHedge = 1$). The results are robust to the choice of threshold (0.1); I show that the results get even stronger if I use a continuous variable, hedge ratio itself. I use the dummy variable to ensure that the results are not driven by outliers.[33]

Table 21 presents the results for the change in log exports. The impact of regulatory

[33] If a firm receives export orders for the next few years and enters FXD 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 firm as $HighHedge$ 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.

shock on exports is substantial; column (1) shows that for one-standard-deviation increase in *Exposure*, firm's export falls by 17.1% for high-hedge firms and rises by 5.7% for low-hedge firms, and therefore the differential effect is 22.8%. Column (2) adds firm controls and the differential result is largely unchanged. Table 22 shows that the results are robust to replacing *HighHedge* variable with export hedge ratio, *HedgeRatio*, which is defined as amount of FXD sold divided by export sales.

Additionally, I test whether the firms with high export hedge ratio reduced their firm-level FXD hedging as they are more exposed to the regulatory shock. Table 23 shows that the change in net FXD position for high hedge firms was indeed large. The net FXD position moved up by 50–56%[34] more for high-hedge firms than for low-hedge firms, for one-standard-deviation increase in *Exposure*.

Further, as a placebo test to confirm that my results reflect the impact of the regulatory shock, I estimate the impact on firms' domestic sales. If the result on exports is driven by a systemic relationship between troubled firms and constrained banks, I expect those troubled firms to experience declines in both domestic and export sales. However, in Table 24, I show that the change in domestic sales is small and insignificant, unlike that in export sales. This result confirms that the decline in export is caused by the reduction in the supply of hedging instruments, rather than a systemic firm-bank relationship.

5 Robustness Results

To ensure that my results indeed reflect the impact of the regulatory shock and not others, I conduct several robustness checks.

First, one potential concern is a confounding effect of non-random sorting of firm-bank. Although firm-bank sorting is non-random, Table 5 shows that the 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 (Appendix Table 27) as

[34] 0.06/0.12, 0.067/0.12

well as the subset of firms with net negative FXD position (Appendix Table 26). Figure 23 in Appendix shows low correlations between firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure to the regulatory shock. Yet, I control for a large number of bank, firm, and contract characteristics to ensure that the results are not confounded by the differences in the characteristics, throughout the analyses.

To corroborate that the results are not confounded by a potentially systemic firm-bank relationship, I conduct an analysis using coarsened exact matching (CEM) (See Blackwell et al. (2009)) based on FC liability share, the dimension along the exposed and non-exposed firms statistically significantly differ. I coarsen the sample into 5 bins, considering the trade-off between keeping observations and the post-match similarity of FC liability share for treated and control groups. Table 46 in Appendix shows that the results remain similar; the interaction term is negative and significant for change in log exports, positive and significant for change in net FXD position (scaled by assets), and small and insignificant for change in log domestic sales. Table 47 in Appendix shows that the results are robust even after matching firms on export share, profitability, and FC liability share.[35] I include export share as a matching variable to address an alternative hypothesis that exporters predominantly traded with foreign banks, which are 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 could be concerned about the difference in business models between foreign banks and domestic banks. Almost by construction, it is likely that foreign banks would suffer more from the regulation, because they are more active in FXD business than domestic banks. In fact, a few foreign banks closed in 2017, after the regulation.[36] However, it is noteworthy that only half (14 out of 29) of foreign banks in my sample were constrained at the imposition of the regulation, and I find stronger results in the bank-level analysis when I constrain my sample to foreign banks (Table 7). This suggests that my results are not

[35] I coarsen the sample into 3 bins per matching variable.

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

driven by the difference in the bank characteristics across foreign banks and domestic banks.

Third, one could be worried that the result is confounded by a credit supply shock. Specifically, an alternative hypothesis is that the constrained banks were in trouble during the GFC, and therefore they were more likely to suffer from the credit supply shock. However, the results that constrained banks' share of FC lending was not significant for the full sample (Table 9), foreign banks (Table 10), and domestic banks (Table 11) corroborate that the mechanism at work is through the hedging channel, rather than the credit channel.

6 Conclusion

In this paper, I exploit a natural experiment in South Korea to examine the real effects of macroprudential FX regulations that were designed to reduce the risk-taking by financial intermediaries. First, by using the cross-bank variation in the tightness of regulation, I find that the regulation limiting the banks' ratio of FX derivatives to equity caused a reduction in the supply of FX derivatives. Second, I find that exporters' hedging with the constrained banks was reduced by 47% relative to that with the unconstrained banks. Third, I find that the reduction subsequently caused firms relying on FX derivatives as a hedging tool to substantially reduce exports. I offer a mechanism in which the imbalances in hedging demand, banks' costly equity financing, and firms' costly switching of banking relationship play a central role in explaining the empirical findings. In sum, my results suggest that macroprudential regulations could affect the real side of the economy.

References

Acharya, Viral V. and Arvind Krishnamurthy, "Capital Flow Management with Multiple Instruments," December 2019, *26*, 169–203.

Admati, Anat R., Peter M. Demarzo, Martin F. Hellwig, and Paul Pfleiderer, "The Leverage Ratchet Effect," *The Journal of Finance*, 2018, *73* (1), 145–198.

Ahnert, Toni, Kristin Forbes, Christian Friedrich, and Dennis Reinhardt, "Macroprudential FX regulations: Shifting the snowbanks of FX vulnerability?," *Journal of Financial Economics*, 2020.

Aiyar, Shekhar, Charles W. Calomiris, and Tomasz Wieladek, "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment," *Journal of Money, Credit and Banking*, 2014, *46* (s1), 181–214.

Alam, Zohair, Adrian Alter, Jesse Eiseman, R. G Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang, "Digging Deeper–Evidence on the Effects of Macroprudential Policies from a New Database," *IMF Working Paper*, 2020.

Allahrakha, Meraj, Jill Cetina, and Benjamin Munyan, "Do higher capital standards always reduce bank risk? The impact of the Basel leverage ratio on the U.S. triparty repo market," *Journal of Financial Intermediation*, 2018, *34* (C), 3–16.

Allayannis, George and James P. Weston, "The Use of Foreign Currency Derivatives and Firm Market Value," *The Review of Financial Studies*, 06 2015, *14* (1), 243–276.

Anbil, Sriya and Zeynep Senyuz, "The Regulatory and Monetary Policy Nexus in the Repo Market," Finance and Economics Discussion Series 2018-027, Board of Governors of the Federal Reserve System (U.S.) April 2018.

Avdjiev, Stefan, Wenxin Du, Cathrine Koch, and Hyun Song Shin, "The Dollar, Bank Leverage, and Deviations from Covered Interest Parity," *American Economic Review: Insights*, September 2019, *1* (2), 193–208.

Ban, Hye Jung and Jeong Kyo Kim, "The Determinants of Hedging with Derivatives," *Korean Academic Society of Business Administration*, 2004, *33* (1), 25–49.

Bergant, Katharina, Francesco Grigoli, Niels-Jakob H Hansen, and Damiano Sandri, "Dampening Global Financial Shocks: Can Macroprudential Regulation Help (More than Capital Controls)?," *IMF Working Paper*, 2020.

Bernanke, Ben and Mark Gertler, "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, 1989, *79* (1), 14–31.

Bernanke, Ben S and Alan S Blinder, "Credit, Money, and Aggregate Demand," *American Economic Review*, May 1988, *78* (2), 435–439.

Bicu, Andreea, Louisa Chen, and David Elliott, "The leverage ratio and liquidity in the gilt and repo markets," Bank of England working papers 690, Bank of England November 2017.

Blackwell, Matthew, Stefano Iacus, Gary King, and Giuseppe Porro, "Cem: Coarsened Exact Matching in Stata," *The Stata Journal*, 2009, *9* (4), 524–546.

Bruno, Valentina and Hyun Song Shin, "Assessing Macroprudential Policies: Case of South Korea*," *The Scandinavian Journal of Economics*, 2014, *116* (1), 128–157.

_ , Ilhyock Shim, and Hyun Song Shin, "Comparative assessment of macroprudential policies," *Journal of Financial Stability*, 2017, *28* (C), 183–202.

Campello, Murillo, Chen Lin, Yue Ma, and Hong Zou, "The Real and Financial Implications of Corporate Hedging," *The Journal of Finance*, 2011, *66* (5), 1615–1647.

Carter, David A., Daniel A. Rogers, and Betty J. Simkins, "Does Hedging Affect Firm Value? Evidence from the US Airline Industry," *Financial Management*, 2006, *35* (1), 53–86.

Cerutti, Eugenio, Stijn Claessens, and Luc Laeven, "The Use and Effectiveness of Macroprudential Policies: New Evidence," *IMF Working Papers*, 2015.

Choi, Changho, "Impact of FX-Related Macroprudential Measures in Korea: An Assessment," in Kyuil Chung, Soyoung Kim, Hail Park, Changho Choi, and Hyun Song Shin, eds., *Volatile Capital Flows in Korea*, Palgrave Macmillan, New York, 2014, chapter 8, pp. 187–216.

Dodd, Randall, "Exotic Derivatives Losses in Emerging Markets: Questions of Suitability Concerns for Stability," *IMF Working Paper*, 2009.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan, "Deviations from Covered Interest Rate Parity," *The Journal of Finance*, 2018, *73* (3), 915–957.

_ , Benjamin M. Hebert, and Amy Wang, "Are Intermediary Constraints Priced?," *NBER Working Paper*, 2019.

Duffie, Darrell, "Financial Regulatory Reform After the Crisis: An Assessment," *Management Science*, 2018, *64* (10), 4835–4857.

Fleckenstein, Matthias and Francis A. Longstaff, "Shadow Funding Costs: Measuring the Cost of Balance Sheet Constraints," *NBER Working Papers*, January 2018, (24224).

Frenkel, Jacob A. and Richard M. Levich, "Covered Interest Arbitrage: Unexploited Profits?," *Journal of Political Economy*, 1975, *83* (2), 325–338.

_ and _ , "Transaction Costs and Interest Arbitrage: Tranquil versus Turbulent Periods," *Journal of Political Economy*, 1977, *85* (6), 1209–1226.

Gabaix, Xavier and Matteo Maggiori, "International Liquidity and Exchange Rate

Dynamics*," *The Quarterly Journal of Economics*, 03 2015, *130* (3), 1369–1420.

Gilje, Erik P. and Jrme P. Taillard, "Does Hedging Affect Firm Value? Evidence from a Natural Experiment," *The Review of Financial Studies*, 07 2017, *30* (12), 4083–4132.

Greenwood, Robin, Samuel G. Hanson, Jeremy C. Stein, and Adi Sunderam, "Strengthening and Streamlining Bank Capital Regulation," *Brookings Papers on Economic Activitiy*, 2017, *Fall.*

Haynes, Richard, Lihong McPhail, and Haoxiang Zhu, "When Leverage Ratio Meets Derivatives: Running Out Of Options?," *CFTC Research Paper*, 2019.

Holmstrom, Bengt and Jean Tirole, "Financial Intermediation, Loanable Funds, and The Real Sector," *The Quarterly Journal of Economics*, 1997, *112* (3), 663–691.

Horen, Neeltje Van and Antonis Kotidis, "Repo market functioning: the role of capital regulation," Bank of England working papers 746, Bank of England 2018.

International Monetary Fund, "The Interaction of Monetary and Macroprudential Policies: IMF Background Paper," *IMF*, 2012.

Ivashina, Victoria, David S. Scharfstein, and Jeremy C. Stein, "Dollar Funding and the Lending Behavior of Global Banks*," *The Quarterly Journal of Economics*, 04 2015, *130* (3), 1241–1281.

Jin, Yanbo and Philippe Jorion, "Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers," *The Journal of Finance*, 2006, *61* (2), 893–919.

Keller, Lorena, "Capital Controls and Risk Misallocation: Evidence From a Natural Experiment," *Jacobs Levy Equity Management Center for Quantitative Financial Research Paper*, 2019.

Khwaja, Asim Ijaz and Atif Mian, "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market," *American Economic Review*, September 2008, *98* (4), 1413–42.

Kim, Woochan, "Structural Issues in the Korean FX Market during the 2008 Global Financial Crisis: Empirical Investigation of FX Risk Management by Nonfinancial Public Firms," *Korea Development Institute Paper*, 2010.

McCauley, Robert N and Jens Zukunft, "Asian banks and the international interbank market," *BIS Quarterly*, 2008.

Ostry, Jonathan, Atish Ghosh, Marcos Chamon, and Mahvash Qureshi, "Tools for managing financial-stability risks from capital inflows," *Journal of International Economics*, 2012, *88* (2), 407–421.

Paravisini, Daniel, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon, "Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export

Data," *The Review of Economic Studies*, 09 2014, *82* (1), 333–359.

Ree, Jack Joo K., Kyungsoo Yoon, and Hail Park, "FX Funding Risks and Exchange Rate Volatility – Korea's Case," *IMF Working Paper*, 2012.

Reinhardt, Dennis and Rhiannon Sowerbutts, "Regulatory arbitrage in action: evidence from banking flows and macroprudential policy," *Bank of England working papers*, September 2015, (546).

Schnabl, Philipp, "The International Transmission of Bank Liquidity Shocks Evidence from an Emerging Market," *The Journal of Finance*, 2012.

Stein, Jermey C., "An Adverse-Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy," *RAND Journal of Economics*, 1998, *29* (3), 466–486.

Figures

Figure 1: Number of Countries using Macroprudential FX Regulations

The number of emerging market (and developing economies) countries using macroprudential FX regulations, based on IMF integrated Macroprudential Policy Database.

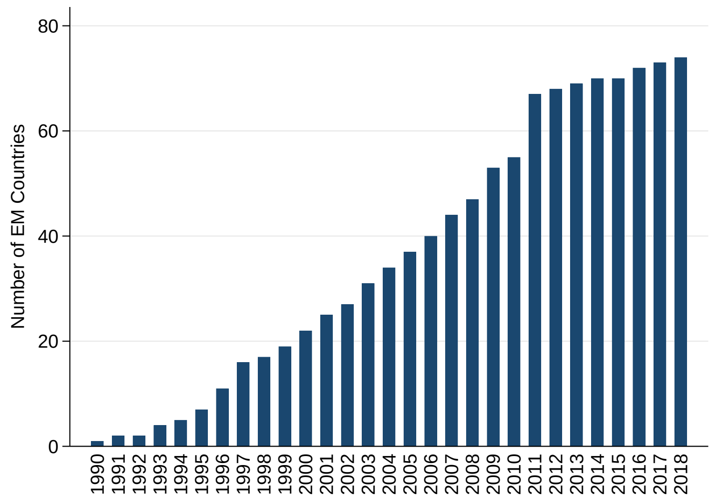


Figure 2: Tightness Macroprudential FX Regulations

The cross-country average of the number of the tightening measures (net of loosening ones), based on IMF integrated Macroprudential Policy Database.

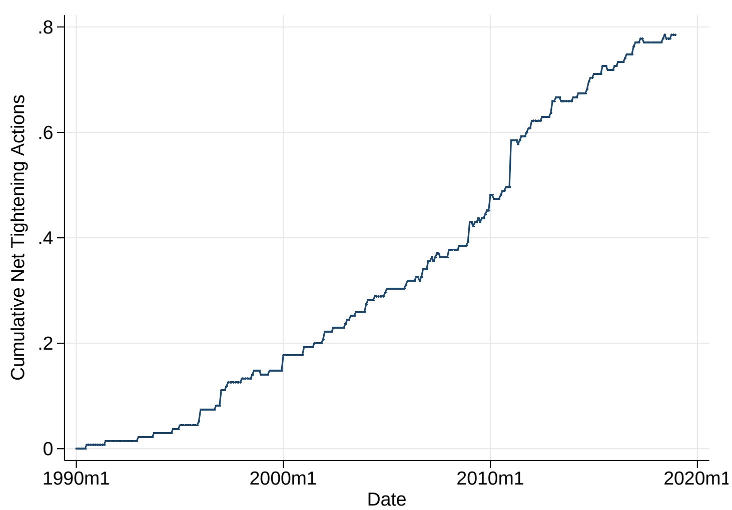


Figure 3: Balance of Payments

Korea's balance of payments. The vertical line indicates the imposition of the regulation.

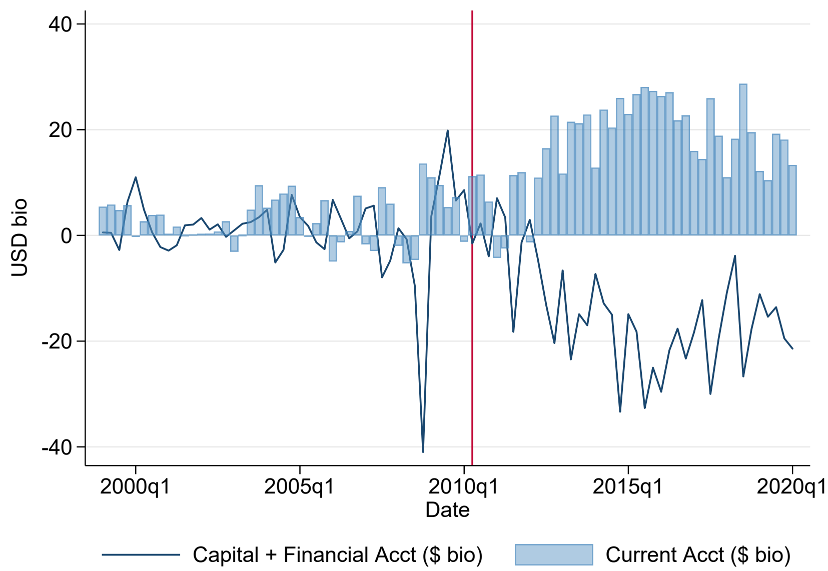


Figure 4: Gross Foreign Capital Inflows

Korea's gross foreign capital inflows. The vertical line indicates the imposition of the regulation.

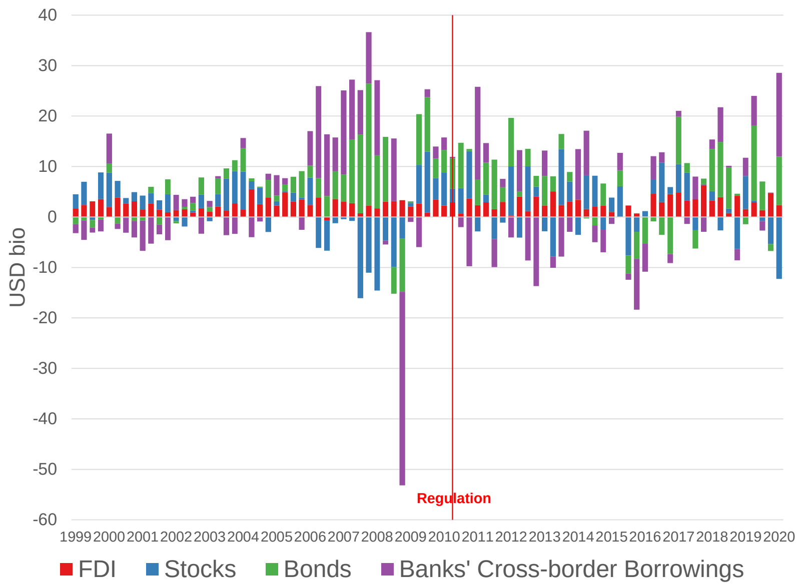


Figure 5: Total External Debt

Korea's total external debt in USD billion (bar) and external debt as a percentage of GDP (line).

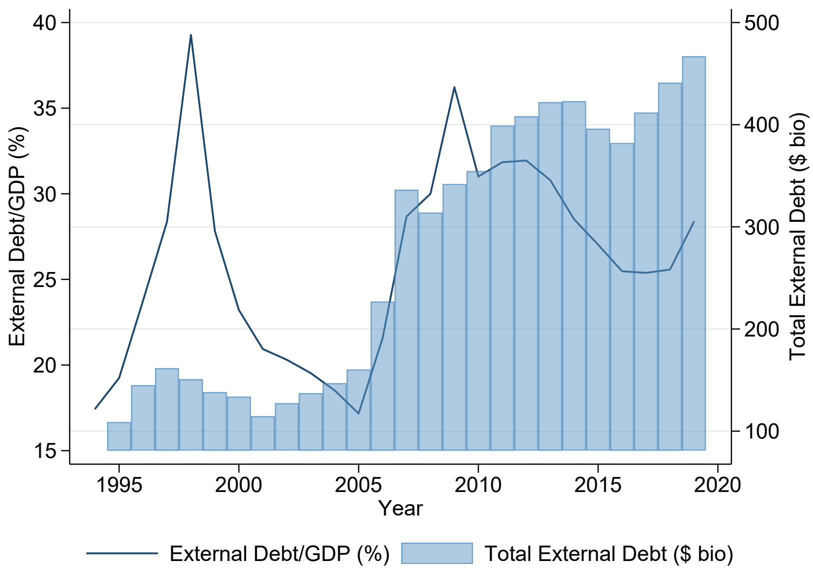


Figure 6: Short-term External Debt

Korea's total short-term external debt in USD billion (bar) and share of short-term external debt in percentage (line).

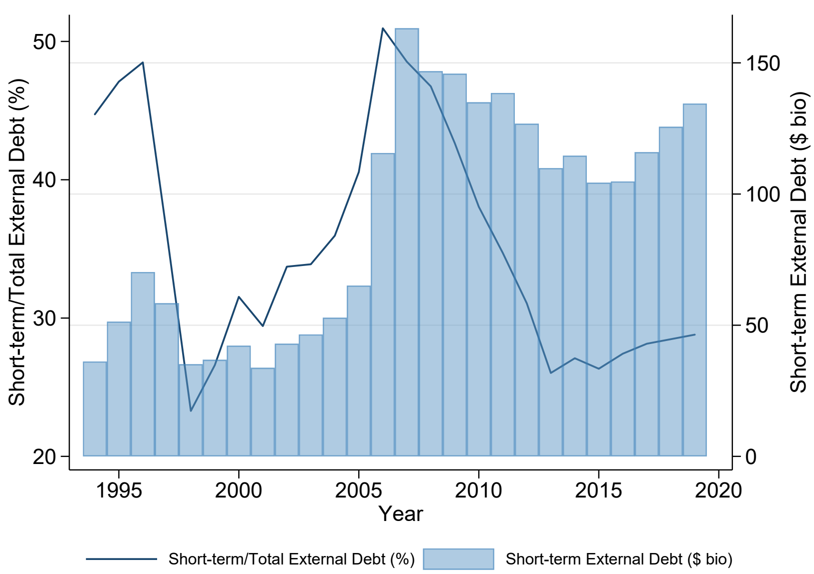


Figure 7: FX Reserves

Bank of Korea's FX reserves in USD billion.

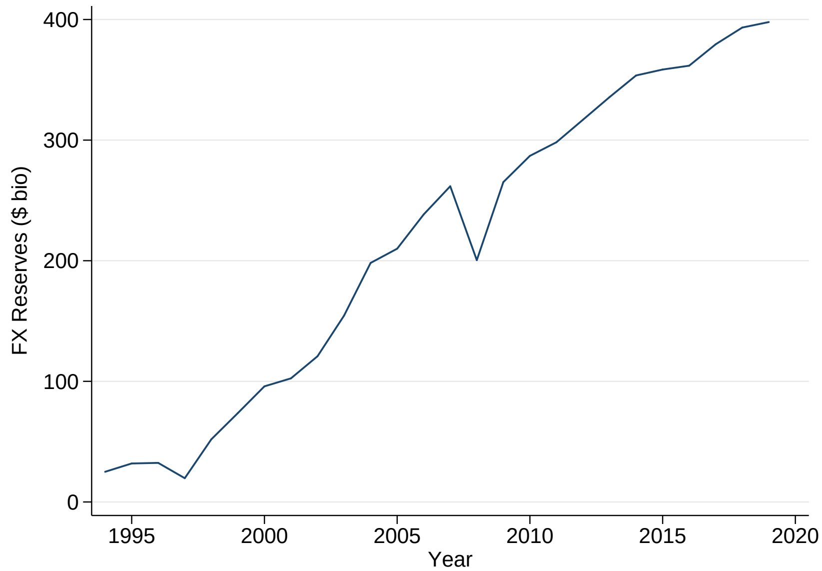


Figure 8: Liquidity

Korea's FX reserves less short-term external debt in USD billion (bar), and liquidity (line), defined as: (FX Reserves - Short-term External Debt)/GDP.

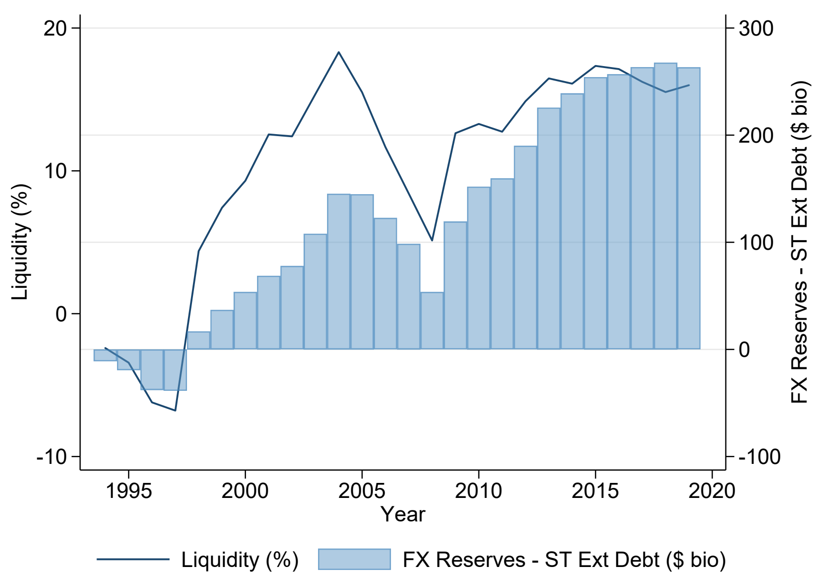


Figure 9: FX Position of Exporters and Banks before the Regulation

The left panel illustrates the structure of exporters' FX position and the right panel illustrates the structure of banks' FX position, prior to the regulation. Exporters had long position in foreign currency (due to export sales), and hedged the long exposure by taking short position in FX derivatives. As banks are the firms' FX derivatives counterparties, banks had long position in foreign currency due to the FX derivatives. Banks hedged the long exposure by foreign currency borrowing.

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 10: CIP Bases

10-day moving average of daily CIP bases for different maturities. CIP basis at time t for maturity n is defined as:

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

where $f_{t,t+n}$ is forward exchange rate, and s_t is spot exchange rate defined as value of 1 USD in terms of KRW. Higher s_t means USD appreciation. I use U.S. treasury yield for USD interest rate ($y^{\$}$) and Korean government bond yield for KRW interest rate ($y^{₩}$).

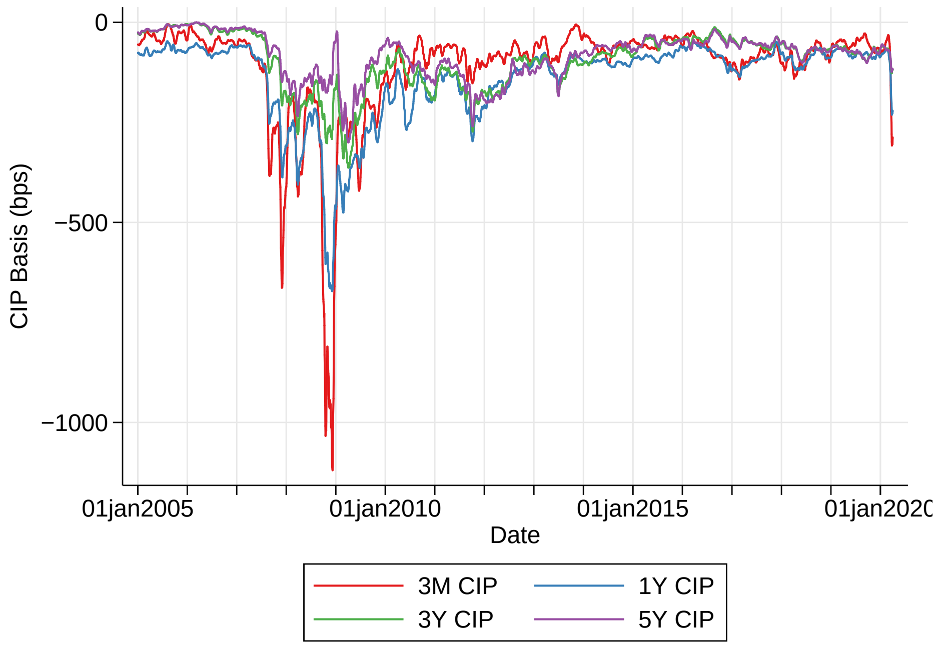


Figure 11: Korean Won Exchange Rate

Exchange rate is defined as value of 1 USD in terms of Korean Won (KRW). A higher exchange rate means depreciation of KRW.

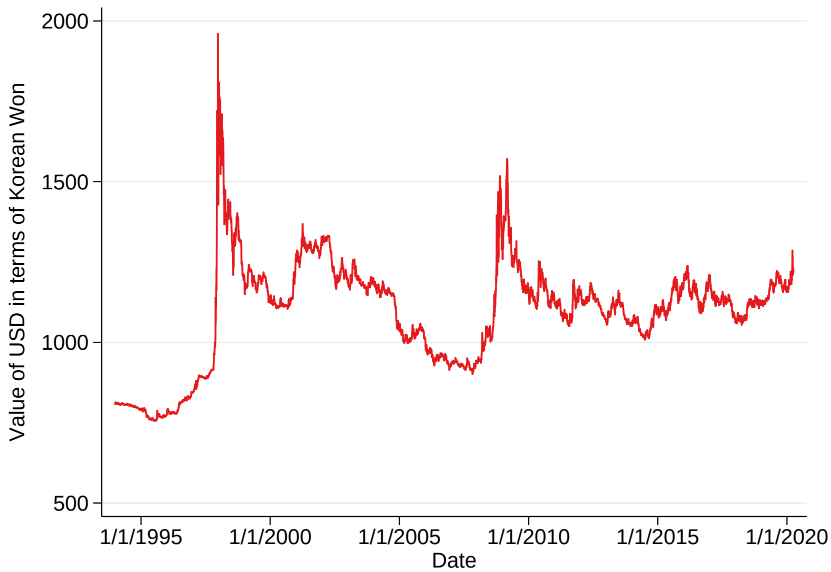


Figure 12: FX Derivatives Position and External Short-term Borrowings

The dotted line is the aggregate external short-term debt and the solid line is the aggregate net FXD position of the banking sector.

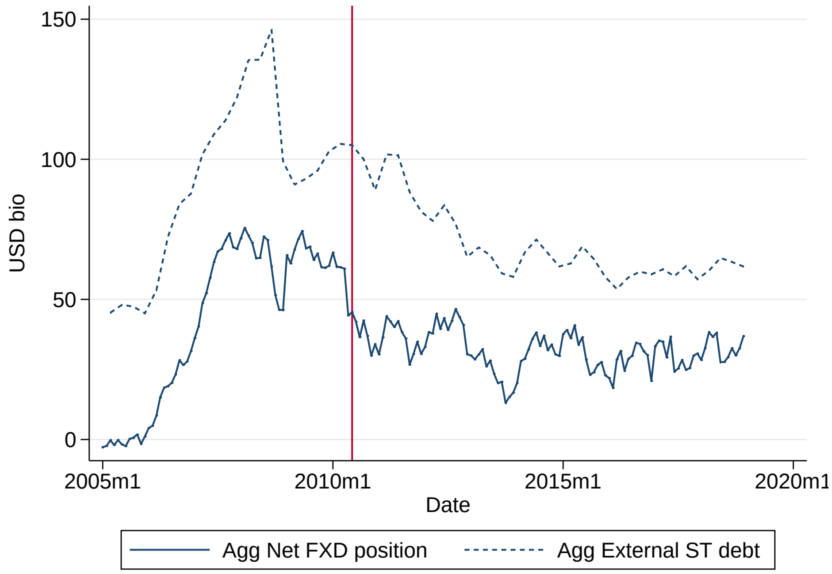


Figure 13: FX Derivatives Position to Capital Ratio, before and after the Regulation (Foreign Banks)

The histogram of FX derivatives position to capital (DPTC) ratio of foreign banks, six months before and six months after the first announcement of regulation.

Foreign Banks

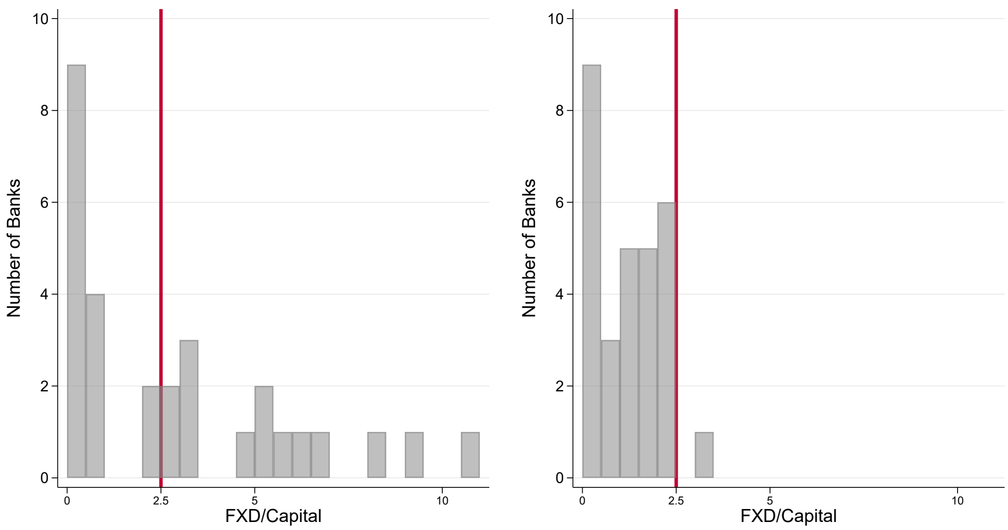


Figure 14: FX Derivatives Position to Capital Ratio, before and after the Regulation (Domestic Banks)

The histogram of FX derivatives position to capital (DPTC) ratio of domestic banks, six months before and six months after the first announcement of regulation.

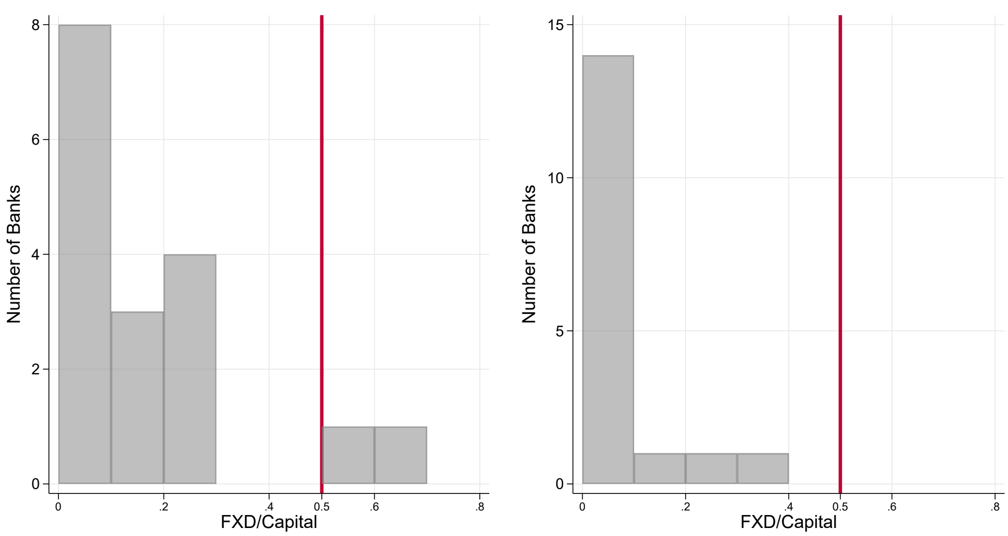


Figure 15: Aggregate FX Derivatives Position of Banks

The top panel shows the aggregate gross FXD position of banks, including both foreign banks and domestic banks, with the announcement dates (vertical lines) of changes in the minimum FXD capital requirement. The bottom panel shows the historical change in the minimum FXD capital requirement that banks are required to hold. The higher regulation indicates *tighter* regulation.

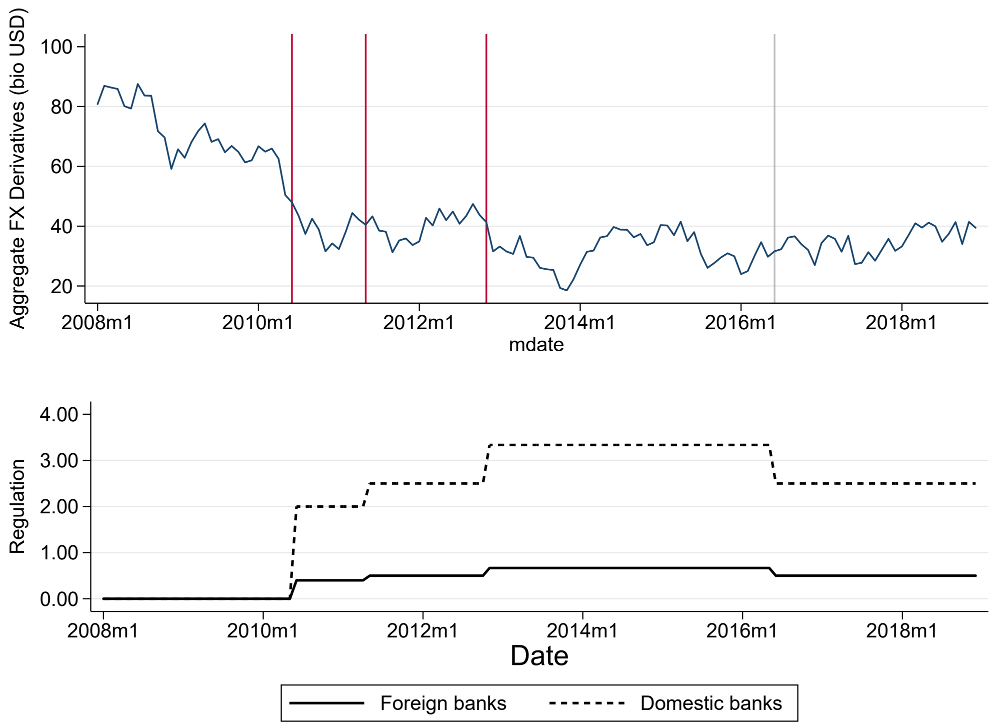


Figure 16: FX Derivatives Position by Treatment

The top panel plots the aggregate FXD position in billion USD of constrained (solid) and unconstrained (dotted) banks. The middle panel plots the average FXD position of constrained (solid) and unconstrained (dotted) banks. The vertical lines indicate the announcement dates of the changes in the minimum FXD capital requirement. The bottom panel plots the minimum FXD capital requirement. The higher value indicates *tighter* regulation. The blue line is the simple average of foreign banks' and domestic banks' minimum FXD capital requirements. The red solid line is weighted average where the weight is FXD position.

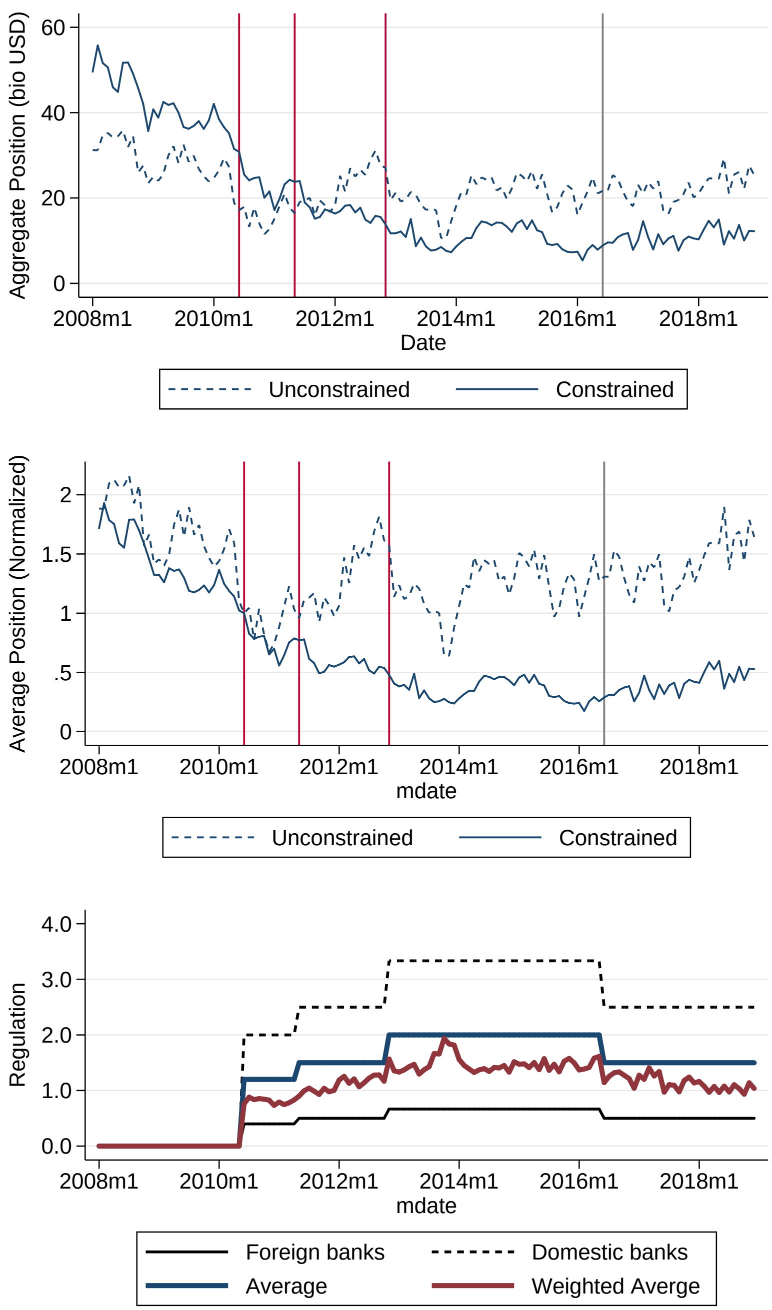


Figure 17: FX Derivatives Position Share

The top panel is FXD position share by constrained banks. The middle panel is FXD position share by foreign banks. The bottom panel shows FXD position share by foreign vs. domestic banks as well as constrained vs. unconstrained banks.

Figure 18: 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 as:

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

$f_{t,t+n}$ is forward exchange rate, and s_t is spot exchange rate defined as value of 1 USD in terms of KRW. Higher s_t means USD appreciation. I use U.S. treasury yield for USD interest rate ($y^{\$}$) and Korean government bond yield for KRW interest rate ($y^{₩}$).

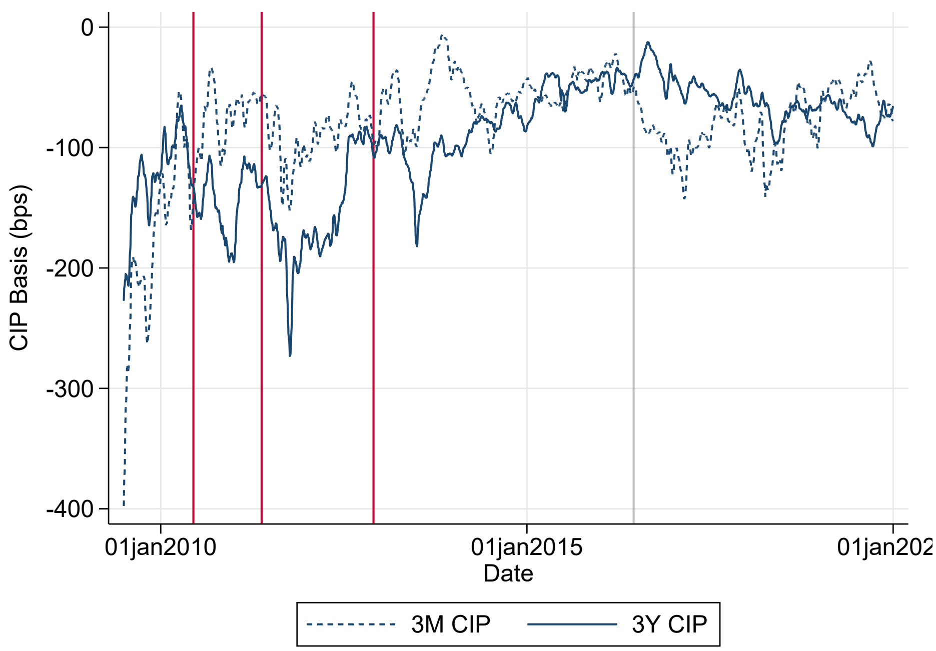
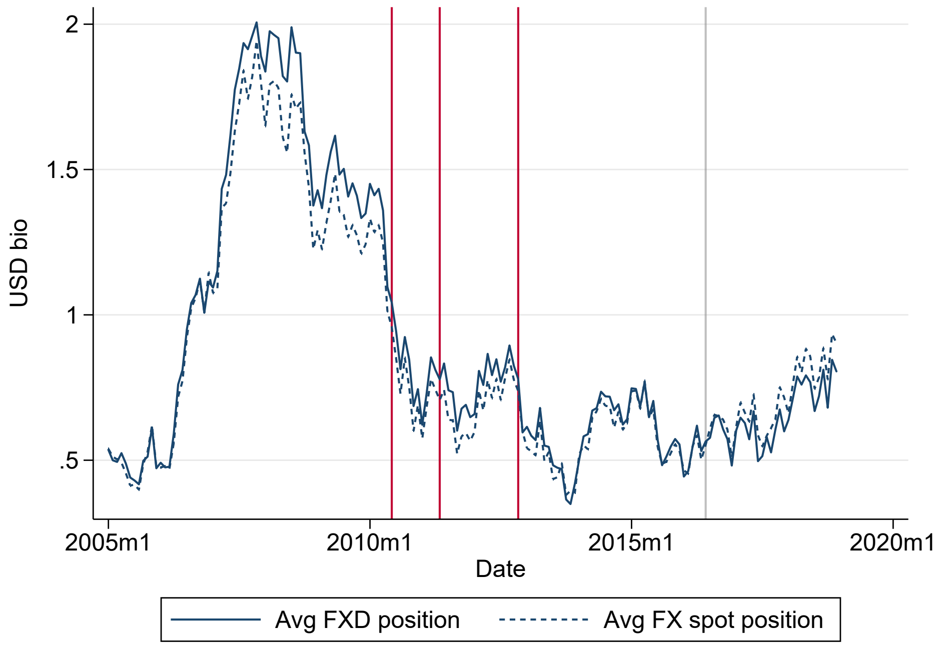


Figure 19: Banks' FX Positions: On-balance sheet position vs. FXD position

The average on-balance sheet FX position of banks (dotted) offsets their average FXD position (solid).



Tables

Table 1: FX Derivatives Position Limits

The top two rows show the historical changes in the regulatory cap on the ratio of FX derivatives to capital. 250% means that a bank's FX derivatives position is required to be lower than 2.5 times its capital. The bottom two rows show the announcement dates and the effective dates. The regulation was first announced on 13 June 2010.

Foreign Banks	250%	200%	150%	200%	250%
Domestic Banks	50%	40%	30%	40%	50%
Announced on	6/13/2010	5/19/2011	11/27/2012	6/16/2016	3/18/2020
Effective from	10/31/2010	7/31/2011	1/31/2013	7/31/2016	3/19/2020

Table 2: Banks' FXD Positions (As of Dec 2009)

Foreign is 1 if the bank is 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 derivatives position that 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.

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

* indicates closed banks. Full names and parent bank's country are listed in Appendix Table 25.

Table 3: Bank Summary Statistics (As of Dec 2009)

	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 4: FX Derivatives Contracts Summary Statistics

	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 5: Firm Summary Statistics (Full Sample)

	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 HedgeRatio	0.409	0.71	0.435	0.72	0.393	0.71	-0.04	(-0.31)
FCL HedgeRatio	0.485	2.11	0.803	3.41	0.300	0.50	-0.50	(-1.07)
Observations	148		53		95		148	

Table 6: Impact on banks' FX Derivatives Position and Capital (Full Sample)

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

Y_{it} is either log(FX Derivatives position), log(Capital) or FXD/Capital. $Constrained_i$ is dummy variable that takes 1 if bank i is constrained and 0 if otherwise. $Regulation_t^{Avg}$ is 0 before the regulation and takes **simple average** of foreign banks' and domestic banks' minimum FXD capital requirements. Higher $Regulation_t^{Avg}$ indicates tighter constraint. Columns (2), (4), and (6) add bank fixed effects:

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

The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.913***	-0.967***	0.0294	0.0276	-3.383***	-3.377***
	(-3.18)	(-3.28)	(0.36)	(0.36)	(-5.13)	(-5.17)
Constrained=1	5.341***		-0.648		6.505***	
	(3.92)		(-1.52)		(5.40)	
BankFE	N	Y	N	Y	N	Y
TimeFE	5906	5906	5886	5886	5886	5886
N	0.109	0.802	0.0548	0.914	0.409	0.497

t statistics in parentheses

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

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

$Regulation_t^{WAvg}$ is the **weighted average** of the minimum FXD capital requirements, where the weight is the FXD position in each month.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-1.207***	-1.292***	0.0230	0.0166	-4.398***	-4.388***
	(-3.05)	(-3.17)	(0.21)	(0.16)	(-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	5906	5906	5886	5886	5886	5886
N	0.109	0.803	0.0548	0.914	0.404	0.492

t statistics in parentheses

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

Table 7: Impact on banks' Derivatives Position and Capital (**Foreign banks**)

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

	(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

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

Table 8: Impact on banks' Derivatives Position and Capital (**Domestic banks**)

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

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.105	-0.126	-0.0588*	-0.0596*	-0.107***	-0.107***
	(-0.61)	(-0.72)	(-2.05)	(-1.98)	(-9.28)	(-9.34)
Constrained=1	4.401**		0.351		0.471***	
	(2.38)		(0.85)		(10.39)	
Constant	17.24***	19.02***	28.60***	28.25***	0.224***	0.252***
	(9.07)	(30.50)	(69.52)	(371.30)	(3.85)	(4.82)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	2208	2208	2192	2192	2192	2192
Adj RSqr	0.0528	0.875	0.0246	0.933	0.535	0.647

t statistics in parentheses

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

Table 9: Impact on Banks' FC Loans and FC Liabilities (**All banks**)

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

Columns (2) and (4) add bank fixed effects:

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

The outcome variables are share of foreign currency loans ($FCLoanShr$) and share of foreign currency liabilities ($FCLiabShr$). The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank.

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLiabShr	(4) 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 10: Impact on Banks' FC Loans and FC Liabilities (**Foreign banks**)

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

The outcome variables are share of foreign currency loans ($FCLoanShr$) and share of foreign currency liabilities ($FCLiabShr$).

	(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 11: Impact on Banks' FC Loans and FC Liabilities (**Domestic banks**)

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

The outcome variables are share of foreign currency loans ($FCLoanShr$) and share of foreign currency liabilities ($FCLiabShr$).

	(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 12: Impact on Banks' 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. KTB is long-term Korean government bond with maturities: 3, 5, 10, 20, 30 yr.
MSB is issued by Bank of Korea and the maturities are: 91day, 1yr, 2yr.

	(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	1692	1692	1692	1692
N	0.114	0.737	0.241	0.756

t statistics in parentheses

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

Table 13: Transmission of Regulatory Shock to FXD Hedging (FXD Contract-level)

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

The dependent variable is change in net FXD position dealt between firm j and bank i, 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 7 industry dummies. Bank controls include log size, loans to assets ratio, leverage ratio, and 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.

	(1)	(2)	(3)	(4)	(5)	(6)
	Exporters	Exporters	Non-exporters	Non-exporters	Full Sample	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 14: Transmission of Regulatory Shock to FXD Hedging (FXD Contract-level)

$$\Delta FXD_{i,j} = \alpha + \beta_{Shock} Shock_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$$

The dependent variable is change in net FXD position dealt between firm j and bank i, 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 7 industry dummies. Bank controls include log size, loans to assets ratio, leverage ratio, and 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.

	(1)	(2)	(3)	(4)	(5)	(6)
	Exporters	Exporters	Non-exporters	Non-exporters	Full Sample	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 15: Transmission of Regulatory Shock to FXD Hedging (Subsample without option contracts)

$$\Delta FXD_{i,j} = \alpha + \beta Constrained_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{j,b}$$

FX option contracts are excluded. The dependent variable is change in net FXD position dealt between firm j and bank i, 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 7 industry dummies. Bank controls include log size, loans to assets ratio, leverage ratio, and 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.

	(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 16: Transmission of Regulatory Shock to FXD Hedging (Subsample without option contracts)

$$\Delta FXD_{i,j} = \alpha + \beta_{Shock} Shock_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j}$$

FX option contracts are excluded. The dependent variable is change in net FXD position dealt between firm j and bank i, 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 7 industry dummies. Bank controls include log size, loans to assets ratio, leverage ratio, and 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.

	(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 17: Impact on Firm-level FXD Position (Full Sample by Size)

$$\Delta Y_j = \beta_E \; Exposed_j + FirmControls_j + \varepsilon_j$$

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 7 industry dummies.

	(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 18: Impact on Firm-level FXD Position (Fully Disclosed Firms by Size)

$$\Delta Y_j = \beta_E \; Exposure_j + FirmControls_j + \varepsilon_j$$

Outcome variable is 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 7 industry dummies.

	(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 19: Impact on Firm-level FXD Position (Full Sample by Net FXD Position)

$$\Delta Y_j = \beta_E \; Exposed_j + FirmControls_j + \varepsilon_j$$

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 7 industry dummies.

	(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 20: Impact on Firm-level FXD Position (Fully Disclosed Firms by Net FXD Position)

$$\Delta Y_j = \beta_E \; Exposure_j + FirmControls_j + \varepsilon_j$$

Outcome variable is 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 7 industry dummies.

	(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 21: Impact on Export Sales

$$\Delta Y_j = \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls_j + \varepsilon_j$$

Outcome variable is change in log export sales. Independent variable $Exposure_j$ is the weighted average shock of the firm j's FXD counterparty banks. $HighHedge_j$ takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and 7 industry dummies.

	(1)	(2)
	LogExport	LogExport
Firm_highHR=1 × Exposure	-0.228*	-0.189*
	(-1.94)	(-1.81)
Exposure	0.0571	0.0956
	(0.77)	(1.55)
Firm_highHR=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

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

Table 22: Impact on Export Sales

$$\Delta Y_j = \beta_E \; Exposure_j + \beta_h HedgeRatio_j + \beta_{Eh} Exposure_j \times HedgeRatio_j + FirmControls_j + \varepsilon_j$$

Outcome variable is change in log export sales. Independent variable $Exposure_j$ is the weighted average shock of the firm j's FXD counterparty banks. $HedgeRatio_j$ 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 7 industry dummies.

	(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

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

Table 23: Impact on Firm-level FXD Position

$$\Delta Y_j = \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls_j + \varepsilon_j$$

Outcome variable is change in firm j's net FXD notional scaled by assets. Independent variable $Exposure_j$ is the weighted average shock of the firm j's FXD counterparty banks. $HighHedge_j$ takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and 7 industry dummies.

	(1) FXD/Asset	(2) FXD/Asset
Firm_highHR=1 × Exposure	-0.228*	-0.189*
	(-1.94)	(-1.81)
Exposure	0.0571	0.0956
	(0.77)	(1.55)
Firm_highHR=1	0.136	0.0217
	(1.30)	(0.24)
Constant	0.187**	-1.640
	(2.35)	(-1.24)
FirmControls	N	Y
N	74	74
RSqr	0.0817	0.324

t statistics in parentheses

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

Table 24: Impact on Domestic Sales as a Placebo Test

$$\Delta Y_j = \beta_E \ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls_j + \varepsilon_j$$

Outcome variable is change in firm j's log domestic sales. Independent variable $Exposure_j$ is the weighted average shock of the firm j's FXD counterparty banks. $HighHedge_j$ takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and 7 industry dummies.

	(1) LogDomesticSales	(2) LogDomesticSales
Firm_highHR=1 × Exposure	-0.0372	-0.00911
	(-0.37)	(-0.09)
Exposure	-0.00754	0.000967
	(-0.09)	(0.01)
Firm_highHR=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

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

Appendices

A List of Bank Names

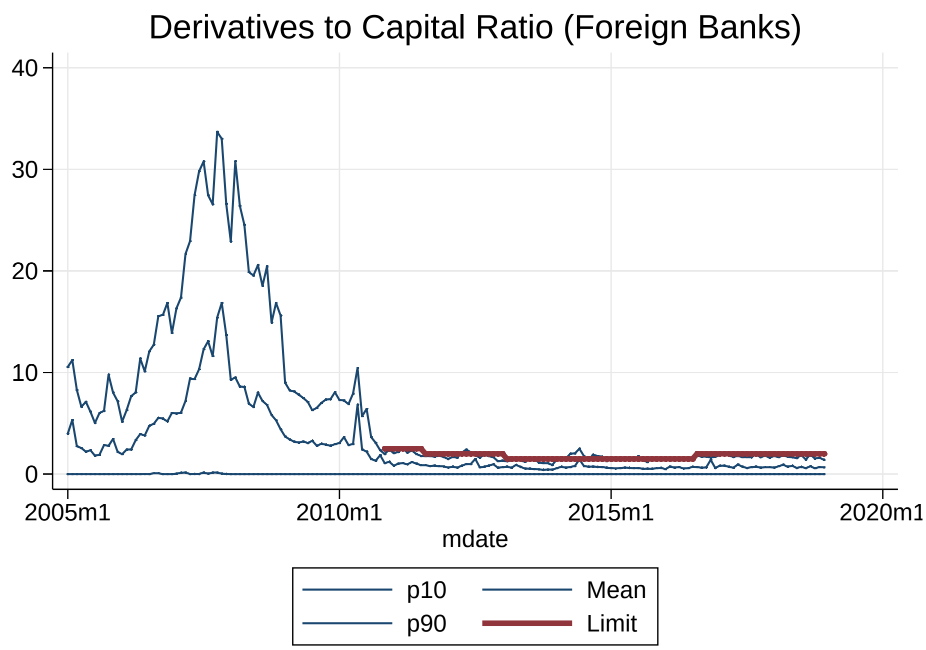
Table 25: Sample Banks

	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	Citibank 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.

B Additional Figures

Figure 20: FX Derivatives Position to Capital (DPTC) Ratio

The 10-percentile, mean and 90-percentile of the derivatives to position ratio for each month. The top panel is across foreign banks and the bottom panel is across domestic banks. The limit plots the change in the regulatory cap of DPTC ratio.



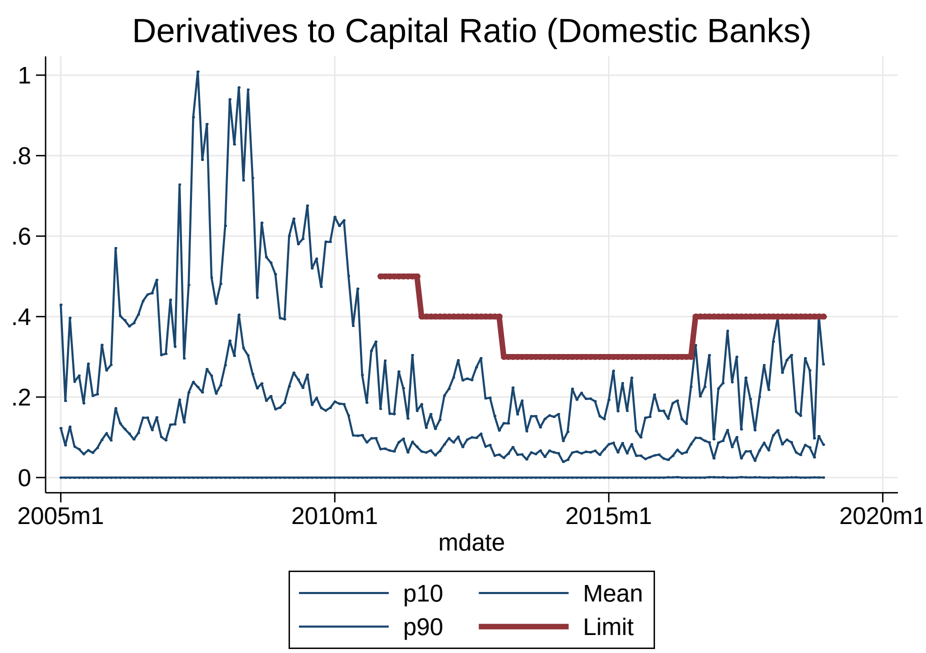


Figure 21: Number of Firms

In 2009: Among 1682 listed firms, 1572 had non-zero FX gains or losses. About 300 firms had non-zero FX derivatives assets or liabilities.

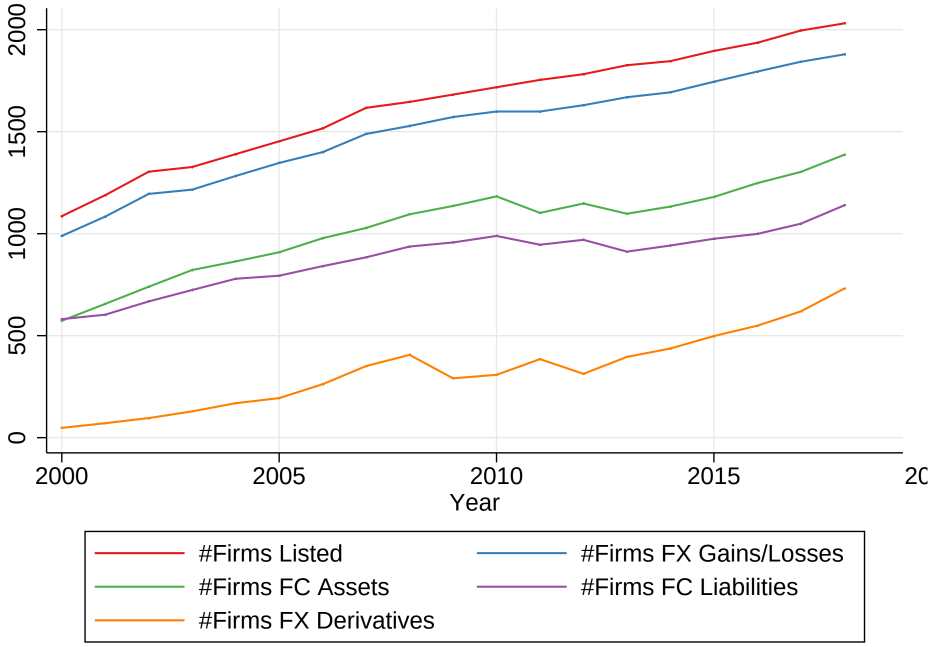


Figure 22: Knock-in Knock-out (KIKO) Option Example

- If the exchange rate (value of 1USD in terms of 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 exchange rate during 2007 was 900–950.

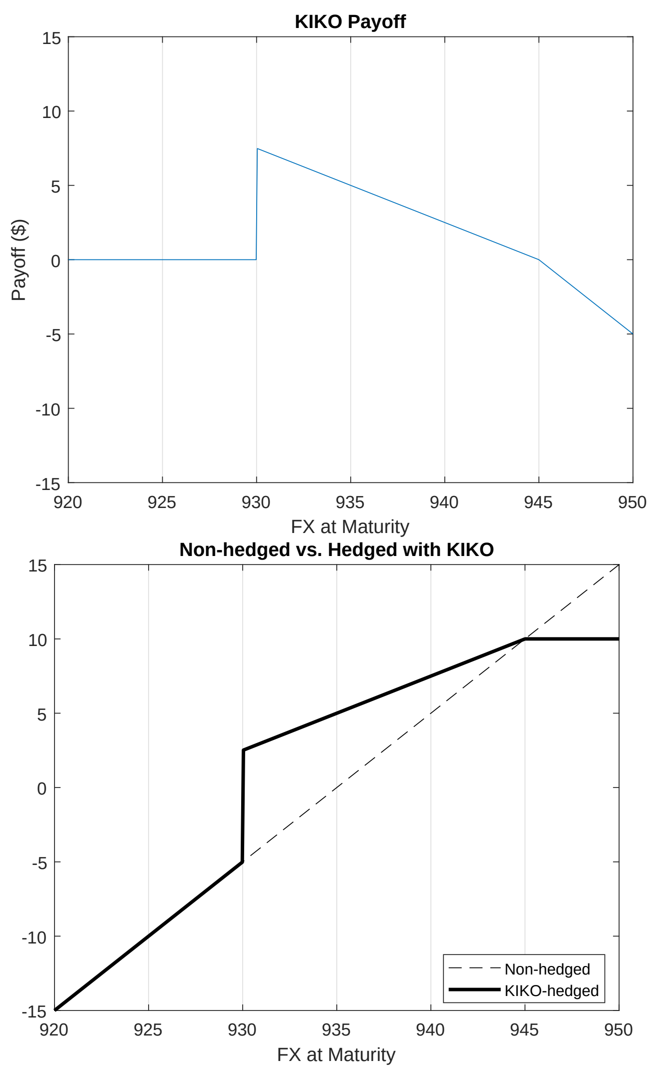
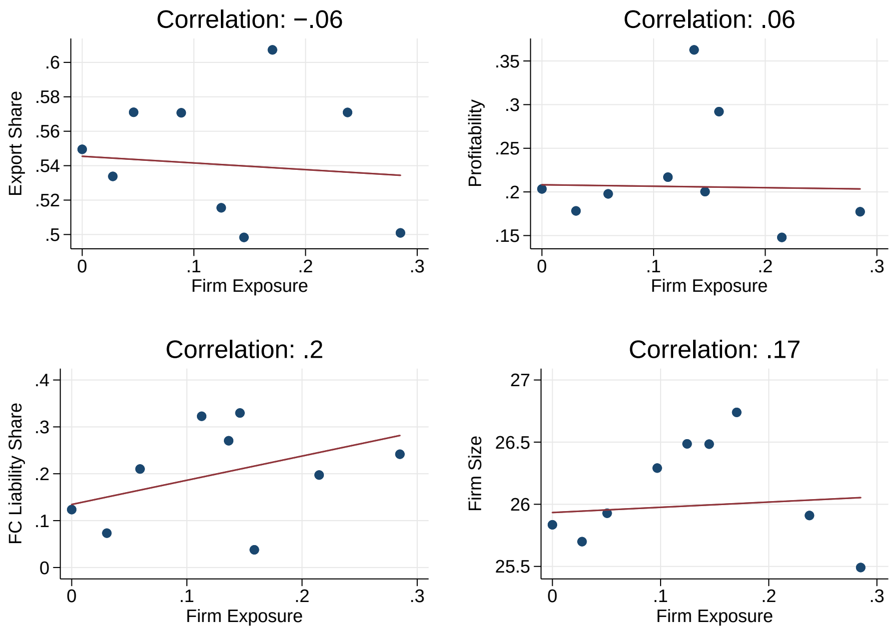


Figure 23: Correlations between Firm Characteristics and Firm Exposure

Binned scatter plots of firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure to the regulation.



C Additional Tables

Table 26: FX Derivatives Contracts Summary Statistics (Exporters' Contracts)

	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 27: Firm Summary Statistics (Fully disclosed Firms)

	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 HedgeRatio	0.357	0.68	0.385	0.67	0.339	0.70	-0.05	(-0.34)
FCL HedgeRatio	0.295	0.46	0.314	0.45	0.283	0.47	-0.03	(-0.38)
Observations	132		49		83		132	

Table 28: Firm Summary Statistics (Exporters)

	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 HedgeRatio	0.597	0.80	0.661	0.81	0.560	0.80	-0.10	(-0.54)
FCL HedgeRatio	0.457	2.84	1.011	4.55	0.118	0.53	-0.89	(-1.07)
Observations	82		30		52		82	

Table 29: Adjustments in FX Derivatives Position and Capital (Full Sample, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

Y_{it} is either log(FX Derivatives position), log(Capital) or FXD/Capital. $Constrained_i$ is dummy variable that takes 1 if bank i is constrained and 0 if otherwise. $Regulation_t^{Avg}$ is 0 before the regulation and takes **simple average** of foreign banks' and domestic banks' minimum FXD capital requirement. Higher $Regulation_t^{Avg}$ indicates tighter constraint. Columns (2), (4), and (6) add bank fixed effects:

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

The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank.

	(1)	(2)	(3)	(4)	(5)	(6)
	LogFXD	LogFXD	LogCapital	LogCapital	FXD/Capital	FXD/Capital
Constrained=1 x Regulation	-0.475***	-0.470***	0.0352	0.0370	-3.013***	-2.996***
	(-4.26)	(-4.09)	(0.39)	(0.42)	(-4.29)	(-4.28)
Constrained=1	0.499*		-2.152***		5.744***	
	(1.93)		(-5.50)		(4.44)	
BankFE	N	Y	N	Y	N	Y
TimeFE	5906	5906	5886	5886	5886	5886
N	0.191	0.400	0.488	0.893	0.410	0.502

t statistics in parentheses

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

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

$Regulation_t^{WAvg}$ is the **weighted average** of the minimum FXD capital requirement, where the weight is the FXD position in each month.

	(1)	(2)	(3)	(4)	(5)	(6)
	LogFXD	LogFXD	LogCapital	LogCapital	FXD/Capital	FXD/Capital
Constrained=1 x Regulation	-0.662***	-0.656***	0.0287	0.0331	-3.936***	-3.915***
	(-3.71)	(-3.58)	(0.22)	(0.26)	(-4.33)	(-4.32)
Constrained=1	0.517*		-2.134***		5.602***	
	(1.80)		(-5.55)		(4.48)	
BankFE	N	Y	N	Y	N	Y
TimeFE	5906	5906	5886	5886	5886	5886
N	0.192	0.402	0.488	0.893	0.408	0.500

t statistics in parentheses

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

Table 30: Adjustments in Derivatives Position and Capital (**Foreign banks**, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(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

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

Table 31: Adjustments in Derivatives Position and Capital (**Domestic banks**, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital	(5) FXD/Capital	(6) FXD/Capital
Constrained=1 x Regulation	-0.128	-0.124	-0.0189	-0.0123	-0.0980***	-0.0983***
	(-1.01)	(-0.98)	(-1.06)	(-0.70)	(-8.94)	(-9.02)
Constrained=1	0.513**		-0.899***		0.424***	
	(2.28)		(-6.19)		(9.79)	
Constant	20.86***	18.70***	29.86***	28.35***	0.275***	0.267***
	(44.30)	(53.35)	(186.39)	(467.51)	(3.04)	(3.11)
BankFE	N	Y	N	Y	N	Y
TimeFE	Y	Y	Y	Y	Y	Y
N	2208	2208	2192	2192	2192	2192
Adj RSqr	0.171	0.481	0.578	0.956	0.680	0.745

t statistics in parentheses

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

Table 32: Impact on Banks' FC Loans and FC Liabilities (**All banks**, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(1)	(2)	(3)	(4)
	FCLoanShr	FCLoanShr	FCLiabShr	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 33: Impact on Banks' FC Loans and FC Liabilities (**Foreign banks**, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(1)	(2)	(3)	(4)
	FCLoanShr	FCLoanShr	FCLiabShr	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

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

Table 34: Impact on Banks' FC Loans and FC Liabilities (**Domestic banks**, Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(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

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

Table 35: Impact on Banks' Security Holdings (Weighted LS)

Weighted least squares models where the weight is FXD position as of Dec 2009.

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

	(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	1692	1692	1692	1692
N	0.0916	0.779	0.157	0.780

t statistics in parentheses

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

Table 36: Net FXD Buyers (As of Dec 2009)

Industry code: 1=Construction/ 5=Agriculture and Fishing/ 6=Retail/ 12=Transportation and Shipping/ 13=Gas and Electricity/ 14=Science and Technology/ 15=IT and Tele-communication/ 16= Manufacturing

No	Stock	Firm	Net	Buy	Sell	DerivType	MainBank	binding	FCAShr	FCLShr	ExpShr	Industry	Size	FCLHedge	ExpHedge	NetPosExcFXD	NetPosIncFXD	FullDisc
1	036460	KoreaGas	2151	2401	250	FXFwd	KEB	0	0.02	0.20		13	30.8	0.81				0
2	030200	KT	1831	1831	0	FXSwap	JPM	0	0.01	0.21		15	30.8	0.74				1
3	096770	SKInnov	1633	1655	22	FXSwap	KDB	0	0.06	0.25	0.59	16	30.7	0.56	0.00	0.88	0.09	0
4	004170	SSG	1619	1619	0	FXSwap	CIG	1	0.00	0.32	0.00	6	30.0	1.00		-0.18	0.18	1
5	015760	Kepco	1051	1051	0	FXSwap	Barclays	1	0.00	0.11	0.00	13	31.9	0.40		-0.04	0.02	1
6	023530	LotteShop	880	880	0	FXSwap	Mizuho	0	0.00	0.23	0.00	6	30.6	0.70	0.00	-0.07	0.06	1
7	004990	LotteHoldings	313	313	0	FXSwap	Mizuho	0	0.00	0.38	0.05	14	28.9	0.92	0.00	-0.09	0.11	1
8	011170	LotteChem	301	301	0	FXSwap	Mizuho	0	0.09	0.41	0.62	16	29.4	0.44	0.00	0.60	0.06	1
9	097950	CJCheil	245	245	0	FXSwap	BNP	1	0.02	0.43	0.06	16	29.0	0.30	0.00	-0.16	0.07	0
10	071320	KoreaHeat	212	212	0	FXSwap	KB	0	0.00	0.12	0.00	13	28.7	1.00				1
11	051910	LGChem	203	208	5	FXSwap	MUFG	0	0.09	0.35	0.74	16	29.8	0.24	0.00	1.18	0.03	0
12	069960	HyundaiDept	201	201	0	FXSwap	DBS	1	0.00	0.26	0.00	6	28.6	1.00		-0.09	0.09	1
13	010950	SOil	200	200	0	FXFwd	DB	0	0.14	0.68	0.60	16	29.8	0.07	0.00	0.92	0.03	1
14	000210	Daelim	193	193	1	FXSwap	Shinhan	0	0.04	0.09	0.31	1	29.8	0.52	0.00	0.22	0.03	1
15	001120	LGIntl	182	202	19	FXFwd	ANZ	1	0.39	0.77	0.84	6	28.2	0.27	0.01	1.88	0.12	1
16	009830	HanhwaSol	115	121	6	FXSwap	Citi	1	0.01	0.12	0.48	16	29.2	0.55	0.00	0.26	0.03	1
17	011780	Kumho	107	107	0	FXSwap	Woori	0	0.04	0.16	0.67	16	28.8	0.29	0.00	0.50	0.04	1
18	003490	KoreanAir	90	90	0	FXSwap	HSBC	1	0.06	0.25	0.87	12	30.5	0.03	0.00	0.34	0.01	1
19	011930	Shinsung	66	66	0	FXFwd	Citi	1	0.04	0.40	0.10	16	26.3	1.03	0.00	-0.22	0.29	1
20	069620	Daewoong	50	50	0	FXSwap	StandChar	1	0.01	0.42	0.02	16	26.9	0.68	0.00	-0.14	0.12	1
21	007070	GSRetail	50	50	0	FXSwap	Shinhan	0	0.00	0.04	0.00	6	28.5	1.00		-0.02	0.02	1
22	006280	GreenCross	50	50	0	FXSwap	Citi	1	0.02	0.31	0.11	16	27.3	0.53	0.00	-0.04	0.08	1
23	003030	SeahSteel	45	55	10	FXSwap	Citi	1	0.04	0.34	0.31	14	27.7	0.43	0.03	0.27	0.05	1
24	001790	DaehanSugar	33	43	10	FXFwd	Citi	1	0.02	0.33	0.20	16	27.5	0.30	0.05	0.08	0.04	1
25	004000	LotteFineChem	31	31	0	FXFwd	Shinhan	0	0.04	0.41	0.45	16	27.7	0.53	0.00	0.43	0.04	1
26	002350	NexenTire	30	30	0	FXSwap	KEB	0	0.09	0.24	0.79	16	27.4	0.38	0.00	0.95	0.04	1
27	000070	Samyang	29	37	8	FXFwd	MUFG	0	0.02	0.37	0.33	14	27.9	0.22	0.02	0.25	0.03	0
28	006120	SKDiscovery	26	50	24	FXFwd	StandChar	1	0.03	0.09	0.38	14	28.3	0.57	0.06	0.22	0.02	0
29	009200	Moorim	22	22	0	FXSwap	StandChar	1	0.03	0.20	0.52	16	27.5	0.23	0.00	0.29	0.03	1
30	010060	OCI	21	30	9	FXSwap	KB	0	0.05	0.09	0.71	16	28.8	0.20	0.01	0.45	0.01	1
31	058650	SeahHoldings	20	20	0	FXSwap	KEB	0	0.00	0.14		16	27.5	1.00				1
32	049770	DongwonFB	20	20	0	FXSwap	KB	0	0.00	0.18	0.06	16	27.0	0.56	0.00	0.02	0.04	1
33	090350	NorooPaint	17	20	3	FXSwap	KB	0	0.02	0.16	0.12	16	26.5	0.92	0.12	0.04	0.06	1
34	001810	MoorimSP	16	16	0	FXSwap	Citi	1	0.01	0.37	0.12	16	26.0	0.72	0.00	-0.04	0.09	1
35	084010	DaehanSteel	15	15	0	FXSwap	StandChar	1	0.03	0.16	0.09	16	27.2	0.36	0.00	0.06	0.03	1
36	006840	AKHoldings	15	15	0	FXSwap	KEB	0	0.12	0.38	0.69	14	26.7	0.25	0.00	1.00	0.04	1
37	004140	Dongbang	11	11	0	FXSwap	KDB	0	0.00	0.10		12	26.8	0.47				1
38	117580	DaesungEnergy	11	11	0	FXSwap	KEBHana	0	0.00	0.04	0.00	13	26.9	1.00		-0.03	0.03	1
39	014190	Wonik	10	10	0	FXFwd	StandChar	1	0.00	0.28		6	25.2	0.77				1
40	002840	Miwon	10	10	0	FXSwap	KDB	0	0.05	0.40	0.59	16	25.5	0.73	0.00	0.77	0.09	1
41	005990	MaeilHoldings	10	10	0	FXSwap	Citi	1	0.01	0.06	0.02	16	26.9	0.80	0.00	0.02	0.02	1
42	067830	Savezone	9	9	0	FXSwap	Shinhan	0	0.00	0.04	0.00	6	26.9	1.00		-0.02	0.02	1
43	000320	Noroo	8	8	0	FXSwap	Woori	0	0.00	0.13	0.67	14	26.3	1.00	0.00	0.20	0.04	1
44	060540	SAT	8	8	0	FXSwap	KEB	0	0.00	0.35	0.00	16	24.6	1.00		-0.17	0.18	1
45	004710	HansolTech	7	22	15	FXFwd	Citi	1	0.14	0.59	0.97	16	26.2	0.42	0.02	4.50	0.04	1
46	155660	DSR	5	5	0	FXFwd	Busan	0	0.05	0.19		16	25.2	1.00				1
47	014160	Daeyoung	5	5	0	FXSwap	IBK	0	0.00	0.12	0.01	16	25.7	1.00	0.00	-0.03	0.04	1
48	010660	Hwacheon	4	4	0	FXFwd	KEB	0	0.00	0.10	0.23	16	25.6	1.00	0.00	0.24	0.04	1
49	166090	HanaMaterials	4	4	0	FXSwap	Citi	1	0.01	0.19		16	24.3	0.69				1
50	059090	MiCo	3	3	0	FXSwap	Citi	1	0.09	0.13		16	25.2	0.64				1
51	003160	DI	3	3	0	FXSwap	IBK	0	0.01	0.10	0.45	16	25.8	0.87	0.00	0.07	0.02	1
52	084870	TBH	3	3	0	FXSwap	HSBC	1	0.01	0.10	0.03	16	26.3	0.34	0.00	-0.01	0.01	1
53	041650	Sangsin	2	2	0	FXSwap	KEB	0	0.07	0.10	0.25	16	25.6	0.41	0.00	0.33	0.02	1
54	033320	JCHyun	2	2	0	FXFwd	KB	0	0.00	0.47	0.01	6	24.8	0.34	0.00	-0.08	0.03	1
55	013520	Hwaseung	1	1	0	FXSwap	KDB	0	0.13	0.05	0.61	16	26.8	0.12	0.00	0.65	0.00	1
56	049480	Openbase	1	1	0	FXFwd	Citi	1	0.00	0.34		15	24.8	0.20				1
Mean			218	225	7				0.04	0.25	0.31		27.6	0.60	0.01	0.35	0.06	
Median			24	30	0				0.02	0.21	0.23		27.3	0.56	0.00	0.14	0.04	

Table 37: Net FXD Sellers (As of Dec 2009)

Industry code: 1=Construction/ 5=Agriculture and Fishing/ 6=Retail/ 12=Transportation and Shipping/ 13=Gas and Electricity/ 14=Science and Technology/ 15=IT and Tele-communication/ 16= Manufacturing

No	Stock	Firm	Net	Buy	Sell	DerivType	MainBank	binding	FCAShr	FCLShr	ExpShr	Industry	Size	FCLHedge	ExpHedge	NetPosExcFXD	NetPosIncFXD	FullDisc
1	9540	HyundaiHeavy	-15313	275	15588	FXFwd	KEB	0	0.05	0.04	0.9	16	30.8	0.49	0.96	0.79	-0.72	0
2	10140	SamsungHeavy	-13576	11606	25182	FXFwd	Barclays	1	0.06	0.03	0.93	16	30.6	24.97	2.42	0.64	-0.79	0
3	42660	DaewooShip	-13152	0	13152	FXFwd	KDB	0	0.09	0.15	0.97	16	30.3	0	1.28	0.78	-1.04	0
4	42670	DoosanInfra	-3052	0	3052	FXFwd	KDB	0	0.11	0.34	0.65	16	29.2	0	2.07	0.23	-0.75	0
5	10620	HyundaiMipo	-2991	0	2991	FXFwd	KEB	0	0.17	0.06	0.99	16	29.4	0	0.95	0.75	-0.58	0
6	34020	DoosanHeavy	-2940	1611	4551	FXFwd	KDB	0	0.09	0.13	0.61	16	29.8	2.42	1.4	0.42	-0.37	0
7	82740	HSDEngine	-2092	4	2097	FXOpt	KDB	0	0.09	0.2		16	28.5	0.01				0
8	6360	GSCons	-1432	564	1996	FXFwd	StandChar	1	0.08	0.09	0.23	1	29.8	1.35	1.36	0.22	-0.19	0
9	77970	STXEngine	-695	18	713	FXFwd	KDB	0	0.1	0.1	0.7	16	28.2	0.19	0.74	0.69	-0.48	0
10	36890	JinSungTEC	-380	0	380	FXFwd	Woori	0	0.07	0	0.68	16	26.3	0	9.95	0.23	-1.66	1
11	97230	HanjinHeavy	-235	0	235	FXFwd	KB	0	0.14	0.2	0.62	1	29.6	0	0.14	0.29	-0.04	0
12	21050	Seowon	-164	0	164	FXOpt	StandChar	1	0.06	0.18	0.41	16	25.9	0	2.01	0.48	-1.04	1
13	660	SKHynix	-161	0	161	FXSwap	KEB	0	0.1	0.43	0.96	16	30.2	0	0.03	0.38	-0.01	1
14	720	HyundaiCons	-156	0	156	FXFwd	StandChar	1	0.05	0	0.47	1	29.7	0	0.04	0.58	-0.02	1
15	83650	BHI	-149	30	179	FXFwd	Citi	1	0.15	0.26	0.45	16	26.3	0.75	1.73	0.43	-0.66	1
16	10120	LS	-136	29	165	FXFwd	Citi	1	0.05	0.02	0.32	16	27.9	2.33	0.42	0.39	-0.12	1
17	10130	KoreaZinc	-131	0	131	FXFwd	DB	0	0.03	0.62	0.75	16	28.6	0	0.08	0.64	-0.06	1
18	5850	SL	-122	0	122	FXFwd	KDB	0	0.14	0.24	0.48	16	26.8	0	0.93	0.38	-0.32	1
19	53660	Hyunjin	-98	5	103	FXOpt	StandChar	1	0.06	0.17	0.46	16	26.7	0.15	0.8	0.35	-0.28	1
20	4060	Segye	-92	0	92	FXFwd	StandChar	1	0.1	0.57	0.68	6	26.4	0	0.49	0.76	-0.38	1
21	12800	Daechang	-85	0	85	FXOpt	StandChar	1	0.12	0.19	0.45	16	26.7	0	0.44	0.58	-0.25	1
22	54950	JVM	-84	0	84	FXOpt	KEB	0	0.04	0.38	0.57	16	26.1	0	2.78	-0.1	-0.48	1
23	13570	DY	-71	0	71	FXFwd	KB	0	0.11	0.11	0.49	14	26.3	0	0.6	0.59	-0.31	1
24	68790	DMS	-56	0	56	FXFwd	KEB	0	0.35	0.06	0.28	16	26.6	0	1.53	0.44	-0.19	1
25	150	Doosan	-51	0	51	FXFwd	KEBHana	0	0.04	0.07	0.42	14	28.6	0	0.12	0.19	-0.02	1
26	91090	SewonCellon	-46	0	46	FXFwd	StandChar	1	0.35	0.07	0.79	16	26.4	0	0.26	1.02	-0.19	1
27	11790	SKC	-41	0	41	FXFwd	KEB	0	0.03	0.03	0.41	16	28.2	0	0.1	0.29	-0.03	1
28	9440	KCGreen	-39	0	39	FXOpt	Citi	1	0.08	0.01	0.23	14	26.1	0	1.4	0.23	-0.21	1
29	65130	TopEngi	-39	0	39	FXFwd	Busan	0	0.21	0.04		16	25.8	0				1
30	79960	DongyangENP	-38	0	38	FXOpt	Citi	1	0.43	0.24	0.91	16	25.7	0	0.16	2.29	-0.31	1
31	23810	Infac	-31	0	31	FXFwd	IBK	0	0.05	0.03	0.41	16	24.8	0	0.94	0.7	-0.61	1
32	5950	IsuChem	-29	1	30	FXFwd	KEB	0	0.08	0.09	0.37	16	27.3	0.06	0.09	0.61	-0.05	1
33	122900	IMarket	-28	1	29	FXFwd	Woori	0	0.07	0	0.13	6	26.6	2.8	0.21	0.52	-0.09	1
34	27580	Sangbo	-28	0	28	FXOpt	Citi	1	0.06	0.29	0.42	16	25.6	0	0.75	0.16	-0.24	1
35	35150	Baiksan	-23	0	23	FXOpt	Citi	1	0.18	0.25	0.93	16	25.7	0	0.28	0.68	-0.19	1
36	95500	MiraeNano	-22	0	22	FXOpt	Citi	1	0.3	0.07	0.7	16	26.3	0	0.13	1.02	-0.1	1
37	34730	SK	-22	36	57	FXFwd	StandChar	1	0	0.03	0.04	14	28.8	0.78	1.29	0	-0.01	1
38	16800	Fursys	-21	0	21	FXFwd	KEB	0	0.01	0	0.08	16	26.6		1.37	0.06	-0.07	1
39	14830	Unid	-20	0	20	FXFwd	Shinhan	0	0.05	0.56	0.51	16	26.9	0	0.1	0.34	-0.05	1
40	37070	Paseco	-20	0	20	FXFwd	Citi	1	0.02	0.25	0.53	16	25.2	0	0.41	0.58	-0.28	1
41	47310	PowerLogics	-18	0	18	FXOpt	Citi	1	0.38	0.56	0.78	16	26.2	0	0.09	1.04	-0.09	1
42	89030	TechWing	-18	0	18	FXFwd	Woori	0	0.31	0.05		16	24.5	0				1
43	11300	Seongan	-18	0	18	FXFwd	Daegu	0	0.02	0	0.97	16	25.6	0	0.29	0.56	-0.16	1
44	11760	HyundaiCorp	-17	2	20	FXFwd	KEB	0	0.47	0.76	0.96	6	27.4	0	0.01	2.91	-0.03	1
45	43150	Vatech	-17	0	17	FXFwd	Woori	0	0.33	0.04	0.53	16	25.4	0	0.4	0.77	-0.18	1
46	44340	Winix	-16	0	16	FXFwd	Citi	1	0.06	0.21	0.28	16	25.2	0	0.67	0.32	-0.22	1
47	53620	Taeyang	-16	0	16	FXFwd	IBK	0	0.17	0.02		16	25.3	0				1
48	9160	Simpac	-16	0	16	FXFwd	KEB	0	0.03	0	0.41	16	25.9	0	0.37	0.31	-0.1	1
49	67310	HanaMicron	-16	0	16	FXFwd	StandChar	1	0.04	0.14	0.82	16	25.9	0	0.13	0.67	-0.1	1
50	78890	KaonMedia	-14	0	14	FXFwd	KB	0	0.2	0.47	0.93	16	25.4	0	0.12	1.25	-0.16	1

Table 38: Net FXD Sellers (As of Dec 2009), Continued

Industry code: 1=Construction/ 5=Agriculture and Fishing/ 6=Retail/ 12=Transportation and Shipping/ 13=Gas and Electricity/ 14=Science and Technology/ 15=IT and Tele-communication/ 16= Manufacturing

No	Stock	Firm	Net	Buy	Sell	DerivType	MainBank	binding	FCAShr	FCLShr	ExpShr	Industry	Size	FCLHedge	ExpHedge	NetPosExcFXD	NetPosIncFXD	FullDisc
51	079950	Invenia	-12	0	12	FXFwd	KDB	0	0.01	0.04	0.05	16	25.1	0.00	3.29	0.05	-0.18	1
52	036930	Joosung	-12	0	12	FXFwd	Citi	1	0.30	0.05	0.59	16	26.6	0.00	0.14	0.54	-0.04	1
53	109740	DSK	-12	0	12	FXFwd	IBK	0	0.12	0.00	0.61	16	24.1	0.00	1.19	0.50	-0.46	1
54	029460	KC	-12	0	12	FXFwd	Woori	0	0.05	0.01	0.23	16	25.9	0.00	0.63	0.17	-0.07	1
55	007630	PolusBioPharm	-10	0	10	FXOpt	Shinhan	0	0.14	0.01	0.32	6	25.2	0.00	0.94	0.28	-0.14	1
56	066110	Hanp	-10	0	10	FXOpt	Citi	1	0.34	0.37	0.93	16	24.9	0.00	0.19	1.18	-0.18	1
57	007860	Seoyon	-10	0	10	FXFwd	KEB	0	0.21	0.11	0.55	14	26.7	0.00	0.05	0.77	-0.03	1
58	079980	Huvis	-10	0	10	FXFwd	KEB	0	0.13	0.22		16	27.0	0.00				1
59	086450	DongkookPharm	-10	0	10	FXFwd	KEB	0	0.06	0.05	0.27	16	25.6	0.00	0.32	0.32	-0.09	1
60	049830	Seungil	-10	0	10	FXFwd	IBK	0	0.07	0.01		16	25.3	0.00				1
61	019490	Hitron	-9	0	9	FXFwd	KEB	0	0.44	0.72	0.98	16	25.3	0.00	0.08	1.44	-0.11	1
62	020150	IljinMaterials	-9	0	9	FXFwd	Citi	1	0.10	0.15	0.87	16	26.0	0.00	0.06	0.97	-0.06	1
63	027970	Seha	-9	0	9	FXFwd	KDB	0	0.29	0.04		16	26.1	0.00				1
64	046310	BGTNA	-8	0	8	FXFwd	Woori	0	0.41	0.11	0.96	16	24.6	0.00	0.16	1.57	-0.20	1
65	054540	SamyoungMT	-7	0	7	FXFwd	KEB	0	0.10	0.00	0.37	16	25.2		0.21	0.52	-0.09	1
66	066310	QSI	-7	0	7	FXFwd	Woori	0	0.17	0.19	0.79	16	24.2	0.00	0.49	0.65	-0.24	1
67	033530	Sejong	-6	0	6	FXFwd	Woori	0	0.16	0.00	0.65	16	26.4	0.00	0.03	0.96	-0.02	1
68	008970	DongyangPipe	-6	0	6	FXFwd	StandChar	1	0.01	0.25	0.14	16	25.6	0.00	0.35	0.06	-0.05	1
69	099320	Satrec	-4	0	4	FXFwd	KEB	0	0.11	0.07	0.49	16	24.4	0.00	0.42	0.39	-0.12	1
70	043340	EssenTech	-4	0	4	FXFwd	Citi	1	0.12	0.02	0.29	16	25.0	0.00	0.22	0.42	-0.07	1
71	053450	Sekonix	-4	0	4	FXFwd	KB	0	0.19	0.54	0.64	16	25.2	0.00	0.11	0.45	-0.05	1
72	001250	GSGlobal	-3	0	3	FXFwd	DB	0	0.43	0.87	0.95	6	25.8	0.00	0.00	7.21	-0.03	1
73	005670	Foodwell	-3	0	3	FXFwd	Daegu	0	0.05	0.00	0.32	16	25.0		0.22	0.31	-0.06	1
74	049550	Inktec	-3	0	3	FXFwd	Shinhan	0	0.16	0.01	0.64	16	25.1	0.00	0.12	0.54	-0.05	1
75	031980	PSK	-3	0	3	FXFwd	ING	1	0.09	0.33	0.48	16	25.6	0.00	0.21	0.19	-0.03	1
76	030720	DongwonFish	-2	0	2	FXFwd	StandChar	1	0.03	0.14	0.68	5	24.9	0.00	0.05	0.86	-0.04	1
77	051360	Tovis	-2	0	2	FXFwd	KB	0	0.37	0.20	0.97	16	25.0	0.00	0.01	2.96	-0.04	1
78	000500	GaonCable	-2	0	2	FXFwd	Citi	1	0.02	0.10	0.11	16	26.5	0.00	0.04	0.20	-0.01	1
79	092460	HanlaIMS	-2	0	2	FXFwd	IBK	0	0.03	0.02	0.66	16	24.7	0.00	0.10	0.47	-0.05	1
80	023960	SCEngi	-2	0	2	FXFwd	KB	0	0.10	0.01	0.59	1	24.8	0.00	0.06	0.71	-0.04	1
81	045100	HanyangENG	-2	0	2	FXFwd	Shinhan	0	0.02	0.00	0.04	14	25.5	0.00	0.45	0.06	-0.02	1
82	007980	Pacific	-2	0	2	FXFwd	KEB	0	0.18	0.46	0.90	16	25.7	0.00	0.01	1.24	-0.01	1
83	024800	YoosungTnS	-2	0	2	FXFwd	Woori	0	0.00	0.01		12	26.2	0.00				1
84	041910	Estech	-2	0	2	FXFwd	KEB	0	0.10	0.01	0.57	16	24.8	0.00	0.10	0.41	-0.03	1
85	052710	Amotech	-2	0	2	FXFwd	KEB	0	0.09	0.18	0.83	16	25.8	0.00	0.03	0.40	-0.01	1
86	070590	HansolInticube	-1	0	1	FXFwd	Citi	1	0.01	0.22	0.00	15	24.5	0.00	11.14	-0.09	-0.03	1
87	065950	Welcron	-1	0	1	FXFwd	IBK	0	0.11	0.01	0.74	16	25.1	0.00	0.02	0.88	-0.02	1
88	019540	IljiTech	-1	0	1	FXFwd	KEB	0	0.04	0.00	0.37	16	24.8		0.07	0.30	-0.02	1
89	092600	NCN	-1	0	1	FXFwd	StandChar	1	0.05	0.88	0.75	16	24.6	0.00	0.02	0.54	-0.01	1
90	105740	DKLok	-1	0	1	FXFut	KB	0	0.18	0.01	0.48	16	24.1	0.00	0.04	0.69	-0.02	1
91	059100	Icomponent	-1	0	1	FXFwd	IBK	0	0.02	0.00	0.24	16	24.6	0.00	0.08	0.18	-0.01	1
92	018880	Hanon	0	0	0	FXFwd	KEB	0	0.09	0.03	0.63	16	27.9	0.00	0.00	0.73	0.00	1
Mean			-633	154	787				0.13	0.17	0.56		26.3	0.41	0.77	0.68	-0.20	
Median			-16	0	16				0.10	0.08	0.57		25.9	0.00	0.22	0.52	-0.09	

Table 39: Adjustments in FX Derivatives Position and Capital (**Excluding 3 banks**)

$$Y_{it} = \beta_0 + \beta_1 Constrained_i + \beta_2 Regulation_t + \beta_3 Constrained_i \times Regulation_t + \varepsilon_{it}$$

Y_{it} is either log(FX Derivatives position) or log(Capital). $Bind_i$ is dummy variable that takes 1 if bank i is constrained and 0 if otherwise. $Constraint_t^{Avg}$ is 0 before the regulation and takes **simple average** of foreign banks' and domestic banks' regulatory cap^{-1}. Higher $Constraint_t^{Avg}$ indicates tighter constraint. Columns (2) and (6) adds bank fixed effects:

$$Y_{it} = \beta_0 + BankFE_i + \beta_2 Regulation_t^{Avg} + \beta_3 Constrained_i \times Regulation_t^{Avg} + \varepsilon_{it}$$

Columns (3),(4),(7) and (8) are weighted least squares models, where the weights are the size of derivatives position as of Dec 2009. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank.

	(1) LogDeriv	(2) LogDeriv	(3) LogDeriv (W)	(4) LogDeriv (W)	(5) LogCapital	(6) LogCapital	(7) LogCapital (W)	(8) LogCapital (W)
Constrained=1	5.701***		0.506*		-0.721		-2.278***	
	(3.86)		(1.86)		(-1.63)		(-6.17)	
Regulation	-0.0299	0.0315	-0.408***	-0.412***	0.263***	0.286***	0.270***	0.266***
	(-0.10)	(0.10)	(-4.85)	(-4.77)	(6.11)	(7.43)	(4.48)	(4.42)
Constrained=1 x Regulation	-0.883***	-0.939***	-0.485***	-0.481***	0.0385	0.0312	0.00434	0.0114
	(-2.86)	(-2.98)	(-4.20)	(-4.05)	(0.48)	(0.42)	(0.05)	(0.13)
Constant	15.81***	20.18***	21.25***	20.16***	27.65***	26.14***	29.52***	26.19***
	(10.75)	(164.83)	(92.55)	(194.60)	(78.43)	(320.85)	(129.98)	(339.08)
BankFE	N	Y	N	Y	N	Y	N	Y
N	5531	5531	5531	5531	5513	5513	5513	5513
Adj RSqr	0.124	0.803	0.132	0.342	0.0552	0.934	0.549	0.917

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

$$Y_{it} = \beta_0 + BankFE_i + \beta_2 Regulation_t^{WAvg} + \beta_3 Constrained_i \times Regulation_t^{Wavg} + \varepsilon_{it}$$

$Constraint_t^{WAvg}$ is the **weighted average** of the regulatory position limit, where the weight is the FXD position in each month.

	(1) LogDeriv	(2) LogDeriv	(3) LogDeriv (W)	(4) LogDeriv (W)	(5) LogCapital	(6) LogCapital	(7) LogCapital (W)	(8) LogCapital (W)
Constrained=1	5.699***		0.526*		-0.691		-2.241***	
	(3.86)		(1.68)		(-1.57)		(-6.13)	
Regulation	-0.0522	0.0364	-0.495***	-0.500***	0.325***	0.355***	0.344***	0.337***
	(-0.14)	(0.09)	(-3.60)	(-3.56)	(6.15)	(7.51)	(4.21)	(4.16)
Constrained=1 x Regulation	-1.095***	-1.178***	-0.621***	-0.617***	0.0186	0.00594	-0.0300	-0.0200
	(-2.73)	(-2.88)	(-3.53)	(-3.42)	(0.19)	(0.07)	(-0.28)	(-0.18)
Constant	15.83***	20.19***	21.24***	20.17***	27.65***	26.18***	29.51***	26.22***
	(10.76)	(138.68)	(77.49)	(174.60)	(78.65)	(333.39)	(130.82)	(357.96)
BankFE	N	Y	N	Y	N	Y	N	Y
N	5531	5531	5531	5531	5513	5513	5513	5513
Adj RSqr	0.124	0.804	0.143	0.353	0.0552	0.934	0.549	0.917

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

Table 40: Impact on Banks' FC Loans and FC Liabilities (**Excluding 3 banks**)

$$Y_{it} = \beta_0 + \beta_1 Constrained_i + \beta_2 Regulation_t + \beta_3 Constrained_i \times Regulation_t + \varepsilon_{it}$$

Columns (2) and (6) adds bank fixed effects:

$$Y_{it} = \beta_0 + BankFE_i + \beta_2 Regulation_t^{Avg} + \beta_3 Constrained_i \times Regulation_t^{Avg} + \varepsilon_{it}$$

Columns (3),(4),(7) and (8) are weighted least squares models, where the weights are the size of derivatives position as of Dec 2009. The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank. The outcome variables are share of foreign currency loans ($FCLoanShr$) and share of foreign currency liabilities ($FCLiabShr$).

	(1) FCLoanShr	(2) FCLoanShr	(3) FCLoanShr	(4) FCLoanShr	(5) FCLiabShr	(6) FCLiabShr	(7) FCLiabShr	(8) FCLiabShr
Constrained=1	0.305**		0.337**		-0.0346		0.0914**	
	(2.25)		(2.29)		(-0.49)		(2.15)	
Regulation	-0.0426*	-0.0398*	0.000801	0.0124	-0.0743***	-0.0750***	-0.0325***	-0.0320***
	(-2.01)	(-1.99)	(0.02)	(0.34)	(-3.01)	(-3.15)	(-4.35)	(-4.62)
Constrained=1 x Regulation	-0.0387	-0.0425	-0.0737	-0.0860*	-0.00579	-0.00460	-0.0508***	-0.0520***
	(-1.20)	(-1.37)	(-1.55)	(-1.81)	(-0.19)	(-0.15)	(-2.90)	(-2.97)
Constant	0.338***	0.959***	0.224***	0.950***	0.232***	6.79e-14	0.103***	-8.55e-15
	(4.78)	(38.45)	(3.56)	(28.82)	(4.08)	(0.97)	(3.41)	(-0.94)
BankFE	N	Y	N	Y	N	Y	N	Y
N	1450	1450	1450	1450	1611	1611	1611	1611
Adj RSqr	0.109	0.858	0.134	0.797	0.0603	0.763	0.161	0.663

t statistics in parentheses

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

Table 41: Impact on Banks' Security Holdings (**Excluding 3 banks**)

The outcome variables are KTB holdings and MSB holdings scaled by assets. KTB is long-term Korean government bond with maturities: 3, 5, 10, 20, 30 yr.
MSB is issued by Bank of Korea and the maturities are: 91day, 1yr, 2yr.

$$Y_{it} = \beta_0 + BankFE_i + \beta_2 Regulation_t + \beta_3 Constrained_i \times Regulation_t + \varepsilon_{it}$$

	(1) KTB/Asset	(2) KTB/Asset	(3) KTB/Asset	(4) KTB/Asset	(5) MSB/Asset	(6) MSB/Asset	(7) MSB/Asset	(8) MSB/Asset
Constrained=1	0.0317		0.0455		0.145***		0.103**	
	(0.88)		(0.87)		(3.05)		(2.36)	
Regulation	-0.0102**	-0.00983*	-0.00616	-0.00569	-0.000494	0.0000609	-0.0106	-0.00949
	(-2.06)	(-1.98)	(-1.00)	(-0.86)	(-0.21)	(0.03)	(-1.44)	(-1.33)
Constrained=1 x Regulation	0.0115	0.0113	0.00406	0.00305	-0.0537***	-0.0538***	-0.0360**	-0.0374***
	(0.86)	(0.83)	(0.22)	(0.16)	(-2.80)	(-2.92)	(-2.67)	(-2.84)
Constant	0.0438***	2.88e-14	0.0567***	1.62e-14	0.0141**	3.61e-14	0.0420*	-5.13e-14
	(4.71)	(0.97)	(5.87)	(0.97)	(2.11)	(0.97)	(1.70)	(-0.97)
BankFE	N	Y	N	Y	N	Y	N	Y
N	1630	1630	1630	1630	1630	1630	1630	1630
Adj RSqr	0.0962	0.723	0.0615	0.753	0.249	0.752	0.146	0.761

t statistics in parentheses

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

Table 42: 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 change in 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 7 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
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 43: 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
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 44: 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 change in 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 7 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	0.0360***	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 45: 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 change in net FXD notional dealt between firm j and bank b, **scaled by sales**.

	(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 46: Firm level OLS (Exporters) after Coarsened Exact Matching based on FC Liability

$$\Delta Y_j = \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls_j + \varepsilon_j$$

Outcome variable is either change in firm j's log export sales, net FXD notional scaled by assets, or log domestic sales. Independent variable *Exposure* is the weighted average shock of the firm's counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and 7 industry dummies. Results are after matching firms based on FC liability.

	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

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

Table 47: Firm level OLS (Exporters) after Coarsened Exact Matching based on FC Liability, Export Share, and Profitability

$$\Delta Y_j = \beta_E \; Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls_j + \varepsilon_j$$

Outcome variable is either change in firm j's log export sales, net FXD notional scaled by assets, or log domestic sales. Independent variable *Exposure* is the weighted average shock of the firm's counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign-currency liability share, and 7 industry dummies. Results are after matching firms based on FC liability, export share, and profitability.

	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

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