STAFF

REPORTS

NO. 989

OCTOBER 2021

REVISED

JULY 2024

Real Consequences of Shocks to Intermediaries Supplying Corporate Hedging Instruments

Hyeyoon Jung

FEDERAL RESERVE BANK *of* NEW YORK

Real Consequences of Shocks to Intermediaries Supplying Corporate Hedging Instruments

Hyeyoon Jung

Federal Reserve Bank of New York Staff Reports, no. 989
October 2021; revised July 2024
JEL classification: E44, F31, G15, G28, G32

Abstract

I show that shocks to financial intermediaries that supply hedging instruments to corporations have real effects. I exploit a quasi-natural experiment in South Korea in 2010, where regulations required banks to hold enough capital for taking positions in foreign exchange derivatives (FXD). Using the variation in exposure to this regulation across banks, I find that the regulation caused a reduction in the supply of FXD, leading to a significant decline in exports for firms that held derivatives contracts with more exposed banks. These results indicate the crucial role of intermediaries in allocating risks through the provision of derivatives and establish a causal relationship between financial hedging and real economic outcomes.

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

---

Jung: Federal Reserve Bank of New York (email: hyeyoon.jung@ny.frb.org). The author thanks Stefano Giglio (editor) and two anonymous referees for their insightful comments. She is grateful to her advisors, Robert Engle, Philipp Schnabl, Ralph Koijen, Alexi Savov, and Joel Hasbrouck, for their unwavering support and guidance. She thanks Jaehoon Jung, Viral Acharya, Wenxin Du, Laura Alfaro, Nina Boyarchenko, Matthew Plosser, Pasquale Della Corte, Marcin Kacperczyk, Tarun Ramadorai, Richard Levich, Nicola Cetorelli, Shan Ge, Julian di Giovanni, Richard Crump, and discussants and participants at the American Economic Association meeting, NBER International Finance and Macroeconomics meeting, IMF Macro-Financial Research Conference, HEC Paris-CEPR Conference, Yale SOM, Vanderbilt Owen, University of South Carolina Darla Moore, NYU Stern, Imperial College London, Warwick Business School, Oxford Said, Stockholm School of Economics, Hong Kong University, Hong Kong University of Science and Technology, Korea University, Federal Reserve Bank of New York, Federal Reserve Board, Federal Reserve Bank of Chicago, Bank of Korea, Society for Financial Econometrics Conference, Federal Reserve Board Pre-Job Market Conference, International Risk Management Conference, Australasian Finance and Banking Conference, Eastern Finance Association Meeting, and WEAI-IBEFA Conference for helpful suggestions and comments. In addition, she thanks the Center for Global Economy and Business, NYU Stern, for research funding. This paper was previously circulated under the titles "Real Consequences of Macroprudential FX Regulations" and "Real Consequences of Foreign Exchange Derivatives Hedging."

1 Introduction

Financial intermediaries play a crucial role in providing corporations with hedging instruments, such as derivatives, for managing risks. Shocks to intermediaries can significantly impact firms' risk management to the extent that the intermediaries transmit the shocks by reducing the supply of hedging instruments, and firms cannot find alternative hedging sources. Such shocks can, in turn, affect the real economic activities of firms, given the increasingly widespread and heavy use of derivatives among corporations, with notional values exceeding $100 trillion in 2022, up from $20 trillion in 2000. Therefore, it is critical to understand the real effects of financial shocks on intermediaries that supply corporate hedging instruments.

In this paper, I examine how shocks to financial intermediaries affect the supply of hedging instruments to corporations and, in turn, whether such shocks impact real economic activities. Exploiting a regulatory shock, I find evidence from intermediaries' provision of foreign exchange derivatives (FXD) to exporters. FXD can play a key role in managing the foreign exchange (FX) risk of exports. This is because exporters in countries that do not use the US dollar (USD) face substantial FX risk, since the majority of international trades are invoiced in USD,[1] and exchange rates are highly volatile.[2] Since exporters in small open economies constitute a significant mass of firms, the implications of FX hedges using derivatives can extend to the macroeconomic level.

To examine how regulatory shocks affect banks' supply of derivatives and the real economic activities of the firms that use them, I exploit a quasi-natural experiment in South Korea. In 2010, regulations required banks to hold enough capital for taking FXD positions. Using the variation in exposure to this regulation across banks, I find that the regulation caused a reduction in the supply of FXD because banks opted to decrease their FXD po-

[1]The average export invoice share in US dollars or euros was 89% across 71 countries in 2019 based on the dataset constructed by Boz et al. (2020).

[2]Exchange rates for emerging markets are especially volatile, with annual volatilities as high as 120% per annum for some emerging market currencies during stress episodes (Figure 1).

sitions instead of raising equity due to costly financing. The reduction in the supply of hedging instruments led to a significant decline in exports for firms that held derivatives contracts with more exposed banks. These findings are relevant to other economies, given that increasingly many countries globally, including developed economies, have restrictions on the financial sector's open FX positions.[3]

This study makes direct contributions to the finance literature by examining the role of financial intermediaries in allocating risk through the provision of derivatives, an area overlooked in prior research on the role of financial intermediaries, which has thus far focused on allocating capital through the provision of credit. Moreover, it also establishes a causal relationship between financial hedging and real economic outcomes. While previous studies have explored the relationship between derivatives usage and firm value, few have established a causal link between financial hedging and real economic outcomes.[4]

Estimating whether and the extent to which financial intermediaries transmit regulatory shocks to firms through a reduction in the supply of derivatives presents significant challenges, as does assessing the real effects of corporate hedging using derivatives. First, regulatory shocks typically affect multiple institutions simultaneously, making it difficult to identify their causal effect through time-series analysis alone. To address this, it is crucial to examine similar financial institutions with varying levels of exposure to the regulation. Second, the economic forces driving the regulation may also directly influence firms' demand for hedging. Therefore, changes in the hedging supply by financial intermediaries must be isolated from the changes in firms' demand for hedging. Third, firms might be able to offset the reduction in the supply of hedging using derivatives by using alternative hedging strategies. Hence, it is critical to observe real outcomes at the firm level to assess the impact of the reduction in

[3]As of 2018, approximately three out of four countries, including developed economies, had restrictions on the financial sector's open FX positions based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). See Figure A.1 for the number of emerging markets and developing countries using such regulations over time.

[4]For example, Gilje and Taillard (2017) use a change in basis risk in the oil and gas industry and Perez-Gonzalez and Yun (2013) exploit the introduction of weather derivatives as exogenous shocks and find that the use of derivatives leads to an increase in firm value.

the supply of derivatives on real economic activity.

To address the challenges discussed above, I employ a quasi-natural experiment in South Korea. By exploiting the cross-bank heterogeneity in the impact of regulatory shocks on banks based on their ratio of FXD positions to equity, I construct a bank-specific measure of exposure to the regulation, addressing the first challenge. To address the second challenge, I hand-collect a unique dataset covering the details of FXD contracts held by all listed firms in South Korea. This allows me to control for changes in the demand for hedging by comparing derivatives contracts of similar firms provided by several banks. Finally, to address the third challenge, I examine the firm-level total hedging and exports to estimate the impact on the real economic activity of firms that had relationships with banks exposed to the regulation. My identification strategy is valid because the regulatory shock is plausibly exogenous to the demand for FXD hedging. This is supported by my finding that the regulatory shock to banks is not correlated with firms' demand for hedging.

To understand how the regulatory shock propagates to firms, I proceed in three steps. First, I evaluate bank-level responses following the imposition of the regulation. I compare banks constrained by the regulation (treatment group) to unconstrained banks (control group), both before and after the regulatory shock in a difference-in-differences (DiD) framework. I find that, following the regulatory shock, constrained banks reduced their FXD positions more than unconstrained banks, and the gap between the FXD positions of the two groups widened as regulations were tightened over time.[5] These findings suggest that it is costly for banks to raise equity capital, and therefore, banks prefer to cut FXD positions to meet the regulatory requirement. In other words, the regulation as well as the banks' costly equity financing are frictions that banks are facing.

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

[5]The results remain robust when I replace the indicator variable, *Constrained*, with a continuous variable, *Shock*, defined as the percentage of its FXD position that a bank was required to reduce when the regulation was imposed.

from banks to firms. I control for changes in the demand for hedging by examining hedging with constrained banks and hedging with unconstrained banks for *similar* firms, defined as those being in the same industry with similar characteristics. I find that exporters' hedging with constrained banks declined 47% more than their hedging with unconstrained banks. These results are robust after controlling for firms' industry–location–size fixed effects, addressing the concern that the results may be confounded by unobservable demand-related characteristics, and corroborating that the regulation caused a reduction in the *supply* of FXD.

In the third step, I conduct a firm-level analysis to understand how the regulatory shock affected the real decisions of firms. I define "exposed" firms as those whose counterparty bank for FXD was constrained. I then compare changes in exposed firms' FXD positions with changes in non-exposed firms. I find that the *total* hedging of exposed exporters fell 40–45% compared with the total hedging of non-exposed exporters, and the effects were concentrated on *small firms*. This firm-level reduction in hedging implies that small firms were not able to offset the shock because switching counterparty banks is likely to be costly to them (e.g., because they borrow and/or have credit lines outstanding with the constrained banks).

Further, I examine whether the reduction in the supply of FXD affected firms' exports, which are the primary source of exposure to FX risk. To develop hypotheses, I construct a simple conceptual framework of exporter hedging. In this framework, firms optimally reduce their exports as a means of strategic risk management when hedging becomes costly. Froot et al. (1993) and Rampini and Viswanathan (2010) posit that firms hedge their risk exposure to avoid falling short on funds available for future investment. Building upon this insight, suppose that firms' export outcomes determine the size of internal funds available for future investment opportunities and that firms are exposed to exchange rate risk. If internal funds fall short, firms would have to rely on costly external financing. Assuming convex costs, firms would face higher expected external financing costs when the volatility of the internal funds is higher. Therefore, they have incentives to lower the volatility of internal funds by using hedging instruments or by reducing exports. When hedging becomes more costly, it is optimal for firms to reduce the underlying exposure, the exports, to lower the volatility of internal funds.

Consistent with the implication of the framework, I find that the impact was large for the firms that relied heavily on hedging using FXD. Firms that used to hedge at least 10% of their export sales with FXD, which I refer to as high-hedging firms, substantially reduced their exports. For a one-standard-deviation increase in a firm's exposure to the regulatory shock transmitted by banks, export sales fell by 16.5% more for high-hedging firms than for low-hedging firms.[6]

One may question whether the documented reduction in exports is due to firms' speculation instead of hedging. Specifically, it might be that the firms having contracts with banks exposed to the regulation were speculating that the USD would depreciate, causing a reduction in exports, and their FXD position was forced to decrease due to the reduction in supply. Had firms been speculating on both exports and FXD, a positive correlation between exports and the FXD before the shock would be expected. Yet, I find that the correlation was, in fact, strongly negative (-0.95). The net FXD positions of the exporters were short USD (paying off when the USD depreciates), while export sales invoiced in USD are better off when the USD appreciates. Therefore, it is unlikely that exporters were holding derivatives for speculation.

In addition, the exporters in the sample were exposed to substantial FX risk. The USD-KRW exchange rate is highly volatile, with annual volatilities as high as 120% per annum during stress episodes (Figure 1), and most exports are invoiced in USD. A simple decomposition exercise suggests that the sample exporters' variance of total sales is 6.7

[6]While not directly comparable, this magnitude is broadly consistent with the literature on the real effects of hedging. For instance, Gilje and Taillard (2017) show that shareholder value for treated firms suffering from a relative reduction in their ability to hedge falls by 17% relative to control firms. In the context of Chilean firms, Alfaro et al. (2021) find that a supply shock in FXD leads to a 20% decline in exports, although the coefficient is not statistically significant.

times the variance of domestic sales. Moreover, firms' profits are a leveraged position on the exchange rate. A numerical exercise suggests that the profits of one of the top exporters fall by 10.7% for a 1% depreciation in the USD against the KRW. This implies that firms can experience staggering net losses due to FX risk. Given these risks, it is even more unlikely that exporters would speculate in a way that increases their exposure.

Another alternative explanation is that the decline in exports is an outcome of the realized risk of unhedged exposure following a failure in risk management. When firms fail to hedge, they are forced to cut their investment due to FX losses, which in turn leads to a decline in their output. Under this channel, high-cash firms are expected to reduce their exports by less than low-cash firms because their cash reserves can weather losses from reduced risk management.

To test this alternative explanation, I investigate the cross-sectional effect of cash holdings on the decline in exports. I find that firms with higher cash holdings and high hedge ratios before the regulation reduced export sales and switched to the domestic market to a greater extent, rejecting the alternative explanation.[7] On the contrary, my theoretical framework can explain this finding. Due to risk-taking incentives, when hedging becomes more costly, exporters with more internal funds are expected to reduce exports by more than those exporters with less.

I perform several tests throughout the analyses to confirm the robustness of the results. First, the results are robust when including bank fixed effects in the bank-level analysis and when controlling for bank, firm, and contract characteristics in the contract-level and firm-level analyses. Additionally, in the contract-level analysis, firms' industry-location-size fixed effects are included to control for unobservable demand-related characteristics, and the results remain robust. Second, I analyze changes in FXD separately for foreign banks and confirm that the relative reduction in FXD of constrained banks is large and significant even

[7]The result also helps rule out the speculation channel. If firms were using FXD for speculative purposes and the reduction in exports was driven by a decline in gains from the reduced speculative FXD positions, high-cash firms may reduce their exports by less than low-cash firms.

among foreign banks, suggesting that the result is not driven by a difference in business models between foreign and domestic banks. Third, I estimate the impact of the regulation on firms' borrowing quantities and costs, and find no significant change. This result helps rule out the potentially confounding effect of a global credit shock and also provides evidence against the hypothesis that the regulation adversely impacted banks' overall credit supply as opposed to their FXD supply.[8] Fourth, I conduct a placebo test to estimate the impact on firms' domestic sales and find it to be small and insignificant. This finding suggests that the decrease in export sales is due to a regulatory shock and not a systemic relationship between troubled firms and constrained banks. Fifth, I show that the decline in exports for exposed firms is only explained by cash when interacting with hedging, not by cash alone. This finding confirms that the hedging channel is the mechanism at work. Finally, I provide further evidence suggesting that the reduction in FXD positions resulted from a decrease in supply, rather than demand, by examining FXD pricing.

Overall, my results indicate that regulatory constraints imposed on financial intermediaries can lead to a decline in the supply of FXD. In turn, it can lead to a reduction in exports by affected firms because firms strategically reduce the underlying risk exposure when hedging becomes more costly. This has important implications: 1) intermediary frictions in FX markets can affect international trade, 2) derivatives are crucial for risk management, 3) firms actively manage their underlying risk exposure when derivatives become more costly, and 4) macroprudential FX regulations aimed at mitigating financial sector vulnerabilities can have adverse effects on the real economic outcomes of the nonfinancial sector.

Contribution to Literature This paper adds to the literature studying the role of intermediaries in financial markets, specifically within the FX market context. It builds on prior theoretical work by Du et al. (2022) and Gabaix and Maggiori (2015), as well as the empirical research by Cenedese et al. (2021), Du et al. (2018), Avdjiev et al. (2019), Fleckenstein and

[8] In addition, I assess the impact of the regulation on banks' foreign currency lending and find no significant change in the share of foreign currency lending of constrained banks compared with that of unconstrained banks. This finding further supports that the global credit shock is not driving my empirical results.

Longstaff (2018), Ivashina et al. (2015) and Liao and Zhang (2020), which examine how constraints imposed on intermediaries affect CIP deviations and exchange rates.[9] Compared to these studies focusing on the effects of intermediary constraints on asset prices, this research documents their impact on real economic activities.

More broadly, this paper adds to the field by identifying a novel *hedging channel* through which frictions in the financial market can have real effects. While a large body of literature (e.g., Khwaja and Mian, 2008; Schnabl, 2012; Jimenez et al., 2017; Gropp et al., 2018) has extensively explored the adverse real effects of credit supply shocks,[10] we have little understanding of the effects of hedging supply shocks on the real economy. In the credit market, it is well known that monitoring and screening make it costly for firms to alter their banking relationships. However, the extent of these costs is not obvious in the derivatives market. My findings suggest that such changes are costly, with larger firms better at coping with the adverse effects of liquidity shocks in the derivatives market, similar to the findings of Khwaja and Mian (2008) in credit markets.

This paper makes a contribution to the literature examining the effects of financial shocks on international trade. Several studies (e.g., Amiti and Weinstein, 2011; Ahn et al., 2011) document the importance of trade finance in international trade. For instance, Amiti and Weinstein (2011) show that the deterioration of Japanese banks' health had a substantial adverse impact on the exports of Japanese firms, through the trade finance channel. Furthermore, prior research (e.g., Niepmann and Schmidt-Eisenlohr, 2017a,b; Demir et al., 2017) highlights the role of banks' provision of letters of credit on exports. For example, Niepmann and Schmidt-Eisenlohr (2017b) find that negative shocks to a country's letter-of-credit supply reduce US exports. Additionally, Paravisini et al. (2014) demonstrate the negative impact of credit shocks on the intensive margin of exports. Compared to these studies, this paper documents the importance of banks' provision of hedging instruments on export

[9] In the context of the commodity market, Acharya et al. (2013) build an equilibrium model of commodity markets and show that producers experience limits to hedging when speculators are capital-constrained.

[10] Refer to Berger et al. (2020) for a comprehensive review.

activities, employing a regulatory change as an identification strategy.

This paper contributes to the literature on the real implications of corporate hedging. Corporate finance theory provides rationales for hedging due to agency theoretic, capital market, asymmetric information, and tax frictions.[11] Recent empirical studies, such as Alfaro et al. (2021), underscore the importance of corporate hedging. While many studies have found that hedging is associated with increases in firm values,[12] only a few papers have identified the *causal* effects of hedging (e.g., Gilje and Taillard, 2017; Perez-Gonzalez and Yun, 2013). This paper adds to the literature by identifying the causal effect of hedging on exports and proposing a new mechanism through which hedging can impact real outcomes: unhedgeable exchange rate fluctuations can raise exporting costs by increasing cash flow volatility.

This paper also adds to the literature on macroprudential regulations. While some studies show the effectiveness of regulations (e.g., Acharya and Vij, 2020; Bruno et al., 2017; Ostry et al., 2012; Choi, 2014), others document unintended negative consequences (e.g., Aiyar et al., 2014; Cerutti et al., 2015; Reinhardt and Sowerbutts, 2015; Ahn et al., 2022; Kim et al., 2022).[13] I contribute by providing novel evidence that macroprudential FX regulations can have a negative effect on exports. This paper is also related to the work of Keller (2019), who examines the effects of a capital control shock in Peru that shifted risks from banks to firms through a credit channel. Additionally, this paper is related to the study by Ahnert et al.

[11] For example, see Purnanandam (2008); Campbell and Kracaw (1987) for agency theoretic frictions, Froot et al. (1993); Rampini and Viswanathan (2010) for capital market frictions, DeMarzo and Duffie (2015) for asymmetric information frictions, and Smith and Stulz (1985); Leland (1998); Graham (2003) for tax frictions.

[12] Such findings are in the context of FX derivatives (e.g., Allayannis and Weston, 2015; Allayannis et al., 2012; Bartram et al., 2011; Graham and Rogers, 2002; Geczy et al., 1997), commodity derivatives (e.g., Rampini et al., 2014; Carter et al., 2006; Haushalter, 2000), and interest rate derivatives (e.g., Campello et al., 2011; Graham and Rogers, 2002). Other studies have documented less prominent effects (e.g., Mackay and Moeller, 2007; Jin and Jorion, 2006; Tufano, 1996; Guay and Kothari, 2003).

[13] Several of these studies focus on Korea's context. For instance, Choi (2014) highlights the effectiveness of FX-related macroprudential measures, while Ahn et al. (2022) document the unintended consequences of a macroprudential stability levy. Kim et al. (2022) examine Korean banks' sensitivity to international shocks and their relationship with credit supply. Compared to these papers, I establish a causal link between macroprudential regulation and its effect on exports by employing novel bank-firm matched *FX derivatives* data.

(2020), who find that macroprudential FX regulations cause firms to increase their issuance of FX debt. I contribute to this literature by providing novel evidence that macroprudential FX regulations can have a negative effect on *exports* through a *reduction in the supply of firms' hedging instruments*.

Outline of the Paper The remainder of the paper proceeds as follows: Section 2 provides the economic context, rationale, and institutional details of the regulation. Section 3 describes the sample and data. Section 4 develops the empirical methodology and reports the results. Section 5 investigates other potential explanations, and section 6 presents robustness results. Section 7 concludes.

2 The Setting

This section provides context for the quasi-natural experiment by describing the economic environment leading up to the imposition of leverage-based FXD capital requirements on banks in South Korea in 2010. Additionally, the section discusses the rationale behind the regulation as well as its institutional details.

2.1 Economic Context

From 2000 to 2007, while Korea had twin surpluses in both the current account and the financial account, there was a significant increase in Korea's external debt. This increase, particularly in its short-term component, was primarily driven by the banking sector. As a result, even after taking the huge accumulation of FX reserves into account, FX liquidity—defined as FX reserves less short-term debt, scaled by GDP—sharply declined from 18% to 5% between 2004 and 2009.[14,15]

[14] This measure of FX liquidity is suggested by Acharya and Krishnamurthy (2019).

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

The substantial short-term borrowing by the banking sector constituted a risk that materialized as a significant problem during the GFC, as highlighted in Figure 2. This figure plots Korea's gross foreign capital inflows by channels and shows a rapid increase in banking sector borrowing from 2006 to 2007, followed by a dramatic reversal during the global financial crisis. Notably, the outflow in the fourth quarter of 2008 was close to $40 billion, or 4% of the country's annual GDP. This pronounced volatility in capital flows through the banking sector prompted regulatory action. The regulation focused on banks' FX derivatives position because the surge in the banking sector's short-term borrowing in 2006–2007 was closely related to an increase in exporter hedging demand.

To illustrate the relationship between exporter hedging demand and the banking sector's short-term cross-border borrowing, Figure 3 presents stylized FX positions of exporters and banks before the regulation. During 2006–2007, high global demand led exporters to have long-term USD receivables. To hedge FX exposure from these USD receivables, exporters sold large amounts of USD forwards to banks.[16] The left panel of Figure 3 presents this structure of firms' FX position.

Because banks purchased USD forwards from exporters, they were long USD forwards. The right panel of Figure 3 presents banks' FX position. Banks needed a hedging strategy for these long positions, yet liquidating them entirely through sales to importers was not feasible because importer hedging demand fell far short of exporter hedging demand for several reasons. For instance, it could be optimal for importers not to hedge when the central bank substantially accumulates FX reserves anticipating the reserves would be used to reduce currency depreciation (see Acharya and Krishnamurthy, 2019). In addition, the main importing sector in Korea is energy. In that sector, firms have sufficiently large market power to pass FX risk to their customers through pricing (see Kim, 2010).

As a result, the majority of banks' FXD positions were derived from exporter hedging demand. Figure 4 shows that, during the first three quarters of 2007, exporters sold 24

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

billion USD in forwards to banks, which amounted to 65% of banks' aggregate net USD forward position.

Given the shortage of natural USD forward buyers, banks needed to cover their long positions in USD forwards by constructing short positions in synthetic forwards. A short position in synthetic forwards is constructed by borrowing USD, converting USD to Korean Won (KRW) in the FX spot market, and investing in risk-free KRW-denominated bonds.[17] In this process, despite the *long-term* maturities of their long positions in USD forwards, banks constructed *short-term* synthetic positions, leaving a maturity mismatch unhedged.[18] The right panel of Figure 4 shows that 73% of USD that banks funded for their USD forwards was via short-term cross-border borrowing during the first three quarters of 2007.

Consequently, although Korean firms and banks hedged their FX mismatches, the country as a whole was left with a substantial FX *maturity* mismatch, which made the financial system vulnerable. Korea suffered severely from a USD funding liquidity crisis during the GFC, as its banks were not able to roll over short-term external debt. The average KRW CIP basis—a measure of FX funding liquidity—was -300bps between 2007 and 2009.[19] The KRW also depreciated rapidly and Korea nearly suffered a currency crisis.[20]

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

[18] Foreign bank branches typically used short-term USD borrowings from their parent banks while their purchased USD forwards were long-term. Domestic banks' maturity mismatches were not as severe as those of foreign bank branches (Ree et al., 2012).

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

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

2.2 Regulation: FXD Position Limit

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

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

Given that the banks' cross-border borrowing was closely linked to their FXD positions as discussed in subsection 2.1, the regulation seeks to induce banks to use more stable sources of funding and thereby lower the volatility of capital flows.

The FXD position is defined as the monthly average of the daily net aggregate delta-adjusted notional value of all FXD contracts a bank holds, including FX forwards, swaps, and options.[21] Since the net FXD position is aggregated across all currencies, banks' FXD positions in a currency pair that does not involve KRW (for example, a EUR-USD pair) have virtually no effect on the constraint. A bank's equity capital base is defined as the sum of Tier 1 capital (paid-in capital) and Tier 2 capital (including borrowing longer than a year from its parent bank) in all currencies. The exchange rate for converting a KRW-denominated capital base to USD is the average of the exchange rate used for the previous year's calculation and the previous year's average exchange rate.

The limit (1) is placed on each bank, namely the absolute value of FXD position of a bank must be below a certain specified level relative to its equity capital at the end of the previous month. At the imposition, the regulatory cap was 50% for domestic banks and 250% for foreign banks. This regulatory cap was adjusted over time; the regulation was tightened in 2011 and 2012 and loosened in 2016 and 2020. (See Table 1 for the full details.) For my empirical analysis, the last change in 2020 is not included. According to the regulator's statements, the main underlying factors that led to adjusting the limit were the banking sector's aggregate short-term external debt and the USD funding liquidity condition.[22]

[21] For non-USD FXDs, the notional values are converted to USD based on the day's exchange rate.
[22] See International Monetary Fund (2012) and Bruno and Shin (2014) for further details.

3 Data and Summary Statistics

3.1 Data Sources

I use three data sets for analysis: bank data, FXD contract data, and firm data. All data are publicly available. Bank FXD position data are hand-collected from bank financial statements.[23] The rest of bank financial data are downloaded from the Korean Financial Statistics Information System managed by Korea's financial regulator, the Financial Supervisory Service.[24] FXD contract data of all listed nonfinancial firms are hand-collected from firm financial statements published on the Korean Data Analysis, Retrieval and Transfer (DART) System.[25] DART is a repository of Korean corporate filings, from which disclosure filings of all Korean firms subject to external audit can be downloaded. The data source for firm-level financial data is TS2000, a commercial data aggregator managed by Korea Listed Companies Association. Market data, such as spot and forward exchange rates, as well as interest rates, are obtained from Bloomberg and Datastream. Macroeconomic data pertaining to Korea are sourced from the Korea Economic Statistics System, offered by the Bank of Korea.[26]

3.2 Bank Data

I focus on 46 banks that were operating as of December 2009, the last reporting period before the imposition of FXD position limits.[27] Among them, 29 are foreign banks and 17 are domestic banks. Banks' on-balance sheet FX positions (defined as foreign currency (FC) assets less FC liabilities), FXD positions, and FXD-position-to-capital (DPTC) ratios are observed on a monthly basis. Other financial variables of banks are observed quarterly. The sample period is from 2008 to 2018.

[23] The reports are aggregated and distributed by the Korea Federation of Banks.
[24] `http://efisis.fss.or.kr/fss/fsiview/indexw.html`
[25] `https://englishdart.fss.or.kr`
[26] `https://ecos.bok.or.kr`
[27] The list of full names of sample banks are in Table IA.C.1.

The size of the regulatory shock in aggregate was substantial. The constrained banks in aggregate needed to reduce their FXD position by about 15 billion USD, or approximately 40%.[28] The tightness of regulation differed across banks when it was introduced. To study the effect of the FXD position limit on banks, I exploit the cross-bank heterogeneity in the tightness of regulation. Figure 5 compares the histograms of the DPTC ratios of foreign banks before and after the first announcement of the regulation. It shows that 14 foreign banks had DPTC ratios above the regulatory cap, and all of them except one managed to reduce their DPTC ratios below the cap after the regulation. Figure 6 shows that two domestic banks with DPTC ratios above the regulatory cap reduced their DPTC ratios below the cap after the regulation. The heterogeneity in DPTC ratios is driven more strongly by its numerator, the FXD position.[29]

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

3.3 FXD Contract Data

All nonfinancial firms in Korea have been required to disclose the details of their existing financial derivatives contracts since 1999 (Ban and Kim, 2004). I hand-collected the details of FXD contracts for the years 2009 and 2010. I focus on 148 firms that used FXD in both 2009 and 2010.[30] Of these, 132 firms fully disclosed their counterparty information, while 16 firms disclosed only that of their main counterparty.[31] Although I am not able to include

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

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

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

[31] The top 10 firms' market share of FXD usage (sum of FXD assets and FXD liabilities) is 88%, yet none of them report the full list of counterparties. This is because the regulator allows firms to disclose at the

those 16 firms (with large FXD market shares) in the contract-level analysis, I include them in the firm-level analysis.

An FXD contract is defined as a firm-bank pair. I aggregate all contracts for a single firm-bank pair in case a bank had multiple contracts with the same bank in the same year. The net FXD position is computed by aggregating the delta-adjusted notional of individual FXD contracts for a firm-bank pair. A positive net FXD position indicates a long position in USD or in a USD equivalent amount for a non-USD foreign currency, such as the EUR. While the delta of forwards, futures, and swaps is 1, the delta of each option needs to be calculated. The regulatory enforcement authorities use the Black-Scholes model to calculate the delta of options. I take a simplified assumption that the delta of every option contract is 0.5. With this assumption, a long position in a call and a short position in a put would result in a delta of 1, which is consistent with the delta of forwards. This assumption is conservative. Using the Black-Scholes delta would only make the results stronger.[32]

To illustrate the calculation of net FXD position of a firm, suppose exporting firm A sold a USD forward with notional of \$100 and wrote a USD call option with notional of \$100 to bank B in the year 2009. In this case, the net FXD position of the firm-bank pair (A,B) in 2009 is $\$ -150$. The negative sign indicates that the firm would record a loss from its FXD trades with bank B if the USD appreciates.

The sample contains 251 contracts between 132 firms and 33 banks.[33] The contracts that do not involve KRW and the contracts without directional (buy or sell) information are excluded.[34] Roughly half of the contracts are firms taking long positions in foreign currency. In terms of pairs, the USD-KRW pair is the most common (86%). All contracts that involve KRW, but not USD, JPY, or EUR, are categorized as one group. Forwards are the most

aggregate level, as opposed to the contract level, if: (1) the number of contracts is excessively large, and (2) the payoff structure is simple enough such that profit and losses from the contracts would be predictable, given future movements in the exchange rate. When firms report at the aggregate level, they typically do not disclose the full list of counterparties.

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

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

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

common type of contract, composing 53% of all contracts in the sample.

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

3.4 Firm Data

The contract-level data are aggregated at the firm level. Table 4 provides summary statistics on firm-level data by exposure.[35] A firm is classified as "exposed" if its main FXD counterparty bank in terms of the FXD notional is constrained. 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 (or -10% of sales). This means on average, if the USD appreciates by one Won, firms make losses from their FXD positions equal to 8% of assets. This translates into a 20% net FXD–position–to–export–sales ratio, given the average export sales share of 47%.

While the differences in characteristics are statistically insignificant, an important caveat is that the sample size is relatively small, leading to relatively large standard errors. To address the concern of potential confounding by firm characteristics, I conduct a battery of robustness tests in section 6, including the coarsened exact matching of firms based on the key firm characteristics. Furthermore, I show that the correlations between the exposure and the key firm characteristics are low in Figure A.4, thereby mitigating the concern. In sections 5.2 and 6, I also test various alternative hypotheses related to the potential confounding effect of the GFC and demonstrate the robustness of my results.

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

To better understand firm hedging behavior, I categorize firms into net FXD buyers and net FXD sellers.[36] The net FXD buyers are firms with a positive net FXD position. These firms profit from their FXD trades when the USD appreciates. They are typically importers or firms with FC borrowings. They mostly use swaps that match the exact cash flows of their FC loans or the FC bonds they issued.[37] Their mean FC liability hedge ratio, defined as the amount of FXD bought divided by FC liabilities, is 0.6. The correlation between FC liabilities and net FXD position is strongly positive at 0.78. This indicates that FXD buyers use FXD to *hedge* their FC liabilities, because the appreciation of USD increases their FC liability burden, but having a long position in FXD can offset this burden.

The FXD sellers are firms with a negative net FXD position, typically exporters. They primarily use forwards to hedge their export sales. Their mean export–hedge ratio, defined as FXD sold divided by export sales, is 0.6.[38] The correlation between export sales and net FXD position is strongly negative at -0.95, which suggests that FXD sellers' primary purpose of holding FXD was also for *hedging* purposes. This is because the depreciation of USD reduces the value of USD-denominated export sales when converted to KRW, but having a short position in FXD can offset these losses.

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

[36] Appendix IA.G provides the list of firms.

[37] Firms may also use long positions in FXD to hedge imports. Although I do not observe firms' imports (because Korean firms were not required to disclose them), firms' long FXD positions were almost always exactly matched with the notional and the maturity of their FC debt, even when they had export sales and short FXD positions. This suggests that firms hedge gross positions rather than net positions, which is consistent with findings of Alfaro et al. (2021).

[38] The hedge ratio of FXD sellers does not provide much information about whether firms used FXD for hedging or speculating because unearned revenues are not captured in sales. To be specific, a manufacturing firm had an export hedge ratio of 9.95, which may look like its FXD position served a speculative purpose. However, the firm received export orders for the next ten years and its FXD position was for hedging future USD cash inflows. Since the orders flow into the unearned revenue account until products are delivered, they do not affect sales. This kind of case makes it difficult to identify whether firms were hedging or speculating by simply looking at the hedge ratio.

4 Empirical Methodology and Results

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

4.1 Impact of Regulations on Banks

This section studies the impact of the regulations on bank FXD positions and capital.[39] For ease of interpretation, I initially use a specification with a binary bank-level explanatory variable $Constrained_i$. Subsequently, I replace it with a continuous variable $Shock_i$ to further tighten the identification.

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

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

The outcome variable is either log of the absolute value of FXD holdings ($LogFXD$) or log of capital ($Log\ Capital$). $Constrained_i$ is a dummy variable that indicates whether the constraint was binding for bank i.[40]

[39] I analyze the impact of regulations on FC liabilities and FC loans in the robustness analyses in section 6.

[40] The variable $Constrained_i$ is based on the time when regulation was first introduced. This is because the first imposition of the regulation was the main shock and subsequent shocks were only adjustments in the intensity of the regulation. Banks impacted by the first shock responded to subsequent shocks as if they were constrained even after adjusting their DPTC ratio well below the limit.

$Regulation_t$ captures the time variation in the overall tightness of the regulation. $Regulation_t$ is defined as the minimum FXD capital requirement (an inverse of the regulatory cap on the DPTC ratio); it is 0 before the regulation's imposition and higher values indicate a tighter regulatory constraint. Because the minimum FXD capital requirement is different for foreign banks and domestic banks, for the full sample regression, 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. To account for the market share, I take the derivatives-position-weighted average. I collapse the bank-type- and time-specific *Regulation* to a time-series variable because the ratio of $Regulation_t^{DB}/Regulation_t^{FB}$ is a constant over time. In robustness analysis, I run the same analyses separately for foreign banks and domestic banks, and I show that the results are not driven by differences in characteristics or differential exposure to the GFC across foreign banks and domestic banks. I use official announcement dates rather than effective dates whenever the minimum FXD capital requirement is adjusted because banks may preemptively react to the regulation upon the announcements before the effective dates.[41]

I include monthly time fixed effects γ_t to control for any potential trends. For some specifications, I add bank fixed effects δ_i to control for differences in time-invariant factors among banks:

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

The sample period is from 2008 to 2018 and the frequency is monthly. I cluster standard errors by bank.

Figure 7 plots the aggregate FXD position, the normalized average FXD position by treatment, and $Regulation_t$. The top panel shows that following the imposition of the

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

regulation, the aggregate position declined and remained low. The middle panel shows that the constrained banks reduced their FXD positions after the imposition of regulation relative to unconstrained banks. In addition, as the regulation gets tighter, shown in the bottom panel, the gap between the FXD position of constrained banks and that of unconstrained banks gets wider in the middle panel.

Table 5 reports the regression results. The top panel results are based on the simple average minimum FXD capital requirement, $Regulation_t^{Avg}$. The main coefficient of interest is β_1; it is expected to have a negative sign for $LogFXD$ because constrained banks' FXD position relative to that of unconstrained banks is expected to decrease as the regulation gets tighter (reflected in a higher $Regulation_t$). The estimated β_1 coefficients in columns (1) and (2) show that the constrained bank FXD position is reduced by 60–62% more than that of unconstrained banks per unit increase in $Regulation_t$.[42] In contrast, columns (3) and (4) show that the estimated β_1 coefficients are small and insignificant when the outcome variable is $LogCapital$. These results are robust to using the weighted average minimum FXD capital requirement, $Regulation_t^{WAvg}$, as reported in the bottom panel of Table 5.

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

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

where Y_{it} is $LogFXD$ and $Post_t$ takes the value of 1 for the time period after the introduction of the regulation. In Figure 8, I plot the monthly coefficient λ_t over time. It shows that λ_t is not significantly different from 0 before the regulation but turns negative after the imposition of regulation and declines further as the regulation gets tighter. The middle panel of Figure 7, which plots the normalized average FXD position by treatment, also confirms that the trends were indeed parallel. It would be concerning if banks in the control group are indirectly affected by the regulation as firms substitute the banks in the treated

[42] $1 - \exp(-0.913)$

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.

To sharpen the identification, I use the following specification by replacing the binary variable $Constrained_i$ with a continuous variable, $Shock_i$.

$$Y_{it} = \beta_0 + \beta_1 Shock_i \times Regulation_t + \delta_i + \gamma_t + \varepsilon_{it} \tag{5}$$

where $Shock_i$ is the percentage of bank i's FXD position that was required to be reduced when the regulation was imposed. For some specifications, I control for the interaction between bank control variables and the $Regulation_t$ to ensure that the treatment is not confounded with the covariates. I find that the results remain robust based on this alternative specification (Table B.2).

In sum, the results from the bank-level analysis suggest that the constrained banks chose to reduce their FXD position instead of increasing their capital. This result aligns with the previous findings in the literature. For instance, Gropp et al. (2018) find that when European banks faced higher capital requirements, they increased capital ratios by reducing risk-weighted assets, not by raising equity.[43]

4.2 Transmission of Shock to Firms

The previous section establishes that the regulation caused a reduction in the FXD position of banks. However, it remains unclear whether the observed relative reduction in hedging by firms that traded with constrained banks is due to an increase in the hedging demand of firms trading with unconstrained banks, or a decrease in the hedging supply from constrained banks. To illustrate the identification challenge, suppose that exporters predominantly trade

[43]On the theory side, Admati et al. (2018) explain that highly leveraged banks avoid raising equity in response to capital requirements because equity holders will likely not be able to reap cash flows from their investment (debt overhang problem). Several studies, including Fraisse et al. (2020) document that bank capital requirements reduce lending and result in negative real effects. See also Aiyar et al. (2014), Hasan et al. (2021), and Schivardi et al. (2021) for related work.

FXD with constrained banks while non-exporters predominantly trade with unconstrained banks. If exporting opportunities were impaired during the GFC, the exporting firms that traded with constrained banks may have demanded less hedging than the firms that traded with unconstrained banks.

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

$$\Delta FXD_{i,j} = \alpha + \beta\; Constrained_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j} \tag{6}$$

The identification assumption is that the change in hedging demand is uncorrelated with the exogenous supply shock, conditional on observed characteristics. To strengthen the identification, I also control for industry-location-size fixed effects in some specifications.

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

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

Table 6 shows the results. Column (1) reports the result for exporter contracts. The scaled net FXD position of contracts dealt by constrained banks increased 5.3% after the shock compared with contracts with unconstrained banks. Given that the pre-shock average scaled net FXD position of exporter contracts was −8%, the change translates into a 66% *reduction* in hedging.[44] Column (2) adds firm controls, bank controls, and contract controls. It shows that the relative reduction in hedging was 47%, which is economically significant. These results indicate that the regulation caused a reduction in the *supply* of hedging instruments for exporters.

Columns (3) and (4) of Table 6 show that the regulatory shock did not strongly affect non-exporter hedging, suggesting a highly inelastic demand for hedging among non-exporters. This aligns with importers' historically weak demand for hedging, both before and after regulatory changes, due to several factors. The central bank of Korea has significantly

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

accumulated its FX reserves since the Asian crisis from 20 billion USD in 1997 to over 250 billion USD in 2007 (refer to Figure IA.A.4), which diminishes importers' incentives for hedging, as they anticipate KRW depreciation mitigation through the reserves (see Acharya and Krishnamurthy (2019)). Additionally, the energy sector, a core component of Korea's imports, has sufficient market power to adjust prices in response to adverse exchange rate movements (Kim, 2010).

Another important group among non-exporters comprises FC borrowers. A plausible explanation for their inelastic hedging demand is that their ability to hedge is most likely not the primary determinant for banks' extending more *hedged* FC loans.[45] In other words, even if the FC borrowers seek to expand their FC loans by hedging more, banks may refrain from extending more loans due to various considerations, including the expected loan performance unrelated to exchange rate risk exposure. In summary, the non-exporters in my setting have notably inelastic demand for hedging relative to exporters.

I report the full sample results in columns (5) and (6) for completeness. In terms of magnitude, firms on average reduced their FXD hedging with constrained banks 45%, compared with their hedging with unconstrained banks.[46]

Since the bank-specific tightness of regulation ($Shock_i$) is observed, I also use the following specification by replacing binary variable $Constrained_i$ in specification (6) with continuous variable, $Shock_i$:

$$\Delta FXD_{i,j} = \beta + \beta_{Shock} Shock_i + FirmControls_j + BankControls_i + ContractControls_{i,j} + \varepsilon_{i,j} \tag{7}$$

$Shock_i$ is the percentage of bank i's FXD position that was required to be reduced when the regulation was imposed.[47] Table B.3 presents consistent results. Columns (1) and (2)

[45]When borrowers are *unhedged*, the exchange rate risk of the FC loan borrowers can translate into credit risk for banks as Niepmann and Schmidt-Eisenlohr (2022) document. However, FC borrowers in my sample are almost perfectly hedged, and therefore banks' decision to extend more *hedged* FC loans is unlikely to be primarily driven by the borrower's ability to hedge more FC loans.

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

[47]Bank-specific shocks are presented in Table IA.D.1.

show that the impact on exporter contracts remains large and significant. Column (2) shows that a one-standard-deviation increase in *Shock* leads to a 2% increase in scaled net FXD position (corresponding to a 28% reduction in hedging) for exporter contracts.[48] Columns (3) and (4) show that non-exporter contracts were not strongly affected.

I note that net option positions increased 8.6% relative to forwards in column (2) of Table 6. As the firm pre-shock net option position was negative, an increase in net position means a reduction in the use of options. This may be related to the fact that some firms' exotic option positions incurred huge losses during the GFC. To test whether option contracts are driving the main results, I use the same specifications without the option contracts and find that the results remain consistent (see Table B.4 and Table B.5). These results, which do not incorporate option contracts, also indicate the robustness of the analyses to the simplified assumption that the delta of options is 0.5.

All results are robust to replacing the dependent variable, assets-scaled FXD position, with sales-scaled FXD position (see Appendix IA.H).

Industry-Location-Size Fixed Effects

While I include a large number of bank, firm, and contract characteristics as well as industry fixed effects, one may be concerned that the results are confounded by unobservable demand-related characteristics. Since half of the sample firms have single bank relationships, I do my best to address this concern by controlling for firms' industry–location–size fixed effects, following Degryse et al. (2019) and others. This allows identifying time-varying cross-sectional bank FXD supply shocks for both single- and multi-bank firms. I do not control for time fixed effects because the dependent variable has already been differenced. Table B.6 shows that the results are robust after controlling for the industry–location–size fixed effects for both the full sample and the sub-sample excluding the option contracts.

In summary, the results from the contract-level analysis suggest that the regulation caused

[48] The standard deviation of *Shock* is 17.5%.

a reduction in the *supply* of hedging, and the effect was particularly large for the exporter contracts.

4.3 Impact on Real Outcomes of Firms

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

4.3.1 Firm-level Reduction in Hedging

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

$$\Delta Y_j = \beta_E \, Exposed_j + FirmControls + \varepsilon_j \tag{8}$$

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

First, I report the effects on firm-level FXD positions by firm size. Table 7 presents the results for the full sample. Columns (1) and (2) show that the net FXD position of exposed firms rose 43–47% relative to non-exposed firms, given that the pre-shock average scaled FXD position was −8.2%.[49] Columns (3)–(6) show that the effects are large for small firms,

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

but small and insignificant for large firms. These findings imply that firms were unable to offset the regulatory shock transmitted by banks, and smaller firms, in particular, had difficulty finding an alternative source of FXD hedging. This evidence aligns with previous studies in the credit market (e.g., Khwaja and Mian, 2008).

Second, I report the effects on firm-level FXD positions by the sign of net FXD positions of firms. In the regulatory context, what matters for constrained banks, and consequently, for exposed firms, is the sign of FXD positions rather than their exporting status. I define firms with negative net FXD positions as exporters and those with positive FXD positions as non-exporters.[50] Table 8 reports the full sample results. Columns (1) and (2) show that exposed exporters reduced firm-level FXD hedging 40–45% relative to non-exposed firms, given that the pre-shock average scaled FXD position for exporters was -16%.[51] In contrast, columns (3) and (4) show that there was almost no effect on non-exporters.

To refine the identification, for the subsample of 132 firms that disclosed complete lists of their counterparties and notional amounts for each counterparty, I construct a continuous variable that measures firm exposure to the regulation. I use the following specification by replacing binary variable $Exposed_j$ in specification (8) with the continuous variable $Exposure_j$:

$$\Delta Y_j = \beta_{\overline{E}}\, Exposure_j + FirmControls + \varepsilon_j \tag{9}$$

where $Exposure_j$ is the notional weighted average shock of firm j's counterparty banks.[52] Under this specification, I find that small firms and exporters, with higher levels of exposure, experienced a greater reduction in total hedging (Table B.7 and Table B.8).

Overall, these results suggest that switching bank relationships in the FXD market is

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

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

[52] I focus on contracts that existed in both years for consistency with the contract-level analyses in section 4.2. I confirm that my results remain nearly identical (in terms of both magnitude and significance of coefficients) when I compute *Exposure* based on all contracts, as *Exposure* measures based on the two approaches are highly correlated (0.97).

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

The firm-level reduction in hedging naturally raises the question: what alternative hedging tools can firms use? First, firms may enter FXD contracts with an offshore bank. However, I find that almost none of the firms that fully disclosed their counterparty banks switched to deal with an offshore entity. This is likely related to the reasons why firms were not able to substitute constrained banks with unconstrained banks within Korea, namely, a high degree of FXD product customization and bundling of FXD products with loan products. Another plausible explanation is the cost for foreign institutions to acquire information about Korean firms. It can be costly for a foreign entity to perform due diligence on Korean firms, especially smaller firms, to assess the credit risks associated with the FXD contracts. My finding that the firm-level hedging of small firms was affected much more than that of large firms is consistent with this explanation. Furthermore, covering KRW-involving-FXD position entails investment in KRW-denominated bonds, which imposes administrative costs on an offshore bank.[53]

Second, firms may use other financial instruments. For instance, exporters may borrow USD and invest in KRW-denominated bonds to replicate the cash flows of a short position in USD forwards. I am not able to directly test the hypothesis because detailed data on firm FC borrowing and security holdings are not available. Yet, it is unlikely, given my finding

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

that the exposed firms did not even substitute their forwards with futures. It suggests that firms tend to prefer dealing FXD with banks to dealing directly in the market, likely due to their limited knowledge and capacity regarding FXD trading.

Third, firms may adjust their risk exposure using nonfinancial instruments, such as operational hedging. While data limitations prevent me from testing this directly, previous studies (e.g. Allayannis et al., 2001) suggest that operational hedging is not an effective substitute for financial risk management. For example, switching invoice currency to KRW or building plants in foreign countries to match income currency and cost currency is unlikely to be a low-cost alternative means of financial hedging.

4.3.2 Impact on Firm Exports: Theoretical Framework

Having documented the negative impact of the regulatory shock on firm-level hedging, I now examine its impact on firm exports. To offer theoretical foundations for empirical tests, I provide a simple conceptual framework of exporter hedging. The primary objective is to illustrate how firms adjust their exports when hedging becomes more costly. The intuitive discussion in this section is based on a model and a numerical example presented in Appendix C.

The underpinning mechanism is that unhedgeable exchange rate fluctuations can raise exporting costs by increasing cash flow volatility. Froot et al. (1993) and Rampini and Viswanathan (2010) posit that firms hedge their risk exposure to avoid falling short on funds available for future investment. Building upon this insight, suppose that firms' export outcomes determine the size of internal funds available for future investment opportunities, and that they are exposed to exchange rate risk. If internal funds fall short, firms would have to rely on external financing with convex costs. Then, they would face higher expected external financing costs when the volatility of the internal funds is higher. Therefore, they have incentives to lower the volatility of internal funds either by using hedging instruments or avoiding exposure through lowering export quantity. When hedging becomes more costly, it is optimal for firms to reduce export quantity to reduce the volatility of internal funds.

The mechanism suggests that hedging increases as the external financing cost rises, as presented in Figure C.5. A lá Froot et al. (1993), the convexity of the external financing cost induces risk-averse behaviors of risk-neutral firms. In other words, the hedge ratio captures the extent of external financing friction.

Moreover, as hedging becomes more costly, the marginal cost of additional exports gets more expensive for firms with higher external financing frictions. Therefore, firms with high hedge ratios are expected to reduce exports by more than firms with low hedge ratios when hedging becomes more expensive (as displayed in Figure C.6). I test this in section 4.3.3.

A feature of this mechanism is that the exporters' domestic sales are expected to be unaffected by the aggravation of hedging friction as domestic sales are not exposed to FX risk. It is also worth noting that in this mechanism, exporters that were heavily relying on FXD hedging can reduce their exports within a short time (e.g., six months) after the shock. This is because, in this setting, the reduction in exports is a risk-management strategy rather than an outcome of hedging failure, which would likely take longer to materialize. I test these implications in sections 4.3.3 and 4.3.4 respectively.

4.3.3 Impact on Firm Exports: Empirical Results

Based on the theoretical framework, I hypothesize that the impact of a decline in hedging supply on exports would be larger for firms with higher export hedge ratios. Provided that the reduction in bank hedging supply primarily affected exporters (net FXD sellers) in section 4.3.1, I confine the sample to exporters and examine the effect of the shock on their exports. I use the following specification to estimate the impact on exports:

$$\Delta Y_j = \beta_E\ Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls + \varepsilon_j \tag{10}$$

The outcome variable is a change in log export sales. $Exposure_j$ is the weighted average shock of firm j's counterparty banks. $HighHedge_j$ is an indicator variable that takes the value 1 if firm j sold FXD equaling more than 10% of its export sales and is 0 otherwise. With this definition, about two thirds of FXD-selling firms that fully disclosed their counterparties are classified as high-hedge firms ($HighHedge = 1$). The results are robust to the choice of threshold, 10%. I show that the results are even stronger if I use a continuous variable: the hedge ratio itself. Still, I use the dummy variable to ensure that the results are not driven by outliers.[54] The firm controls are the same as those in the previous regressions. It is worth noting that the exchange rate is common for all firms. All exporters are better off when the USD appreciates and the analysis focuses on exporters only. Therefore, the exchange rate is not a confounding factor, as long as export sales sensitivity to the exchange rate has been controlled for. I control for the heterogeneous export sensitivity to the exchange rate by including pre-shock FX derivatives position.

Table 9 presents the results. The top panel specification uses the dummy variable, *HighHedge*, and the bottom panel specification uses the continuous variable, *Export Hedge Ratio*, which is defined as the amount of FXD sold divided by export sales. The impact of the regulatory shock on exports is substantial. Column (1) shows that for a one-standard-deviation increase in *Exposure*, firm exports fall 15% for high-hedge firms and rise 5% for low-hedge firms. Therefore the differential effect is 20%. Between 2009 and 2010, the USD appreciated against KRW, and even with this favorable exchange rate movement for exporters, my results show that the exports fell for the firms that were more exposed to the regulatory shock and that relied more on FXD before the regulation. Column (2) adds firm controls and the differential result is largely unchanged; the differential effect is 16.5%. The bottom panel shows that the results are robust to replacing *HighHedge* variable with

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

$ExportHedgeRatio$.[55,56]

While my research design does not allow for deducing an aggregate effect of hedging supply on exports, I provide a back-of-the-envelope estimate of an aggregate effect. Assuming that the differential effect of -16.5% is borne on the high-hedge firms and the low-hedge firms are considered counterfactual firms, by multiplying -16.5% by the ratio of high-hedge firm's exports to Korea's total exports (5%), the aggregate effect on Korea's total exports is -0.8% per one standard deviation firm-level regulatory shock. Because one standard deviation regulatory shock corresponds to a 10% decline in the bank's FXD position (if the firm had a single-banking relationship) while the mean regulatory shock is 8%, a counterfactual statement would be that: Korea's total exports would have been 0.64%[57] higher without the regulation. Under a more severe scenario in which the regulatory shock had corresponded to a two-standard deviation, Korea's total exports would experience a decline of 1.6%.[58] Given that approximately 40% of Korea's GDP comes from exports, this is economically significant.

The assumption that the low-hedge group can be considered a counterfactual group is plausible given that overall exports in Korea increased substantially during the period. It seems more likely that the increase in exports experienced by low-hedge firms was on the back of the rising trend in exports in general rather than the regulation having a favorable impact.

It is worth noting that the suggested aggregate effect indicates that shocks to the supply of hedging can have economically important effects even though a relatively small fraction of firms use financial hedging. In line with Rampini et al. (2014), which underscore the limited engagement of firms in financial hedging, the most impacted entities represent only 5% of

[55] I winsorize the top 2% and bottom 2% of the $ExportHedgeRatio$ to ensure that the results are not driven by outliers.

[56] Additionally, I find some evidence that the regulatory shock negatively affects exporter profitability, albeit the results are not statistically significant for some specifications. See tables B.9, B.10, and B.11 for the impact on gross profit margin. To assess the robustness of these results, refer to tables IA.I.1, IA.I.2, and IA.I.3, which examine the impact of regulation on earnings before interest and taxes (EBIT) scaled by assets.

[57] $0.8\% \times 8/10$

[58] $0.8\% \times 2$

total exports in my empirical setting. Nonetheless, shocks to the supply of hedging can lead to significant economic outcomes, because firms that do hedge are very sensitive to hedging costs.

Additionally, I test whether the firms with high export hedge ratios reduce their firm-level FXD hedging given that they are more exposed to the regulatory shock. Table 10 shows that the change in the net FXD position for high-hedge firms was indeed large. The net FXD position moved up 5–6% more for high-hedge firms than for low-hedge firms, for a one-standard-deviation increase in $Exposure$. These translate into 40–50% reduction in hedging, given the pre-shock average net FXD position of -12% among fully disclosed exporters.[59]

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

4.3.4 Cross-sectional Effect of Internal Funds

In this section, I examine the cross-sectional effect of internal funds to rule out an alternative explanation that the decline in exports is an outcome of the realized risk of unhedged exposure following a failure in risk management. When firms fail to hedge, they are forced to cut their investment due to FX losses, which in turn leads to a decline in their output. Under this channel, high-cash firms are expected to reduce their exports by less than low-cash firms because their cash reserves can weather the losses from failed risk management and allow them to maintain their output.

I test this alternative explanation by investigating the cross-sectional effect of cash hold-

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

ings on the decline in exports by using the following specification:

$$\Delta Y_j = \beta_E \; Exposure_j + \beta_h HighHedge_j + \beta_c Cash_j$$
$$+ \beta_{Eh} Exposure_j \times HighHedge_j + \beta_{Ec} Exposure_j \times Cash_j + \beta_{hc} HighHedge_j \times Cash_j$$
$$+ \beta_{Ehc} Exposure_j \times HighHedge_j \times Cash_j + FirmControls + \varepsilon_j \tag{11}$$

where $Cash_j$ is cash and cash equivalent balance scaled by total assets before the regulation. Column (1) of Table 12 shows that β_{Ehc} is negative, which implies that firms with higher cash and a high hedge ratio (before shock) reduced export sales by *more*. Furthermore, column (2) shows that those firms switched to the domestic market to a greater extent. These findings are inconsistent with the alternative explanation.

The speculation channel also fails to explain these results. If firms were using FXD for speculation purposes and the reduction in exports was driven by a decline in gains from the reduced speculative positions in FXD, high-cash firms are expected to reduce their exports by less than low-cash firms.

On the contrary, my mechanism can explain this result. The intuition is as follows: when hedging becomes more costly, high-cash firms may reduce exports by more than low-cash firms would because high-cash firms can ensure, through hedging, that they always have enough internal funds, even in a state with an unfavorable exchange rate. Therefore, they would reduce exports rather than maintain unhedged exports and risk a shortfall of internal funds. In contrast, low-cash firms may be willing to be exposed to FX risk rather than foregoing exports because they would never have enough internal funds without taking some risk. In other words, they may prefer to take FX risk and earn the risk premium so that they have enough internal funds at least in a state with a favorable exchange rate.[60] Built on the numerical example, Figure C.8 shows that an increase in hedging friction can lead to

[60]Risk aversion increasing in internal funds depends on the specific parametrization of the model. In Appendix C, I provide a set of parameters where this holds, and can therefore explain the finding. I also discuss when this does not hold and provide intuition. The key takeaway of this section is that my model can explain both directions, whereas the alternative explanation is clearly rejected.

a relatively greater decline in exports for high-cash firms compared to low-cash firms. (See Figure C.9 and Table C.3 as well.)

5 Other Potential Explanations

In this section, I investigate other potential explanations for the decline in exports. I begin by addressing the concern that the results might be driven by firms' speculative behavior rather than hedging activities. Then, I examine a potentially complementary channel, the credit channel. Lastly, I discuss the presence of potential reputation risk.

5.1 Speculation

One may question whether the documented reduction in exports is due to firms' speculation instead of hedging. Specifically, it might be that the firms having contracts with banks exposed to the regulation were speculating that USD would depreciate, causing a reduction in exports, and their FXD position was forced to decrease due to the supply reduction. In this case, had firms been speculating on both exports and FXD, a positive correlation between exports and the FXD before the shock would be expected. However, I find that the pre-shock correlation was in fact strongly negative (-0.95). Furthermore, the net FXD positions of the exporters were short positions (paying off when the USD depreciates), while export sales invoiced in USD are better off when the USD appreciates. Therefore, it is unlikely that exporters were holding derivatives for speculation.

In addition, I document the following evidence corroborating the hedging channel:[61]

1. Exporters in Korea face substantial FX risk due to the majority of trades being invoiced in USD, which is compounded by the highly volatile USD-KRW exchange rate shown

[61] This is consistent with Allayannis and Ofek (2001) finding that firms use currency derivatives for hedging and their use significantly reduces exchange rate exposures firms face, and Bartram (2019) finding no evidence of corporate speculation with derivatives for firms, except for some firms using commodity price derivatives.

in Figure 1. During the Asian crisis, the annual volatility reached almost 120%, and during the GFC and COVID, it reached 70% and 20%, respectively.

2. In a simple decomposition exercise based on my sample exporters before the shock, I find that 85% of the variance of sales revenue is due to the variance of export sales (58%) and the covariance of export sales and domestic sales (27%). That is, exporters' total variance of sales is 6.7 times the variance of domestic sales.[62]

3. Exporters' profits are leveraged position on the exchange rate. To show this, I present a numerical example.

	Case	Export Sales (USD million)	Exchange Rate	Export Sales (KRW billion)	Domestic Sales (KRW billion)	COGS (KRW billion)	Profit (KRW billion)
A	Base level (Export Share 83%, Profit Margin 24%)	$10,440	1,165	12,163	932	11,956	1,139
	After a 1% depreciation of USD	$10,440	1,153	12,041	932	11,956	1,018
							-10.68%
B	Base level (Export Share 56%, Profit Margin 25%)	$10,440	1,165	12,163	9,402	16,174	5,391
	After a 1% depreciation of USD	$10,440	1,153	12,041	9,402	16,174	5,270
							-2.26%
C	Base level (Export Share 56%, Profit Margin 20%)	$10,440	1,165	12,163	9,402	17,252	4,313
	After a 1% depreciation of USD	$10,440	1,153	12,041	9,402	17,252	4,191
							-2.82%

Exhibit 1: Stylized Example of the Impact of Exchange Rate on Profit

In Exhibit 1, the base export sales in USD are the same across three cases, but the export share and the profit margin differ. Case A is based on the balance sheet data of Samsung Heavy, one of the top exporters, as of 2009. It shows that a 1% of depreciation of USD is associated with a 10.7% decline in its profit. The leverage effect is greater if the export share is higher and the profit margin is lower. Case B takes the average export share of the sample firms, and case C takes the average export share and the average profit margin of the sample firms. Combined with the fact that the bottom 1 percentile daily return on the USD-KRW exchange rate was -2.1% for the pre-shock period, from 1990 to 2009, the exchange rate risk was indeed substantial for the exporters. A back-of-envelope calculation suggests that in a tail event, the profit

[62] Based on the fully disclosed sample of 74 firms before the shock, exporters' total variance of sales is 5 times the variance of domestic sales.

falls by 22.4%, 4.7%, and 5.9% *per day* for cases A, B, and C, respectively. This implies that firms can have staggering losses due to exchange rate risk.

Given these risks, it is even more unlikely that exporters would speculate in a way that increases their exposure.

5.2 Credit Channel

My results so far suggest that regulation reduced the supply of FXD, and the reduced availability of hedging, in turn, resulted in a decline in exports. However, there could be other potential explanations involving the credit channel. One alternative hypothesis is that constrained banks were in trouble during the global financial crisis (GFC) and therefore were more likely to suffer from the global credit supply shock. Another related alternative hypothesis is that the regulation acted as a shock to the banks' overall credit supply rather than a shock specific to the FXD supply. I test these credit channel hypotheses in this section.

Impact on Overall Borrowing Quantity and Cost Under the credit channel hypotheses, higher exposure to the regulation would result in a more substantial decline in borrowing. To test this, I regress the change in borrowing on exposure, controlling for the same set of control variables used throughout the analyses. In columns (1) and (2) of Table B.14 the effect of regulatory shock on borrowing quantity is insignificant and positive, rejecting both alternative hypotheses. In columns (3) and (4), its effect on borrowing costs is also insignificant and negative. These results help rule out potential confounding of the credit channel.

The insignificance of the regulation's impact on firm borrowing is likely related to the regulation being specifically designed to target the banks' FXD business. That is, banks can meet the regulatory requirement by adjusting their FXD position (or equity) without altering their lending operations. Therefore, the regulation constitutes a shock to the bank's FXD business, rather than a shock to its overall liquidity which has been extensively analyzed in prior literature (e.g. Khwaja and Mian, 2008).

Impact on Borrowing: High-Hedge vs. Low-Hedge Firms To further investigate whether my main results on exports are driven by the credit channel, I analyze the impact of regulation on firm borrowing quantity and cost using the same specification as (10), replacing only the outcome variable.

By replacing the outcome variable with firm borrowings scaled by assets:

$$\Delta FirmBorrowing_j = \beta_E\, Exposure_j + \beta_h HighHedge_j + \beta_{Eh} Exposure_j \times HighHedge_j + FirmControls + \varepsilon_j$$

I find that the coefficients on the interaction terms are insignificant in Table B.15. While the negative sign suggests that high-hedging firms' borrowing fell more than low-hedging firms', the overall effect of exposure on borrowing is small and positive. Moreover, even though the negative sign on the interaction term might suggest the potential presence of the credit channel for high-hedging firms, my findings collectively indicate a more prominent role for the hedging channel. Specifically, (1) exposed firms did not experience a significant decline in borrowing, (2) their hedging and export decreased, and (3) their domestic sales remained unaffected, suggesting that the hedging channel plays a more central role.

To further corroborate the importance of the hedging channel relative to the credit channel, I perform a two-step regression analysis. I first regress the change in log exports on the change in log borrowings, followed by a second-step regression of the residual from the first step on the same independent variables specified in equation (10). The results in Table B.16 indicate that, even after orthogonalizing the effect of changes in borrowing, the coefficients on the interaction terms are consistently negative and significant, with magnitudes remaining similar to those presented in Table 9.[63]

[63] One may instead consider employing the same specification as (10) while controlling for the changes in log borrowing. Table IA.J.1 shows that the results are almost identical; the negative and significant effects on exports persist.

To examine the impact of regulation on firms' borrowing costs, I use the same specification as (10), replacing only the outcome variable:

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

where the outcome variable is the change in interest expenses scaled by assets. The results in Table B.17 show that the coefficients on the interaction terms are both economically and statistically insignificant.[64]

The insignificant change in firm borrowing quantity and cost is consistent with my theoretical framework. In the absence of the credit channel, there are two counteracting forces on borrowing. On one hand, firm borrowing may decrease alongside a reduction in exports, as firms rely on external financing to support export-related working capital needs, as suggested by previous studies (e.g., Amiti and Weinstein, 2011; Paravisini et al., 2014). On the other hand, as an increase in hedging cost leads firms to reduce their hedging and exports, firms are left with lower cash flows to finance long-term investments (that may not necessarily be related to exports). Consequently, firms' demand for external financing is expected to increase, as implied by my theoretical framework.[65] In principle, these two effects could offset each other, resulting in no significant impact on firms' bank borrowing.

In summary, the results in this subsection, combined with the findings that exposed firms' hedging and exports decreased yet their domestic sales remained unaffected, collectively indicate that the hedging channel is playing a central role.

[64] To ensure robustness, I repeat the same tests examining the impact of regulation on firm borrowing quantity and cost using the larger sample of 92 exporters. The results, presented in Table IA.J.2 remain consistent.

[65] While the numerical example indicates a positive effect of the double interaction of hedging friction, h, and external financing friction, k, on borrowing (see Figure C.7), it is worth noting that the magnitude of the interaction can vary widely. When h is high and k is low, the double derivative, $\partial^2 Borrowing/\partial h \partial k$, can be small. This implies that the magnitude of the coefficient on the interaction in the regression can be insignificant, even if there is no decrease in borrowing due to a decline in exports (which is the former force described above).

5.3 Other Considerations

A relevant question regarding my finding of the decline in exports is whether it is optimal for firms to reduce exports in the presence of potential reputation risk. Since any presence of reputation risk only suggests higher importance of hedging, it does not pose a threat to the identification. Moreover, reducing exports does not necessarily entail reputation risk. While it may be difficult for firms to alter the contracts that have already been made, they can still choose to downsize new export contracts going forward. Then, export sales can fall without the non-fulfillment of existing contracts. Furthermore, reputation concern is likely not the primary force driving export decisions, because some firms appeared to be willing to sacrifice their reputation for profits.[66] The fact that the most affected firms were small manufacturers, not large firms with established brand names, also makes it plausible that the cost related to reputation is lower than the benefit of reducing exports.

6 Robustness Results

To ensure that my results reflect the impact of the regulatory shock and not confounding factors, I conduct several additional robustness tests.

First, one potential concern is the confounding effect of non-random sorting of firm-bank relationships. However, Table 4 shows that key firm characteristics are not statistically significantly different across exposed firms and non-exposed firms.[67] This holds for the subset of firms that fully disclose their counterparty information as well as the subset of firms with net negative FXD positions.[68] Moreover, Figure A.4 shows low correlations between firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure

[66] As a supporting piece of evidence, based on a leading newspaper article, car manufacturers substantially *increased* export shares in the time of USD *appreciation* in 2022, letting the delivery of products delayed for domestic customers up two and half years. This is not a likely outcome when adjusting the exports is detrimental to the firm reputation. (`https://www.hankyung.com/economy/article/2022100609681`)

[67] An important caveat is that the sample size is relatively small, which leads to relatively large standard errors.

[68] See Table IA.F.2 – Table IA.F.5.

to the regulatory shock, mitigating the endogeneity concern. Nevertheless, I control for a large number of bank, firm, and contract characteristics to ensure that the results are not confounded by the differences in these characteristics throughout my analyses.

To corroborate that the results are not confounded by potentially systemic firm-bank relationships, I conduct an analysis using coarsened exact matching (CEM) (see Blackwell et al., 2009) based on FC liability share, the dimension along which the exposed and non-exposed firms differ with statistical significance. I coarsen the sample into five bins, considering the trade-off between keeping observations and the post-match similarity of FC liability share for the treatment and control groups. The top panel of Table B.12 shows that the results remain similar. The interaction term is negative and significant for change in log exports, positive and significant for change in the net FXD position (scaled by assets), and small and insignificant for change in log domestic sales. The bottom panel of Table B.12 shows that the results are robust even after matching firms on export share, profitability, and FC liability share.[69] I include export share as a matching variable to address an alternative hypothesis that exporters predominantly traded with foreign banks, which represent the majority of constrained banks. I also include profitability as a matching variable to address an alternative hypothesis that troubled firms predominantly traded with constrained banks.

Second, one may be concerned about the difference in business models between foreign and domestic banks. Almost by construction, it is likely that foreign banks would suffer more from the regulation because they were more active in the FXD business than domestic banks. In fact, a few foreign banks closed in 2017, after the regulation was imposed.[70] However, it is noteworthy that only half (14 out of 29) the foreign banks in my sample were constrained when the regulation was imposed, and I find stronger results in the bank-level analysis when I restrict my sample to foreign banks (Table B.13a).[71] This finding suggests that my results

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

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

[71]The bottom table of Table B.13 suggests that constrained domestic banks reduced their capital bases compared with unconstrained domestic banks. This result is driven by domestic banks with smaller FXD market shares. When the observations are weighted by bank FXD positions, domestic banks' adjustments in *LogCapital* are not significant.

are not driven by the differences in characteristics between foreign and domestic banks. In addition, the strong result within foreign banks suggests that my bank-level results are unlikely to be mainly driven by the GFC, which cannot explain the variation within foreign banks.

Third, concerns may arise about potential confounding by a credit supply shock. However, my analyses in subsection 5.2 show that the impacts of regulation on both the quantity and cost of borrowing at the firm level are insignificant. This contradicts an alternative hypothesis suggesting that constrained banks were in trouble during the GFC and therefore were more likely to suffer from the global credit supply shock. Additionally, I examine the impact of regulation on banks' FC lending to test whether constrained banks, which relied more on USD funding from their US-based parent banks before the regulation, reduced the supply of FC lending compared to unconstrained banks. I focus on the foreign currency share of bank lending because USD funding from US-based parent banks can be used for both providing FXD and FC loans to firms. The results indicate that the change in the share of FC lending of constrained banks was not significant for the full sample (Table B.18), foreign banks (Table B.19), and domestic banks (Table B.20), corroborating that my empirical results are not driven by the GFC through the FC credit channel. This is likely because banks used the USD funding obtained from abroad primarily for providing FXD rather than FC loans to firms.

Fourth, one may be concerned that holding a high cash balance is a substitute for hedging and the main result is driven by cash balance rather than hedging. However, when the high hedge dummy variable is replaced with the high cash dummy variable in specification (10), the coefficient on the interaction term is not significant (Table B.21). This is consistent with the mechanism that high cash firms have an incentive to hedge to ensure that they have enough cash even in a state with an unfavorable exchange rate. That cash alone fails to explain the decline in exports supports the hedging channel.

Lastly, I document additional suggestive evidence that the reduction in the FXD position was driven by a reduction in supply as opposed to a reduction in demand, by looking at the FXD pricing. If the reduction in the FXD position was driven by a reduction in supply, one would expect to see an increase in the price of FXD hedging. An increase in FXD hedging cost from the perspective of exporters corresponds to a decrease in USD forward prices since exporters are *sellers* of USD forwards. Put differently, constrained banks would lower forward prices to reduce their long positions. Since I do not observe firm-specific pricing on derivatives, I am not able to directly show that constrained banks lowered USD forward prices relative to unconstrained banks. Nevertheless, I show suggestive evidence that firms' forwards hedging costs increased after the regulation by comparing short-term and long-term CIP deviations. I define CIP deviation for maturity n at time t, $x_{t,t+n}$, as the difference between the USD rate ($y^{\$}_{t,t+n}$) and the USD rate implied by forward price ($f_{t,t+n}$), spot exchange rate (s_t),[72] and KRW rate ($y^{₩}_{t,t+n}$):

$$x_{t,t+n} = y^{\$}_{t,t+n} - \left(y^{₩}_{t,t+n} - \frac{1}{n}(f_{t,t+n} - s_t) \right) \tag{12}$$

CIP deviation, $x_{t,t+n}$, would likely fall or, equivalently, increase in magnitude as banks lower forward prices to reduce their long positions. Since forward positions are subject to the FXD position limit while synthetic forward positions are not, the shadow cost of the constraint would widen the wedge between the price of forwards and the price of synthetic forwards. In the cross-section of tenors of CIP, the regulation would likely affect long-term CIP deviation more than the short-term because bank long positions in USD forwards are concentrated in longer tenors. Figure A.5 plots three-month and three-year CIP deviations. It shows that the three-year CIP deviation fell relative to the three-month CIP deviation, particularly after the first two announcements.

While the empirical results presented in this study remain robust to a series of placebo and sensitivity tests addressing various endogeneity concerns, there is an important caveat to note. The firm-level analyses are based on a relatively small sample size, leading to relatively

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

large standard errors. One should therefore take caution in interpreting the results, in that there are some differences in characteristics between exposed and non-exposed firms, despite the statistical insignificance of the differences.[73]

7 Conclusion

In this paper, I examine how shocks to financial intermediaries affect the supply of hedging instruments to corporations and, in turn, whether such shocks impact real economic activities. I exploit a quasi-natural experiment in South Korea at the bank level that can be traced through firms. By using cross-bank variation in the regulation's tightness, I show that the regulation caused a reduction in the supply of FXD, resulting in a substantial decline in exports among small firms that heavily relied on hedging using FXD.

The results of this study highlight the crucial role that intermediaries play in risk allocation through the provision of derivatives, by finding evidence that intermediary frictions in FX markets can affect international trade. Additionally, this study establishes a causal relationship between financial hedging and the real economic activities of firms, implying that derivatives are crucial for firms' risk management. Furthermore, my findings suggest that macroprudential FX regulations aimed at discouraging risk-taking among financial intermediaries may have adverse effects on the real economy. These effects should be carefully considered in developing future policy that integrates financial, macroprudential, and trade toolkits, as suggested recently by the IMF (Basu et al., 2020).

Looking beyond this paper, there are multiple promising research directions to pursue. First, I anticipate that the literature on hedging will expand to provide verifiable insights into international trade and FX hedging. A fruitful avenue would be to consider factors such as firms' choices regarding currency invoicing, production and sales locations, and

[73] To alleviate this concern, I conduct analyses using coarsened exact matching of firms based on the key characteristics that might serve as confounding variables in Table B.12, and I find that the results remain significant. Additionally, it is worth noting that Table IA.F.5 shows that the differences between exposed and non-exposed firms are more modest in the subsample (of exporting firms that fully disclosed their counterparty banks) used for the main results.

endogenous exchange rates. Second, future research could assess the welfare implications of the regulations designed to reduce risk-taking among financial intermediaries. While my analysis reveals that the regulation caused a reduction in exports, it does not provide a comprehensive welfare evaluation. These research directions could contribute to a deeper understanding of the relationship between FX hedging, international trade, and intermediary frictions.

References

Acharya, Viral V. and Arvind Krishnamurthy, *Capital Flow Management with Multiple Instruments*, Vol. 26 of *Central Banking, Analysis, and Economic Policies Book Series*, Central Bank of Chile, December 2019.

_ **and Siddharth Vij**, "Foreign Currency Borrowing of Corporations as Carry Trades: Evidence from India," *NBER Working Paper*, 2020.

_ **, Lars A. Lochstoer, and Tarun Ramadorai**, "Limits to arbitrage and hedging: Evidence from commodity markets," *Journal of Financial Economics*, 2013, *109* (2), 441–465.

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.

Ahn, JaeBin, Mary Amiti, and David E. Weinstein, "Trade Finance and the Great Trade Collapse," *American Economic Review*, May 2011, *101* (3), 298–302.

_ **, Youngju Kim, and Hyungjoon Lim**, "For Whom the Levy Tolls: The Case of a Macroprudential Stability Levy in South Korea," *IMF Economic Review*, 2022.

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, John Hooley, Yevgeniya Korniyenko, and Tomasz Wieladek, "The international transmission of bank capital requirements: Evidence from the UK," *Journal of Financial Economics*, 2014, *113* (3), 368–382.

Alfaro, Laura, Mauricio Calani, and Liliana Varela, "Currency Hedging: Managing Cash Flow Exposure," Working Paper 28910, National Bureau of Economic Research June 2021.

Allayannis, George and Eli Ofek, "Exchange rate exposure, hedging, and the use of foreign currency derivatives," *Journal of International Money and Finance*, 2001, *20* (2), 273–296.

_ **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.

_ **, Jane Ihrig, and James P. Weston**, "Exchange-Rate Hedging: Financial versus Operational Strategies," *American Economic Review*, May 2001, *91* (2), 391–395.

_ **, Ugur Lel, and Darius P. Miller**, "The use of foreign currency derivatives, corporate governance, and firm value around the world," *Journal of International Economics*, 2012, *87* (1), 65–79. Symposium on the Global Dimensions of the Financial Crisis.

Amiti, Mary and David E. Weinstein, "Exports and Financial Shocks," *The Quarterly*

Journal of Economics, 10 2011, *126* (4), 1841–1877.

Avdjiev, Stefan, Wenxin Du, Cathérine 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.

Bank of Korea, "Investigation on the Imbalance of Supply and Demand in the FX Forward Market," https://www.bok.or.kr/viewer/skin/doc.html?fn=FILE_201803300725242942.pdf&rs=/webview/result/P0000559/200801 2008. Accessed: 2021-08-17.

Bartram, Söhnke M., "Corporate hedging and speculation with derivatives," *Journal of Corporate Finance*, 2019, *57*, 9–34. Corporate Governance in Multinational Enterprises.

_ **, Gregory W. Brown, and Jennifer Conrad**, "The Effects of Derivatives on Firm Risk and Value," *Journal of Financial and Quantitative Analysis*, 2011, *46* (4), 967–999.

Basu, Suman, Emine Boz, Gita Gopinath, Francisco Roch, and Filiz Unsal, "A Conceptual Model for the Integrated Policy Framework," *IMF Working Paper*, 2020.

Beck, Thorsten, Hans Degryse, Ralph De Haas, and Neeltje Van Horen, "When arm's length is too far: Relationship banking over the credit cycle," *Journal of Financial Economics*, 2018, *127* (1), 174–196.

Berger, Allen N., Phil Molyneux, and John O.S. Wilson, "Banks and the real economy: An assessment of the research," *Journal of Corporate Finance*, 2020, *62* (C).

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

Boz, Emine, Camila Casas, Georgios Georgiadis, Gita Gopinath, Helena Le Mezo, Arnaud Mehl, and Tra Nguyen, "Patterns in Invoicing Currency in Global Trade1," *IMF Working Paper*, 2020.

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.

Campbell, Tim S. and William A. Kracaw, "Optimal Managerial Incentive Contracts and the Value of Corporate Insurance," *The Journal of Financial and Quantitative Analysis*, 1987, *22* (3), 315–328.

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.

Cenedese, Gino, Pasquale Della Corte, and Tianyu Wang, "Currency Mispricing and Dealer Balance Sheets," *The Journal of Finance*, 2021, *76* (6), 2763–2803.

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*, New York: Palgrave Macmillan US,

Degryse, Hans, Olivier De Jonghe, Sanja Jakovljević, Klaas Mulier, and Glenn Schepens, "Identifying credit supply shocks with bank-firm data: Methods and applications," *Journal of Financial Intermediation*, 2019, *40*, 100813. Bank-firm relationships in the post-crisis era.

DeMarzo, Peter M. and Darrell Duffie, "Corporate Incentives for Hedging and Hedge Accounting," *The Review of Financial Studies*, 05 2015, *8* (3), 743–771.

Demir, Banu, Tomasz K. Michalski, and Evren Ors, "Risk-Based Capital Requirements for Banks and International Trade," *The Review of Financial Studies*, 07 2017, *30* (11), 3970–4002.

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

_ , Benjamin Hébert, and Amy Wang Huber, "Are Intermediary Constraints Priced?," *The Review of Financial Studies*, 08 2022.

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

Fraisse, Henri, Mathias Lé, and David Thesmar, "The Real Effects of Bank Capital Requirements," *Management Science*, 2020, *66* (1), 5–23.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein, "Risk Management: Coordinating Corporate Investment and Financing Policies," *The Journal of Finance*, 1993, *48* (5), 1629–1658.

Gabaix, Xavier and Matteo Maggiori, "International Liquidity and Exchange Rate Dynamics*," *The Quarterly Journal of Economics*, 03 2015, *130* (3), 1369–1420.

Geczy, Christopher, Bernadette A. Minton, and Catherine Schrand, "Why Firms Use Currency Derivatives," *The Journal of Finance*, 1997, *52* (4), 1323–1354.

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

Graham, John R., "Taxes and Corporate Finance: A Review," *The Review of Financial Studies*, 2003, *16* (4), 1075–1129.

— **and Daniel A. Rogers**, "Do Firms Hedge in Response to Tax Incentives?," *The Journal of Finance*, 2002, *57* (2), 815–839.

Gropp, Reint, Thomas Mosk, Steven Ongena, and Carlo Wix, "Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment," *The Review of Financial Studies*, 04 2018, *32* (1), 266–299.

Guay, Wayne and S.P Kothari, "How much do firms hedge with derivatives?," *Journal of Financial Economics*, 2003, *70* (3), 423–461.

Hasan, Iftekhar, Gazi Hassan, Suk-Joong Kim, and Eliza Wu, "The real impact of ratings-based capital rules on the finance-growth nexus," *International Review of Financial Analysis*, 2021, *73*, 101628.

Haushalter, G. David, "Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers," *The Journal of Finance*, 2000, *55* (1), 107–152.

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.

Jimenez, Gabriel, Steven Ongena, Jose-Luis Peydro, and Jesús Saurina, "Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments," *Journal of Political Economy*, 2017, *125* (6), 2126 – 2177.

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.

Kim, Youngju, Hyunjoon Lim, and Youngjin Yun, "International Liquidity Shock and Bank Resilience: Evidence from Matched Bank-Firm Data," Inha University IBER

Working Paper Series 2022-2, Inha University, Institute of Business and Economic Research December 2022.

Leland, Hayne E., "Agency Costs, Risk Management, and Capital Structure," *The Journal of Finance*, 1998, *53* (4), 1213–1243.

Liao, Gordon Y. and Tony Zhang, "The Hedging Channel of Exchange Rate Determination," International Finance Discussion Papers 1283, Board of Governors of the Federal Reserve System (U.S.) May 2020.

Liberti, José María and Jason Sturgess, "The Anatomy of a Credit Supply Shock: Evidence from an Internal Credit Market," *Journal of Financial and Quantitative Analysis*, 2018, *53* (2), 547–579.

Mackay, Peter and Sara B. Moeller, "The Value of Corporate Risk Management," *The Journal of Finance*, 2007, *62* (3), 1379–1419.

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

Nakashima, Kiyotaka and Koji Takahashi, "The real effects of bank-driven termination of relationships: Evidence from loan-level matched data," *Journal of Financial Stability*, 2018, *39* (C), 46–65.

Niepmann, Friederike and Tim Schmidt-Eisenlohr, "International trade, risk and the role of banks," *Journal of International Economics*, 2017, *107*, 111–126.

_ **and** _ , "No guarantees, no trade: How banks affect export patterns," *Journal of International Economics*, 2017, *108*, 338–350.

_ **and** _ , "Foreign currency loans and credit risk: Evidence from U.S. banks," *Journal of International Economics*, 2022, *135*, 103558.

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.

Perez-Gonzalez, Francisco and Hayong Yun, "Risk Management and Firm Value: Evidence from Weather Derivatives," *The Journal of Finance*, 2013, *68* (5), 2143–2176.

Purnanandam, Amiyatosh, "Financial distress and corporate risk management: Theory and evidence," *Journal of Financial Economics*, 2008, *87* (3), 706–739.

Rampini, Adriano A., Amir Sufi, and S. Viswanathan, "Dynamic risk management," *Journal of Financial Economics*, 2014, *111* (2), 271–296.

_ **and S. Viswanathan**, "Collateral, Risk Management, and the Distribution of Debt Capacity," *The Journal of Finance*, 2010, *65* (6), 2293–2322.

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).

Schivardi, Fabiano, Enrico Sette, and Guido Tabellini, "Credit Misallocation During the European Financial Crisis," *The Economic Journal*, 04 2021, *132* (641), 391–423.

Schnabl, Philipp, "The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market," *The Journal of Finance*, 2012, *67* (3), 897–932.

Smith, Clifford W. and Rene M. Stulz, "The Determinants of Firms' Hedging Policies," *The Journal of Financial and Quantitative Analysis*, 1985, *20* (4), 391–405.

Tufano, Peter, "Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry," *The Journal of Finance*, 1996, *51* (4), 1097–1137.

Figures

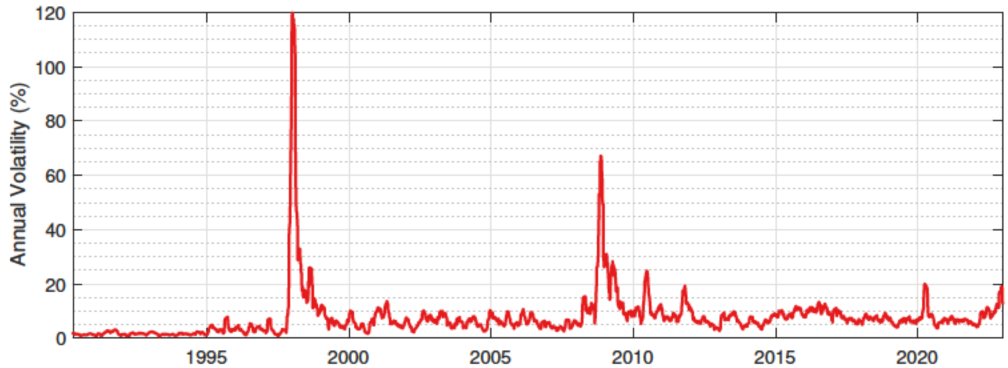


Figure 1: **Volatility of USD-Korean Won Exchange Rate** The annualized 30-day historical volatility of USD-KRW exchange rate.

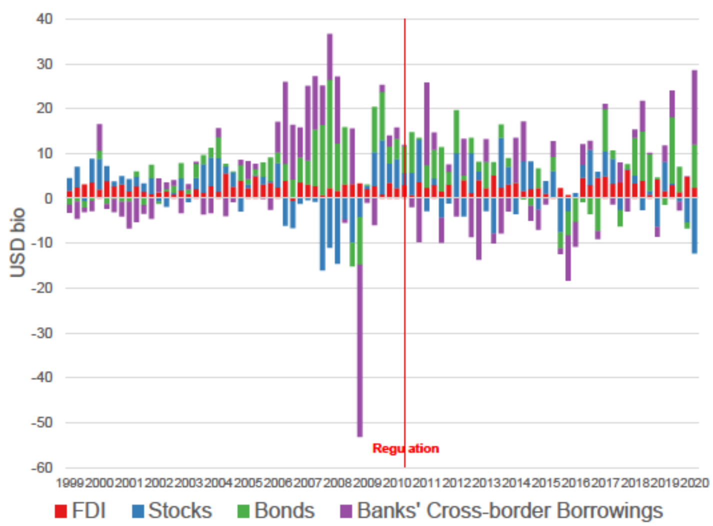


Figure 2: **Gross Foreign Capital Inflows** Korea's gross foreign capital inflows. The vertical line indicates the imposition of the regulation.

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

Figure 3: **FX Positions of Exporters and Banks before the Regulation** The left panel illustrates the structure of the exporter FX position and the right panel illustrates the structure of the bank FX position prior to the regulation. Exporters had a long position in foreign currency (due to export sales) and hedged the exposure by taking short positions in FXD. As banks are firms' FXD counterparties, banks had a long position in foreign currency due to the FXD. Banks hedged the long exposure by foreign currency borrowing.

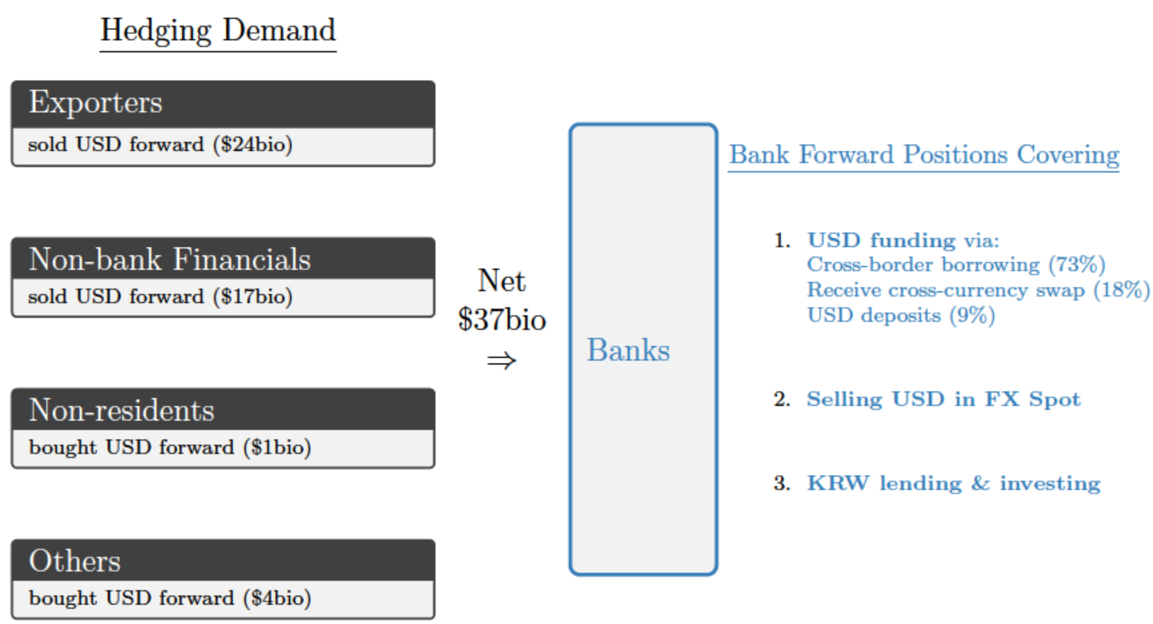
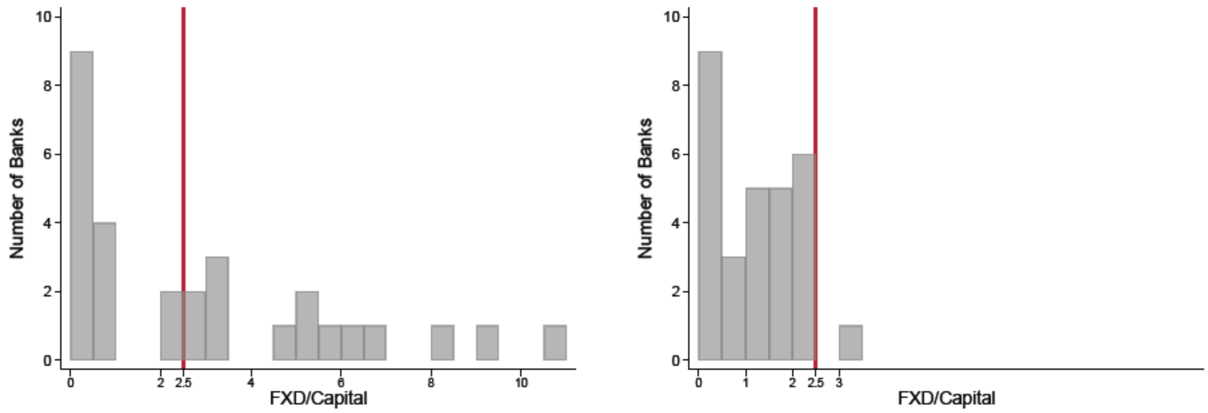
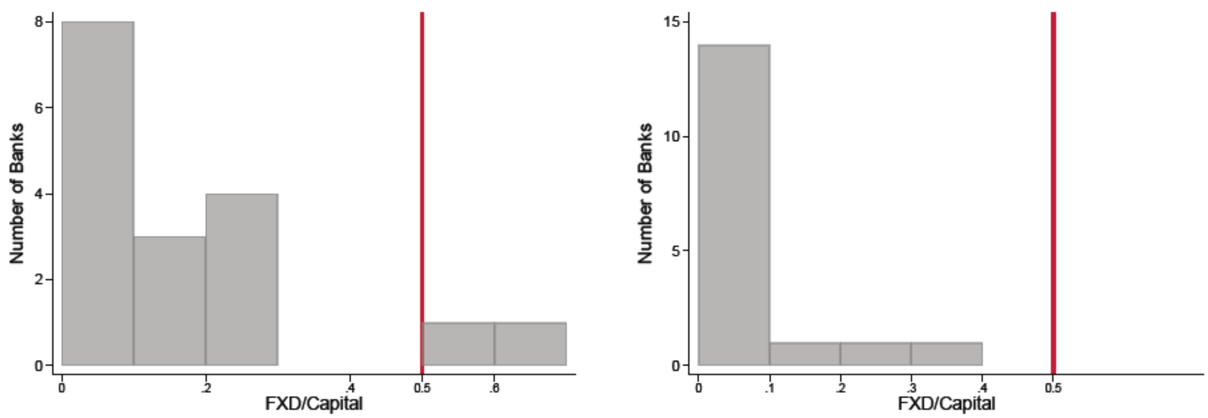


Figure 4: **FX Forward Hedging Demand and Bank Positions Covering** The left panel shows the amount of USD forwards each non-bank sector purchased from or sold to banks during the first three quarters of 2007. The right panel shows how banks covered the net long position of 37 billion USD in forwards. Source: Bank of Korea (2008).



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

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



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

Figure 6: **FXD Position to Capital Ratio, Before and After the Regulation (Domestic Banks)** The histogram of the FXD position to the capital (DPTC) ratio of domestic banks, six months before and six months after the first announcement of regulation. The vertical line indicates the regulatory cap on the DPTC ratio.

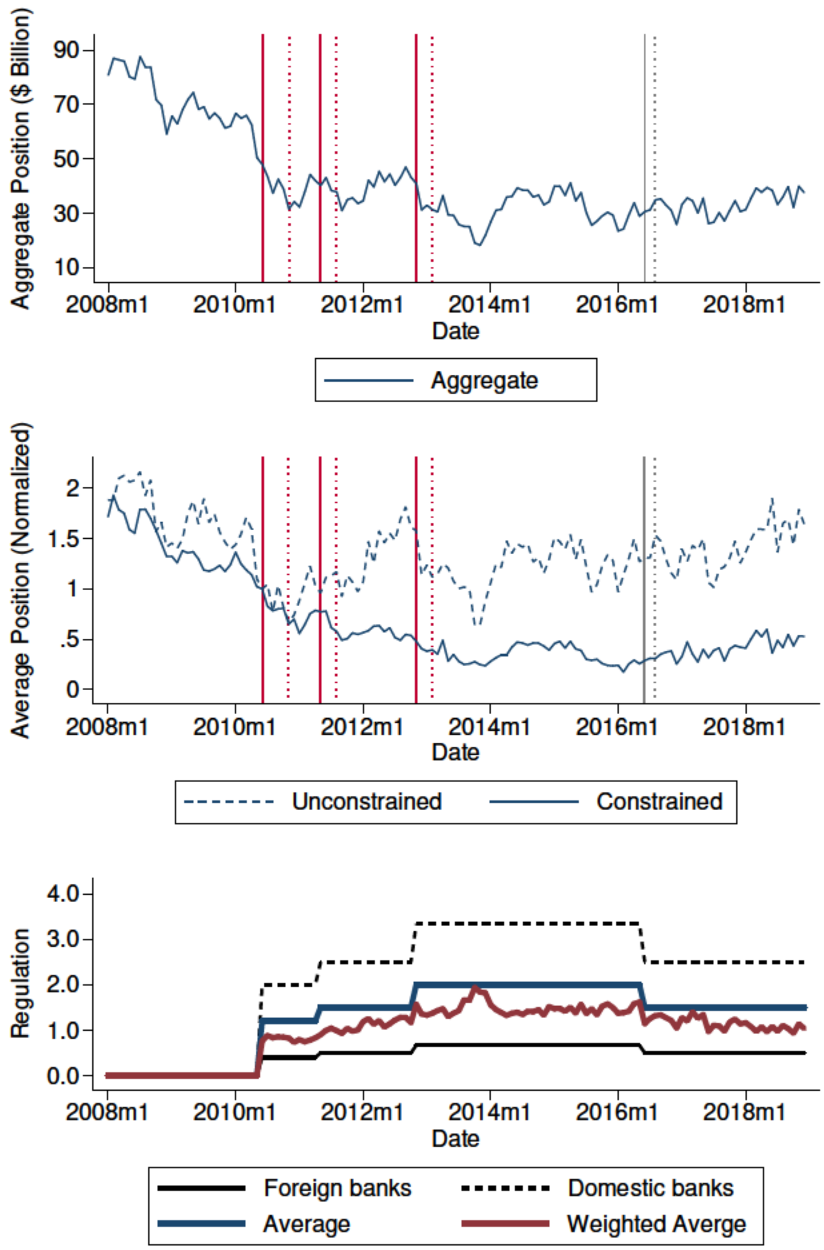


Figure 7: **FXD Position by Treatment** The top panel plots the aggregate FXD position. The vertical solid (dotted) lines indicate the announcement (effective) dates of changes in the minimum FXD capital requirement, with red (grey) lines indicating tightening (loosening) adjustments. The middle panel plots the normalized average FXD position of constrained (solid) and unconstrained (dotted) banks. The average FXD positions are normalized such that they are 1 at the imposition of the regulation. The bottom panel plots the minimum FXD capital requirements. The blue line is the simple average and the red line is the weighted average minimum FXD capital requirements where the weight is FXD position.

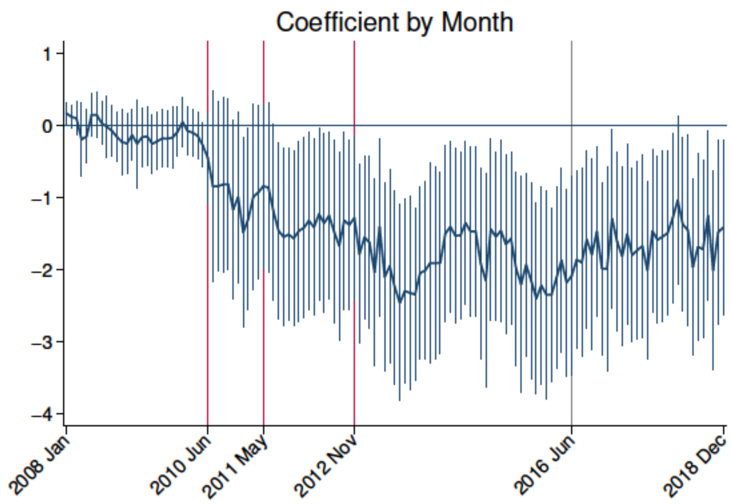


Figure 8: **Coefficient by Month** Plot of λ_t over time in the following specification: $Y_{it} = \beta_0 + \beta_1 Constrained_i + \beta_2 Post_t + \sum_t \lambda_t Constrained_i \times \gamma_t + \varepsilon_{it}$ where *Post* takes the value of 1 for the time period after the regulation (June 2010) and 0 otherwise. γ_t is the time dummy variable for each month. The vertical lines correspond to the adjustments of the regulatory cap. The first three vertical lines (in red) indicate tightening adjustments and the last vertical line (in grey) indicates a loosening adjustment.

Tables

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

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

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

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

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

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

	Full Sample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	2,371.130	6422.07	2,673.585	8728.05	2,202.391	4719.67	-471.19	(-0.36)
FXDNet/Assets	-0.082	0.19	-0.065	0.18	-0.091	0.20	-0.03	(-0.79)
Sales (USD mio)	1,936.725	4648.93	1,801.008	4534.04	2,012.440	4733.92	211.43	(0.27)
FXDNet/Sales	-0.097	0.28	-0.061	0.26	-0.118	0.30	-0.06	(-1.23)
Number of Banks	2.385	2.41	2.472	2.08	2.337	2.58	-0.13	(-0.35)
Leverage	0.487	0.18	0.511	0.16	0.474	0.19	-0.04	(-1.26)
Gross Profit Margin	0.211	0.17	0.210	0.19	0.211	0.15	0.00	(0.02)
FC Asset Share	0.096	0.11	0.088	0.11	0.101	0.11	0.01	(0.66)
FC Liab Share	0.197	0.19	0.240	0.19	0.173	0.20	-0.07^{*}	(-2.05)
Export Share	0.473	0.31	0.425	0.32	0.502	0.30	0.08	(1.38)
Export Hedge Ratio	0.409	0.71	0.435	0.72	0.393	0.71	-0.04	(-0.31)
FCL Hedge Ratio	0.485	2.11	0.803	3.41	0.300	0.50	-0.50	(-1.07)
Cash/Assets	0.080	0.07	0.074	0.07	0.083	0.07	0.01	(0.83)
Borrowings/Assets	0.191	0.13	0.202	0.15	0.185	0.12	-0.02	(-0.70)
Interest Exp/Assets	0.015	0.01	0.016	0.01	0.015	0.01	-0.00	(-0.91)
Observations	148		53		95		148	

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

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital
Constrained=1 x Regulation	-0.913***	-0.967***	0.0268	0.0262
	(-3.18)	(-3.28)	(0.33)	(0.34)
Constrained=1	5.341***		-0.646	
	(3.92)		(-1.52)	
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	5906	5906	5885	5885
Adj RSqr	0.109	0.802	0.0550	0.915

t statistics in parentheses

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

(a) Based on Simple Average FXD Capital Requirement

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital
Constrained=1 x Regulation	-1.207***	-1.292***	0.0203	0.0152
	(-3.05)	(-3.17)	(0.19)	(0.15)
Constrained=1	5.312***		-0.631	
	(3.91)		(-1.49)	
BankFE	N	Y	N	Y
TimeFE	Y	Y	Y	Y
N	5906	5906	5885	5885
Adj RSqr	0.109	0.803	0.0550	0.915

t statistics in parentheses

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

(b) Based on Weighted Average FXD Capital Requirement

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

	(1)	(2)	(3)	(4)	(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 6: **Transmission of Regulatory Shock to FXD Hedging at the Contract Level** The regressions in this table examine the impact of the regulatory shock on firm FXD contracts. I define contract as a firm-bank pair. The dependent variable is the change in net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $\mathbf{Constrained_i}$ is 1 if the contract is dealt with a constrained bank and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

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

t statistics in parentheses

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

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

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

t statistics in parentheses

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

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

	(1) LogExport	(2) LogExport
High Hedge=1 × Exposure	-0.199*	-0.165*
	(-1.94)	(-1.81)
Exposure	0.0498	0.0834
	(0.77)	(1.55)
High Hedge=1	0.143	0.0271
	(1.34)	(0.30)
Constant	0.210**	-1.618
	(2.58)	(-1.23)
FirmControls	N	Y
N	74	74
RSqr	0.0817	0.324

t statistics in parentheses

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

(a) High Hedge vs. Low Hedge Firms

	(1) LogExport	(2) LogExport
Exposure × Export Hedge Ratio	-0.176***	-0.212**
	(-3.96)	(-2.24)
Exposure	-0.0499	-0.0479
	(-1.02)	(-0.85)
Export Hedge Ratio	0.0887	0.164**
	(1.35)	(2.26)
Constant	0.301***	-1.660
	(6.17)	(-1.30)
FirmControls	N	Y
N	74	74
RSqr	0.228	0.464

t statistics in parentheses

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

(b) Continuous Hedge Ratio

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

	(1) FXD/Asset	(2) FXD/Asset
High Hedge=1 × Exposure	0.0518***	0.0581***
	(2.70)	(2.84)
Exposure	0.0108	0.0108
	(1.22)	(1.16)
High Hedge=1	0.0401**	0.0413**
	(2.04)	(2.06)
Constant	-0.00855	-0.125
	(-1.06)	(-0.56)
FirmControls	N	Y
N	74	74
RSqr	0.215	0.319

t statistics in parentheses

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

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

	(1) LogDomesticSales	(2) LogDomesticSales
High Hedge=1 × Exposure	-0.0324	-0.00794
	(-0.37)	(-0.09)
Exposure	-0.00657	0.000843
	(-0.09)	(0.01)
High Hedge=1	0.128	0.0935
	(1.46)	(0.95)
Constant	0.0888	0.315
	(1.25)	(0.35)
FirmControls	N	Y
N	74	74
RSqr	0.0353	0.118

t statistics in parentheses

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

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

	(1) LogExport	(2) ExpShare
High Hedge=1 × Exposure × Cash	-3.327**	-1.301***
	(-2.10)	(-3.72)
High Hedge=1 × Exposure	0.0817	0.0596**
	(0.68)	(2.26)
High Hedge=1 × Cash	-1.677	-0.983***
	(-1.29)	(-3.35)
Exposure × Cash	2.196	0.837**
	(1.63)	(2.56)
Exposure	-0.0162	-0.0199
	(-0.22)	(-0.94)
High Hedge=1	0.0780	0.0403
	(0.58)	(1.56)
Cash	2.844**	1.030***
	(2.42)	(3.66)
Constant	-2.588**	-0.631**
	(-2.22)	(-2.63)
FirmControls	Y	Y
N	74	74
RSqr	0.423	0.527

t statistics in parentheses

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

Table 12: **Role of Internal Funds on Export Sales and Export Share** The regressions in this table examine the impact of the regulation, hedge ratio, and internal funds (cash balance) on export sales and share of export sales. The outcome variable is export sales or share of export sales. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. $Cash_j$ is firm's pre-shock cash and cash equivalent balance scaled by total assets. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

Appendix

A Additional Figures

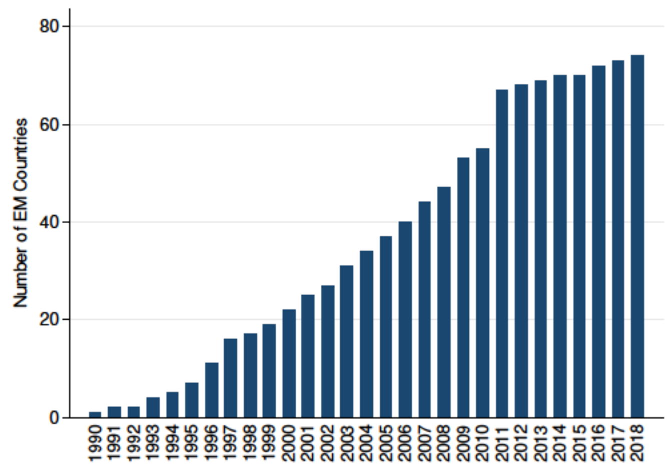


Figure A.1: **Number of Countries using Macroprudential FX Regulations** Source: IMF integrated Macroprudential Policy Database.

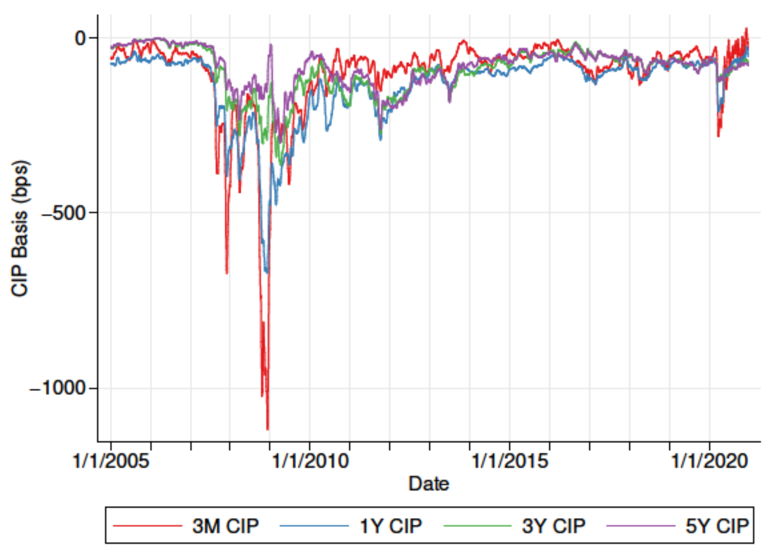


Figure A.2: **CIP Bases** 10-day moving average of daily CIP bases for different maturities. CIP basis at time t for maturity n is defined in equation (12).

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

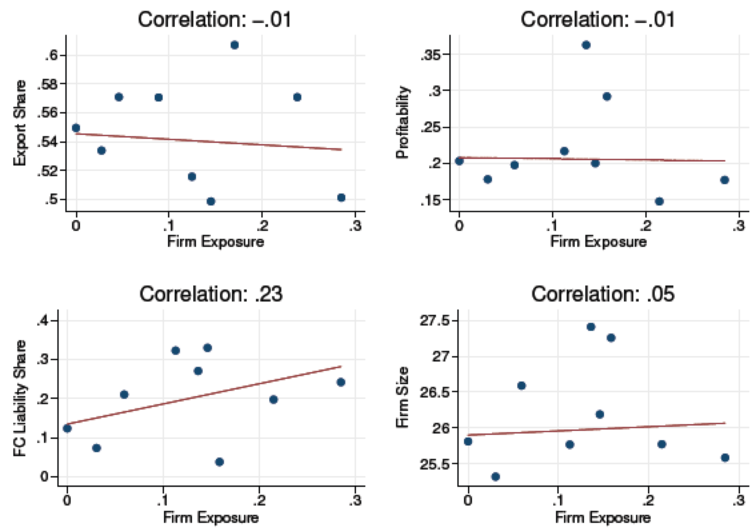


Figure A.4: **Correlations between Firm Characteristics and Firm Exposure** Binned scatter plots of firm characteristics (export share, profitability, FC liability share, and firm size) and firm exposure to the regulation.

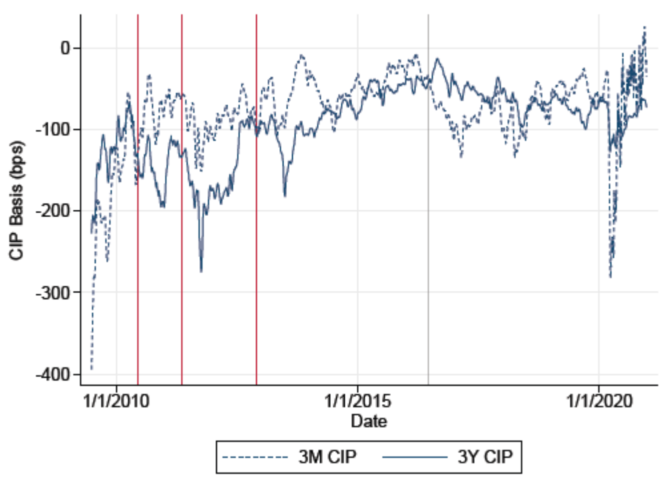


Figure A.5: **CIP Deviations: Short-term and long-term** 10-day moving average of 3-year (solid) and 3-month (dotted) USD-KRW CIP deviations where CIP deviation is defined in equation (12). The first three red vertical lines indicate tightening adjustments while the last grey vertical line indicates a loosening adjustment.

B Additional Tables

Variable	Definition
	Bank-level Variables
FXD	FXD position
Capital	Total bank capital
Asset	Total bank assets
FXD/Assets	FXD position as a share of assets
Loans/Assets	Bank loans as a share of assets
Deposits/Assets	Bank deposits as a share of assets
Equity/Assets	Bank equity as a share of assets
FC Loan Share	Bank's foreign currency loans as a share of loans
FC Liab Share	Bank's foreign currency borrowings as a share of borrowings
LogFXD	Natural logarithm of total FXD position
LogCapital	Natural logarithm of total capital
FXD/Capital	FXD position as a share of capital
$Constrained_i$	Indicator variable equal to one if bank i is constrained and zero otherwise
$Regulation^{Avg}$	Simple average regulatory capital requirement (Blue solid line in Figure 7)
$Regulation^{WAvg}$	Weighted average regulatory capital requirement (Red solid line in Figure 7)
	FXD Contract-level Variables
Notional Net	FXD position at the contract (firm-bank pair) level
FXDNet/Assets	Net FXD as a share of assets from the firm's perspective
Direction	FXD that firm sells to banks as a share of FXD
Pair: USD-KRW	FXD that involves USD-KRW as a share of FXD
Pair: JPY-KRW	FXD that involves JPY-KRW as a share of FXD
Pair: EUR-KRW	FXD that involves EUR-KRW as a share of FXD
Type: Forwards	FX forwards as a share of FXD
Type: Swaps	FX swaps as a share of FXD
Type: Options	FX options as a share of FXD
Type: Futures	FX futures as a share of FXD
$Constrained_{ij}$	Indicator variable equal to one if bank i is constrained and zero otherwise
$Shock_i$	Percentage of bank i's FXD position that needed to be reduced on imposition of the regulation
	Firm-level Variables
Assets	Total firm assets
FXDNet/Assets	Firm's net FXD position as a share of assets
Leverage	Firm liabilities as a share of assets
Gross Profit Margin	Firm gross profit as a share of liabilities
FC Asset Share	Firm's foreign currency assets as a share of assets
FC Liab Share	Firm's foreign currency liabilities as a share of liabilities
Export Share	Firm's export sales as a share of sales
Export Hedge Ratio	Amount of FXD that firm sold as a share of its export sales
FCL Hedge Ratio	Amount of FXD that firm bought as a share of its foreign currency liabilities
Exposed	Indicator variable equal to one if the firm's main bank is constrained and zero otherwise
Exposure	Weighted average shock of the firm's FXD counterparty banks
HighHedge	Indicator variable equal to one if the firm's export hedge ratio is higher than 10%, zero otherwise
Cash/Asset	Firm's cash and cash equivalent as a share of assets
Borr/Asset	Firm's borrowings as a share of assets
Interest Expense/Asset	Firm's interest expense as a share of its assets

Table B.1: **Variable Definitions**

	(1) LogFXD	(2) LogFXD	(3) LogFXD	(4) LogFXD	(5) LogFXD	(6) LogFXD
Shock x Regulation	-1.393***	-1.443***	-2.804***	-1.776***	-1.871***	-3.662***
	(-2.96)	(-2.99)	(-2.95)	(-2.80)	(-2.85)	(-2.87)
Shock	8.431***	13.67***	18.95**	8.322***	13.60***	18.64**
	(3.63)	(13.35)	(2.19)	(3.59)	(13.22)	(2.20)
Bank FE	N	Y	Y	N	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Bank Controls x Regulation	N	N	Y	N	N	Y
N	5906	5906	1718	5906	5906	1718
Adj RSqr	0.0732	0.801	0.838	0.0731	0.801	0.837

t statistics in parentheses

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

Table B.2: **Impact on Bank FXD Position based on *Shock* variable** The regressions in this table examine the impact of the regulatory shock on the bank FXD position. Columns (1)-(3) use $Regulation_t^{Avg}$, which takes 0 before the regulation and the **simple average** of foreign bank and domestic bank minimum FXD capital requirements. Columns (4)-(6) use $Regulation_t^{WAvg}$, which is the **weighted average** of the minimum FXD capital requirements, where the weight is the FXD position in each month. In either case, a higher value indicates tighter constraint. Columns (2) and (5) add bank fixed effects. Columns (3) and (6) includes terms bank characteristics (size, loan-to-assets ratio, and leverage) interacted with $Regulation_t$. Because bank characteristics data are quarterly, the number of observations drops. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.3: **Transmission of Regulatory Shock to FXD Hedging at Contract Level using continuous variable, Shock** The regressions in this table examine the impact of the regulatory shock on firm FXD contracts. I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $\mathbf{Shock_i}$ is the percentage of bank i's FXD position that needed to be reduced when the regulation was imposed. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.4: **Transmission of Regulatory Shock to FXD Hedging, Excluding Option Contracts (1)** The regressions in this table examine the impact of the regulatory shock on firm FXD contracts when **I exclude all option contracts from the data.** I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $Constrained_i$ is 1 if the contract is dealt with a constrained bank and 0 if otherwise. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.5: **Transmission of Regulatory Shock to FXD Hedging, Excluding Option Contracts (2)** The regressions in this table examine the impact of the regulatory shock on firm's FXD contracts when **I exclude all option contracts from the data.** I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $Shock_i$ is the percentage of bank i's FXD position that needed to be reduced at the imposition of the regulation. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. All variables are defined in the Appendix.

	(1) Exporters	(2) Non-exporters	(3) Full Sample	(4) Exporters	(5) Non-exporters	(6) Full Sample
Shock	0.0202**	0.00187*	0.00576	0.0217**	0.00225**	0.00507
	(2.58)	(1.94)	(1.65)	(2.47)	(2.08)	(1.42)
Type Swaps	-0.0102	0.00455	0.0100**	-0.00838	0.00344	0.00597
	(-0.34)	(1.18)	(2.18)	(-0.25)	(0.62)	(1.04)
Type Options	0.0893***	0	0.0999***	0	0	0
	(4.88)	(.)	(8.34)	(.)	(.)	(.)
Type Futures	-0.0144	0	-0.0119	-0.0158	0	-0.00980
	(-0.47)	(.)	(-0.82)	(-0.50)	(.)	(-0.70)
Pair EURKRW	0.0765*	0	0.0436	0.0415	0	0.0255
	(1.86)	(.)	(1.24)	(1.25)	(.)	(1.50)
Pair JPYKRW	-0.0288	0.00850*	-0.00696	-0.0228	0.00938*	-0.00494
	(-1.25)	(1.89)	(-0.77)	(-0.86)	(2.02)	(-0.53)
Pair XXXKRW	-0.0123	0.00169	-0.000316	-0.000784	0.00303	0.00866
	(-0.47)	(0.11)	(-0.02)	(-0.03)	(0.20)	(0.52)
Firm Controls	Y	Y	Y	Y	Y	Y
Bank Controls	Y	Y	Y	Y	Y	Y
I-L-S FE	Y	Y	Y	Y	Y	Y
N	129	121	250	111	121	232
RSqr	0.412	0.272	0.372	0.180	0.240	0.129

t statistics in parentheses

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

Table B.6: **Transmission of Regulatory Shock to FXD Hedging at Contract Level, after including Industry-Location-Size Fixed Effect** The regressions in this table examine the impact of the regulatory shock on firm FXD contracts. I define contract as a firm-bank pair. The dependent variable is the change in the net FXD position dealt between firm j and bank i between 2009 and 2010, scaled by assets. $\mathbf{Shock_i}$ is the percentage of bank i's FXD position that needed to be reduced when the regulation was imposed. Firm controls include log size, net FXD notional (scaled by sales) before the shock, and foreign currency liability share. The industry-location-size fixed effect is based on seven industry groups, five locations, and two size bins. Bank controls include log size, loans-to-assets ratio, leverage ratio, and a foreign bank indicator variable. Contract controls include bank i's share of firm j's total FXD notional, type, and currency pair. The omitted categories are forwards and USD-KRW pair. Standard errors are clustered at the bank level. Columns (1)-(3) are based on the full sample and columns (4)-(6) are after excluding all option contracts. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Small	(4) Small	(5) Large	(6) Large
Exposure	0.0235***	0.0265***	0.0320***	0.0331***	0.0152**	0.0170***
	(3.45)	(3.86)	(2.83)	(3.13)	(2.27)	(2.73)
Constant	0.00976	0.145	0.0179	-0.154	0.00240	0.222
	(1.29)	(1.26)	(1.37)	(-0.23)	(0.31)	(1.11)
FirmControls	N	Y	N	Y	N	Y
N	132	132	66	66	66	66
RSqr	0.0687	0.164	0.0888	0.465	0.0537	0.154

t statistics in parentheses

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

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

	(1) Exporter	(2) Exporter	(3) Non-exporter	(4) Non-exporter
Exposure	0.0447***	0.0507***	0.00131	0.000644
	(3.95)	(4.22)	(0.45)	(0.19)
Constant	0.0231*	0.0166	-0.00569**	0.0590
	(1.98)	(0.07)	(-2.08)	(0.88)
FirmControls	N	Y	N	Y
N	82	82	50	50
RSqr	0.140	0.245	0.00502	0.0851

t statistics in parentheses

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

Table B.8: **Impact on Firm-level FXD Position by Net FXD Position, Fully Disclosed Firms** The regressions in this table compare the impact of regulation on the firm-level FXD positions of exporters and non-exporters when I restrict the sample to firms that fully disclosed their FXD counterparty information. The outcome variable is the change in firm j's net FXD position scaled by assets. A firm is classified as an exporter (non-exporter) if it holds a negative (positive) net FXD position. Independent variable *Exposure* is the weighted average shock of the firm's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.9: **Impact on Profitability by Net FXD Position, Full Sample** The regressions in this table examine the impact of the regulation on firm profitability. The outcome variable is the change in gross profit margin. Independent variable *Exposed* is 1 if the firm's main FXD counterparty bank is constrained. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Full Sample	(2) Full Sample	(3) Exporter	(4) Exporter	(5) Non-exporter	(6) Non-exporter
Exposure	-0.00123	-0.00293	-0.00584	-0.0103*	0.00105	0.00722
	(-0.25)	(-0.49)	(-1.12)	(-1.72)	(0.13)	(0.85)
Constant	0.00240	-0.150	-0.00805	-0.348	0.0185	-0.0230
	(0.39)	(-1.16)	(-1.29)	(-1.48)	(1.45)	(-0.15)
FirmControls	N	Y	N	Y	N	Y
N	132	132	82	82	50	50
RSqr	0.000302	0.0801	0.00886	0.173	0.000174	0.674

t statistics in parentheses

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

Table B.10: **Impact on Profitability by Net FXD Position, Fully Disclosed Firms** The regressions in this table examine the impact of the regulation on firm profitability when I restrict the sample to firms that fully disclosed their FXD counterparty information. The outcome variable is the change in gross profit margin. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Profitability	(2) Profitability
High Hedge=1 × Exposure	-0.00516	-0.00486
	(-0.49)	(-0.48)
Exposure	-0.00326	-0.00752
	(-0.40)	(-0.78)
High Hedge=1	-0.0108	-0.00582
	(-0.83)	(-0.49)
Constant	0.000948	-0.364
	(0.10)	(-1.50)
FirmControls	N	Y
N	74	74
RSqr	0.0240	0.202

t statistics in parentheses

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

Table B.11: **Impact on Profitability** The regressions in this table examine the impact of the regulation on firm profitability. The outcome variable is the change in firm j's gross profit margin. Independent variable $Exposure_j$ is the weighted average shock of 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 seven industry dummies. All variables are defined in the Appendix.

	LogExport	FXD/Asset	LogDomesticSales
High Hedge=1 × Exposure	-0.155*	0.0608**	-0.172
	(-1.95)	(2.08)	(-1.54)
Exposure	0.109**	0.0123	0.118
	(2.49)	(0.68)	(1.17)
High Hedge=1	0.0546	0.0391	0.342**
	(0.68)	(1.00)	(2.43)
Constant	-0.299	-0.548	1.528
	(-0.18)	(-1.55)	(1.36)
FirmControls	Y	Y	Y
N	68	68	68
RSqr	0.286	0.454	0.252

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(a) Matching Based on FC Liability Share

	LogExport	FXD/Asset	LogDomesticSales
High Hedge=1 × Exposure	-0.166*	0.0535***	-0.0277
	(-1.73)	(2.66)	(-0.29)
Exposure	0.0650	0.0144	-0.000664
	(1.27)	(1.49)	(-0.01)
High Hedge=1	0.0749	0.0273	0.105
	(0.76)	(1.49)	(1.04)
Constant	-1.476	-0.112	0.705
	(-1.07)	(-0.48)	(0.80)
FirmControls	Y	Y	Y
N	72	72	72
RSqr	0.312	0.323	0.0790

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

Table B.12: **Firm-level Impacts on Exporters after Coarsened Exact Matching** The top panel shows results after matching firms based on FC liability share only. The bottom panel shows results after matching firms based on FC liability share, export share, and gross profit margin. All variables are defined in the Appendix.

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital
Constrained=1 x Regulation	-4.318***	-4.551***	-0.0418	-0.0156
	(-2.88)	(-2.99)	(-0.14)	(-0.05)
Constrained=1	6.341***		0.123	
	(3.08)		(0.30)	
Constant	16.11***	21.04***	26.22***	25.81***
	(8.07)	(50.75)	(66.20)	(179.85)
Bank FE	N	Y	N	Y
Time FE	Y	Y	Y	Y
N	3698	3698	3694	3694
Adj RSqr	0.155	0.760	0.0528	0.835

t statistics in parentheses

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

(a) Foreign Banks

	(1) LogFXD	(2) LogFXD	(3) LogCapital	(4) LogCapital
Constrained=1 x Regulation	-0.105	-0.126	-0.0659**	-0.0663**
	(-0.61)	(-0.72)	(-2.51)	(-2.39)
Constrained=1	4.401**		0.357	
	(2.38)		(0.86)	
Constant	17.24***	19.02***	28.60***	28.25***
	(9.07)	(30.50)	(69.51)	(370.80)
Bank FE	N	Y	N	Y
Time FE	Y	Y	Y	Y
N	2208	2208	2191	2191
Adj RSqr	0.0528	0.875	0.0243	0.934

t statistics in parentheses

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

(b) Domestic Banks

Table B.13: **Impact on Bank FXD Position and Capital of Foreign and Domestic Banks** The regressions in this table examine the impact of the regulatory shock on the bank FXD position. The top panel is the result when I restrict the data to foreign banks. The bottom panel is the result when I restrict the data to domestic banks. Columns (2) and (4) add bank fixed effects. The sample period is 2008–2019 on a monthly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

	(1) Borr/Asset	(2) Borr/Asset	(3) Interest Exp/Asset	(4) Interest Exp/Asset
Exposure	0.00951	0.0127	-0.000533	-0.000602
	(1.20)	(1.41)	(-0.90)	(-0.88)
Constant	0.00145	0.339***	-0.00143**	0.00737
	(0.21)	(2.86)	(-2.35)	(0.58)
FirmControls	N	Y	N	Y
N	74	74	74	74
RSqr	0.0237	0.200	0.00956	0.0491

t statistics in parentheses

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

Table B.14: **Impact of Exposure on Borrowing Quantity and Cost** The regressions in this table examine the impact of the exposure to regulation on borrowings. In columns (1) and (2), the outcome variable is the change in borrowings scaled by assets. In columns (3) and (4), the outcome variable is the change in interest expenses scaled by assets. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Borr/Asset	(2) Borr/Asset
High Hedge=1 × Exposure	-0.0172	-0.0220
	(-1.04)	(-1.30)
Exposure	0.0215	0.0285*
	(1.52)	(1.94)
High Hedge=1	-0.0116	-0.0153
	(-0.78)	(-0.83)
Constant	0.00990	0.365***
	(0.79)	(2.87)
FirmControls	N	Y
N	74	74
RSqr	0.0475	0.234

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(a) High Hedge vs. Low Hedge Firms

	(1) Borr/Asset	(2) Borr/Asset
Exposure × Export Hedge Ratio	-0.00610	-0.0207
	(-0.99)	(-1.57)
Exposure	0.0114	0.0113
	(1.50)	(1.42)
Export Hedge Ratio	-0.00595	-0.000610
	(-0.72)	(-0.05)
Constant	0.00303	0.326***
	(0.45)	(2.74)
FirmControls	N	Y
N	74	74
RSqr	0.0536	0.253

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(b) Continuous Hedge Ratio

Table B.15: **Impact on Borrowings** The regressions in this table examine the impact of the regulation on borrowings. The outcome variable is the change in borrowings scaled by assets. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. The top panel uses $HighHedge_j$, which takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. The bottom panel uses $ExportHedgeRatio_j$, which is firm j's sold amount of FXD divided by export sales. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) LogExport	(2) LogExport (Orth)	(3) LogExport (Orth)
LogBorrowing	-0.0164		
	(-1.54)		
High Hedge=1 × Exposure		-0.199*	-0.164*
		(-1.98)	(-1.85)
Exposure		0.0507	0.0824
		(0.79)	(1.53)
High Hedge=1		0.138	0.0254
		(1.31)	(0.28)
Constant	0.299***	-0.0846	-1.640
	(5.40)	(-1.03)	(-1.22)
FirmControls	N	N	Y
N	74	74	74
RSqr	0.0319	0.0826	0.328

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(a) High Hedge vs. Low Hedge Firms

	(1) LogExport	(2) LogExport (Orth)	(3) LogExport (Orth)
LogBorrowing	-0.0164		
	(-1.54)		
Exposure × Export Hedge Ratio		-0.184***	-0.244***
		(-4.25)	(-3.02)
Exposure		-0.0467	-0.0494
		(-0.98)	(-0.92)
Export Hedge Ratio		0.0808	0.147**
		(1.23)	(2.20)
Constant	0.299***	0.00510	-1.711
	(5.40)	(0.11)	(-1.32)
FirmControls	N	N	Y
N	74	74	74
RSqr	0.0319	0.247	0.488

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(b) Continuous Hedge Ratio

Table B.16: **Impact on Exports after Orthogonalizing the Effects of Borrowings** The regressions in this table examine the impact of the regulation on exports, after orthogonalizing the effects from borrowings. In column (1), the outcome variable is the change in log export sales and the independent variable is the change in log borrowing. In columns (2) and (3), the outcome variable is the residual from the regression in column (1). The independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. The top panel uses $HighHedge_j$, which takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. The bottom panel uses $ExportHedgeRatio_j$, which is firm j's sold amount of FXD divided by export sales. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) Interest Exp/Asset	(2) Interest Exp/Asset
High Hedge=1 × Exposure	-0.000167	-0.000251
	(-0.14)	(-0.20)
Exposure	-0.000514	-0.000645
	(-0.59)	(-0.66)
High Hedge=1	0.00194*	0.00205
	(1.71)	(1.39)
Constant	-0.00270***	0.00404
	(-3.65)	(0.31)
FirmControls	N	Y
N	74	74
RSqr	0.0408	0.0767

t statistics in parentheses

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

(a) High Hedge vs. Low Hedge Firms

	(1) Interest Exp/Asset	(2) Interest Exp/Asset
Exposure × Export Hedge Ratio	-0.0000571	-0.000298
	(-0.10)	(-0.16)
Exposure	-0.000656	-0.000749
	(-1.14)	(-0.90)
Export Hedge Ratio	0.00118	0.00170
	(1.22)	(0.97)
Constant	-0.00161***	0.00774
	(-2.98)	(0.63)
FirmControls	N	Y
N	74	74
RSqr	0.0690	0.111

t statistics in parentheses

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

(b) Continuous Hedge Ratio

Table B.17: **Impact on Interest Expenses** The regressions in this table examine the impact of the regulation on interest expenses. The outcome variable is the change in interest expenses scaled by asset. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. The top panel uses $HighHedge_j$, which takes 1 if firm j sold amount of FXD is more than 10% of its export sales, and 0 if otherwise. The bottom panel uses $ExportHedgeRatio_j$, which is firm j's sold amount of FXD divided by export sales. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1) 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 B.18: **Impact on Bank FC Loans and FC Liabilities** The regressions in this table examine the impact of the regulatory shock on the foreign currency shares of bank lending and borrowing. Columns (2) and (4) add bank fixed effects. The sample period is 2008–2019 on a quarterly basis. Standard errors are clustered by bank. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.19: **Impact on Bank FC Loans and FC Liabilities, Foreign Banks** The regressions in this table examine the impact of regulation on the banks' foreign currency share of bank lending and borrowing, when I restrict the sample to foreign banks. All variables are defined in the Appendix.

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

t statistics in parentheses

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

Table B.20: **Impact on Bank FC Loans and FC Liabilities, Domestic Banks** The regressions in this table examine the impact of regulation on the bank foreign currency share of lending and borrowing when I restrict the sample to domestic banks. All variables are defined in the Appendix.

	(1) LogExport	(2) ExpShare
Exposure	-0.00553	0.00952
	(-0.11)	(1.08)
HighCash=1	0.242**	0.0350
	(2.15)	(1.57)
HighCash=1 × Exposure	0.00595	-0.0203
	(0.06)	(-0.89)
Constant	-1.641	-0.365
	(-1.34)	(-1.13)
FirmControls	Y	Y
N	74	74
RSqr	0.357	0.287

t statistics in parentheses

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

Table B.21: **Placebo Test of Impact of Internal Funds on Export Sales and Export Share** The regressions in this table examine the impact of the regulation and internal funds (cash balance) on export sales and share of export sales. The outcome variable is export sales or share of export sales. Independent variable $Exposure_j$ is the weighted average shock of firm j's FXD counterparty banks. $HighCash_j$ takes value of 1 if the firm's pre-shock cash and cash equivalent balance scaled by total assets is in the top 50 percentile. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

C Export Hedging Mechanism

In this section, I provide a simple framework of exporter hedging in order to offer theoretical foundations of empirical tests. The primary objective is to provide a mechanism in which firms optimally reduce exports when hedging becomes more costly.

Setting

Consider the model of Froot et al. (1993) where a firm faces a two-period investment and financing decision. I extend their basic paradigm by adding an earlier period in which the firm chooses the volatility of its internal funds via export and hedging decisions.

In the first period, the firm begins with initial internal funds w_0, and chooses export quantity q and the size of hedging q_H. Net cash flows from exports and hedging, as well as initial internal funds w_0, become internal funds w:

$$w = R(q) - C^q(q) + H^{CF}(q_H) - H^{Cost}(q_H)$$

where R denotes export revenue, C^q denotes production cost, H^{CF} denotes cash flow from the hedging contract, and H^{Cost} denotes hedging cost. q denotes export quantity, and q_H denotes hedging quantity. Without hedging, w is exposed to FX risk because export sale proceeds are in foreign currency.

I assume that all sales are coming from exports, and therefore revenue function $R(q)$ is the product of price in foreign currency, p, export quantity, q, and exchange rate, ϵ.[74] Following the assumptions that are standard in the literature, I assume that C^q is a convex product cost function such that the marginal cost increases in q (i.e., $C^{q''} > 0$), and the marginal hedging cost increases in the size of hedging.

Since exporters' revenue R *increases* in ϵ, they would enter hedging contracts that yield cash flows *decreasing* in ϵ. That is, H^{CF} decreases in ϵ. For simplicity, I consider hedging contracts with a linear payoff (e.g. forwards):

$$H^{CF} = (\epsilon_0 - \epsilon)q_H$$

where ϵ_0 is the forward price.

The firm enters the second period with internal funds w (in local currency) at hand, and chooses investment expenditure I and external financing need $e = I - w$ to maximize the net

[74] I define exchange rate ϵ as the value of foreign currency in terms of the local currency. (e.g. $1\,USD = \epsilon\,Won$)

expected profits:

$$E[P(w)] = \max_I E[F(I) - C(e)]$$

On the investment side, the net present value of investment expenditure is given by:

$$F(I) = f(I) - I$$

where investment function f is increasing and concave ($f' > 0, f'' < 0$). On the financing side, there are deadweight costs, $C(e)$, to the firm of external finance, such that $C_e \geq 0$.

In the third and final period, the output from the investment is realized and distributed to investors.

Firms' Optimal Strategy

To illustrate the mechanism, I provide firms' optimal strategy based on a numerical example with a set of specific functional forms of $C^q(q)$, $H^{Cost}(q_H; h)$, $F(I)$, and $C(e; k)$ that satisfy the assumptions stated in the setting. In particular, $H^{Cost}(q_H; h)$ increases in the hedging friction parameter, h, and external financing cost, $C(e; k)$, increases in the external financing friction parameter, k. I consider the following functional forms:

$$R(q) = pq\epsilon \tag{13}$$

$$C^q(q; c) = \frac{c}{2}q^2 \tag{14}$$

$$H^{CF}(q_H; \epsilon_0; \epsilon) = (\epsilon_0 - \epsilon)q_H \tag{15}$$

$$H^{Cost}(q_H; h) = \frac{h}{2}q_H^2 \tag{16}$$

$$f(I) = (2gI)^{\gamma_I} \tag{17}$$

$$C(e; k) = \frac{k}{2}e^{\gamma_C} \tag{18}$$

For simplicity, I assume a binary distribution for exchange rate ϵ:

$$\epsilon = \begin{cases} \epsilon_H \text{ w.p. } 0.5 \\ \epsilon_L \text{ w.p. } 0.5 \end{cases} \tag{19}$$

I use the following parameter values:

Parameter	Value
Forward Exchange Rate (ϵ_0)	1000
Realized Exchange Rate in High State (ϵ_H)	1300
Realized Exchange Rate in Low State (ϵ_L)	700
Product Price (p)	5
Production Cost Parameter (c)	1000
Investment Function Parameter (γ_I)	0.5
External Financing Cost Parameter (γ_C)	1.1
Investment Return Parameter (g)	100000

Table C.1: Parameters

Given the functional forms and parameter values, I solve for firms' optimal strategy with backward induction. In the second period, the firm chooses optimal investment $I^*(w)$ that maximizes firm value given internal fund w. Then, in the first period, the firm chooses optimal export q and hedge q_H, and therefore the distribution of internal fund w, that maximizes expected firm value $E[P(w)]$.

Figure C.1 shows that optimal investment in the second period, $I^*(w)$, is non-decreasing but bounded above. This upper bound is the optimal investment when the firm no longer has to resort to external financing. Therefore, any internal fund in excess of this upper bound does not contribute to investment.

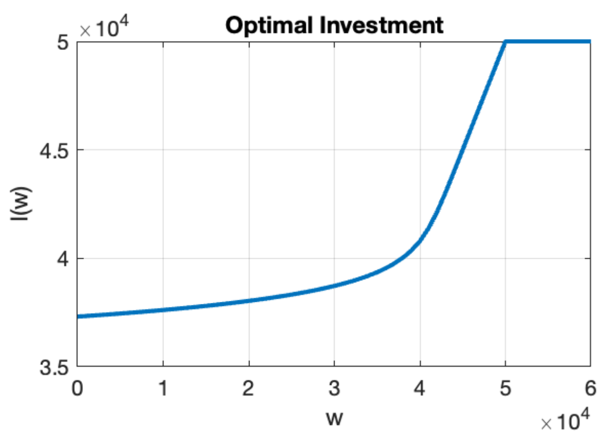


Figure C.1: **Optimal Investment given Internal Fund** $k = 0.1$ was used. Other parameter values are reported in Table C.1.

Given the optimal investment, the firm value $P(w)$ is concave in internal fund w, as shown in Figure C.2. As in Froot et al. (1993), this concavity causes expected firm value to decrease in the uncertainty of internal funds, thus generating "risk aversion". Consistent with optimal investment being bounded above, any internal fund in excess of the upper bound does not add value to the firm.

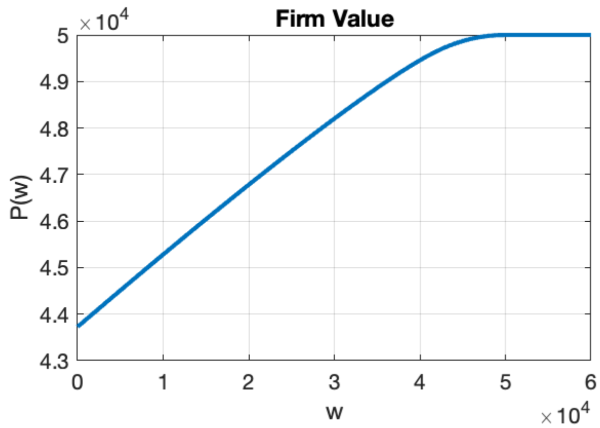


Figure C.2: **Firm Value given Internal Fund** $k = 0.1$ was used. Other parameter values are reported in Table C.1.

By varying the parameter h, Figure C.3 shows that the firm chooses to reduce exports and hedging when the hedging supply falls and hedging friction rises. The intuition is that, when the supply of hedging falls, the marginal cost of production is the same (at a given level of quantity) but the marginal benefit from exporting goes down because of the FX risk exposure from the export sales. Therefore, it is optimal for the firm to reduce exports.

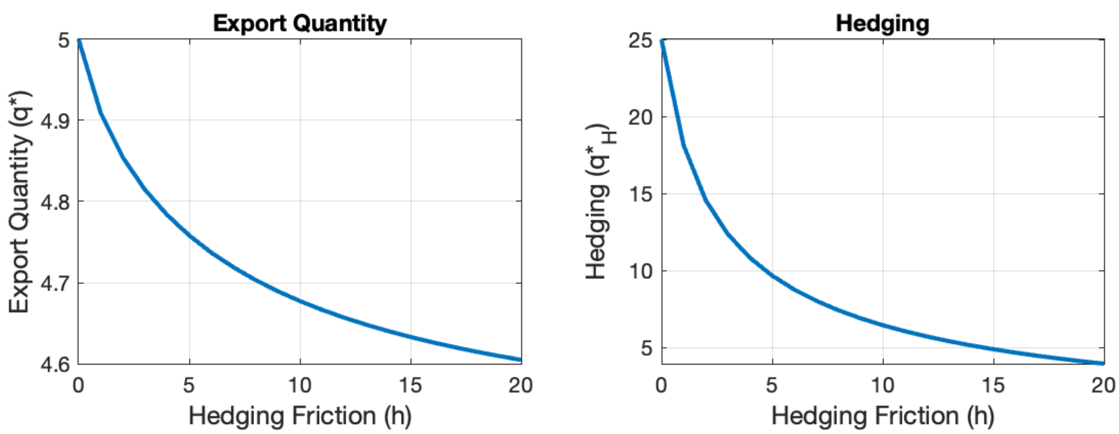


Figure C.3: **Export Quantity and Hedging Quantity as a Function of Hedging Friction** $k = 0.1$ and $w_0 = 25000$ were used. Other parameter values are reported in Table C.1.

At the same time, the mechanism also suggests that the firm value (net expected profits, $E[P(w)]$) also falls as the hedging cost rises, as depicted in Figure C.4, which adds to the validity of the framework.

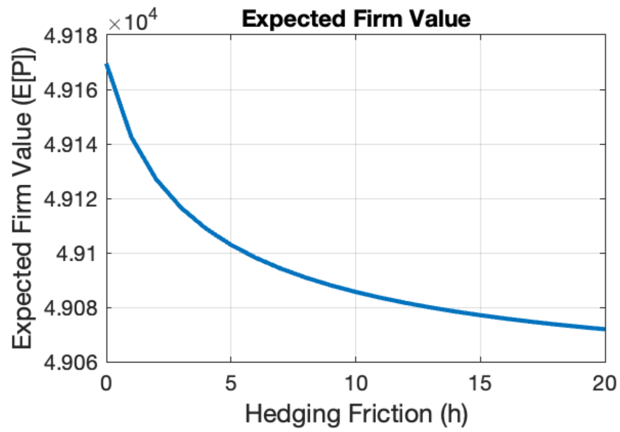


Figure C.4: **Expected Firm Value as a Function of Hedging Friction** $k = 0.1$ and $w_0 = 25000$ were used. Other parameter values are reported in Table C.1.

Additionally, Figure C.5 shows that hedging increases as the external financing cost rises. A lá Froot et al. (1993), the convexity of the external financing cost induces risk-averse behaviors of risk-neutral firms. In other words, the hedge ratio captures the extent of external financing friction, k.

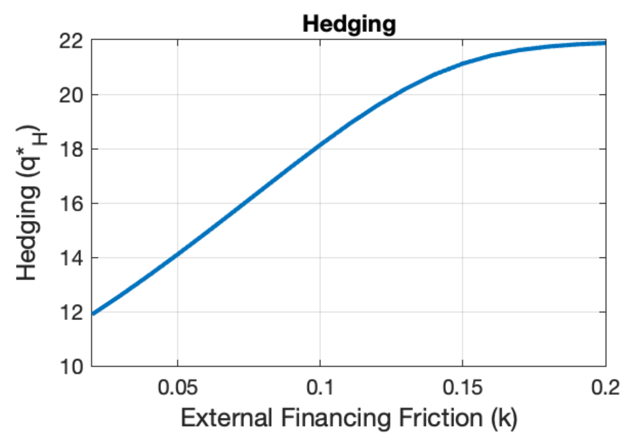


Figure C.5: **Hedging Quantity as a Function of External Financing Friction** $k = 0.1$ and $w_0 = 25000$ were used. Other parameter values are reported in Table C.1.

As hedging becomes more costly, the marginal cost of additional exports gets more expensive for firms with higher financing frictions. Because the firms that face higher financing frictions hedge more (as displayed in Figure C.6), high hedging firms are expected to reduce exports by more than low hedging firms when hedging becomes more expensive. The regression specification (10) tests this hypothesis.

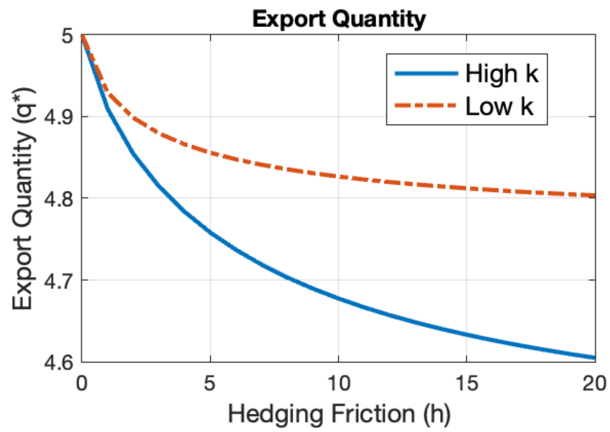


Figure C.6: **Reduction in Exports: High k vs. Low k Firms** $k_H = 0.1$, $k_L = 0.05$, and $w_0 = 25000$ were used. Other parameter values are reported in Table C.1.

In terms of borrowing, as hedging becomes more costly, firm borrowing increases. As depicted in Figure C.7, the increase is higher for firms with higher k, and therefore the sign of the interaction is positive.

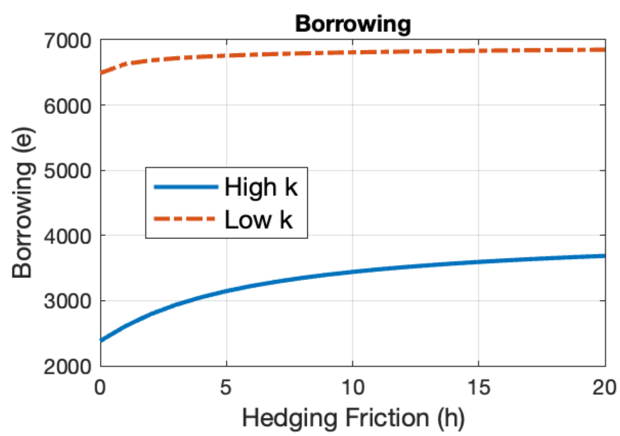


Figure C.7: **Borrowing vs. Hedging Friction** $k_H = 0.1$, $k_L = 0.05$, and $w0_H = 25000$ are used. Other parameter values are reported in Table C.1.

Triple Interaction of Internal Funds, External Financing Frictions, and Hedging Frictions

In this subsection, I rationalize the seemingly counterintuitive empirical finding from Table 12 that the higher the external financing friction and the higher internal funds firms hold, the more they will reduce exports.[75]

[75] I use the terms "cash" and "internal funds" interchangeably, as I use cash as a proxy for internal funds when linking the model to the data.

When hedging becomes more costly, all firms would reduce hedging. Then, the firm's next problem to solve is whether to continue exporting without hedging or to reduce exports, which represents a standard risk-return tradeoff. Facing this tradeoff, the "risk preference" is different across firms with high internal funds and those with low internal funds: firms with ample internal funds reduce exports substantially to avoid the exchange rate risk, whereas those with little internal funds maintain their unhedged exports to earn risk premium from exchange rate risk.

As firms with higher internal funds are more "risk averse", the model can generate the empirical pattern that the higher the external financing friction and the higher internal funds firms hold, the more they will reduce exports. This is visualized in Figure C.8.

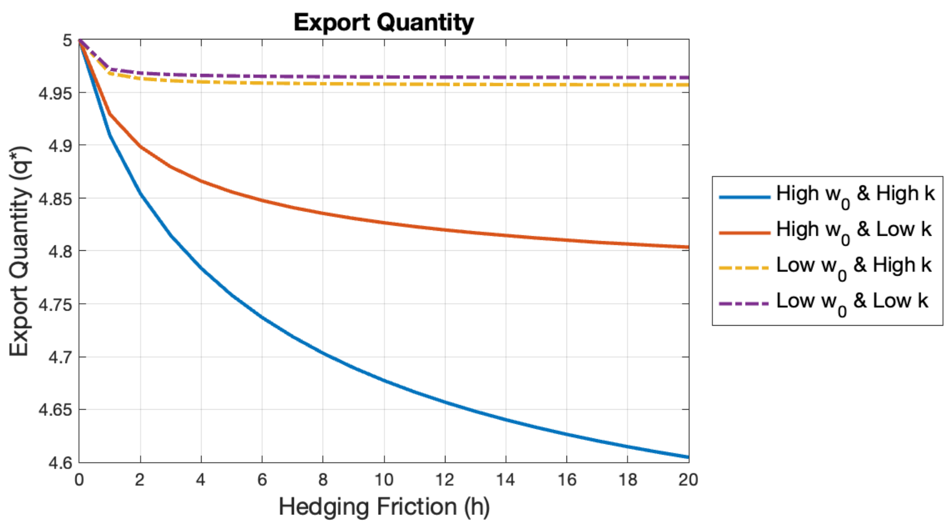


Figure C.8: **Reduction in Exports: Interaction of w_0 and k.** High $k = 0.1$, low $k = 0.05$, high $w_0 = 25000$, and low $w_0 = 0$ were used. Other parameter values are reported in Table C.1.

I further show that under the following range of variable values, numerical values of $\frac{\partial^3 q}{\partial h \partial k \partial w_o}$ are negative.

Variable	Value
External Financing Cost (k)	[0.05:0.1]
Internal Fund (w_0)	[0:25000]
Hedging Friction (h)	[0:20]

Table C.2: Range of Variable Values

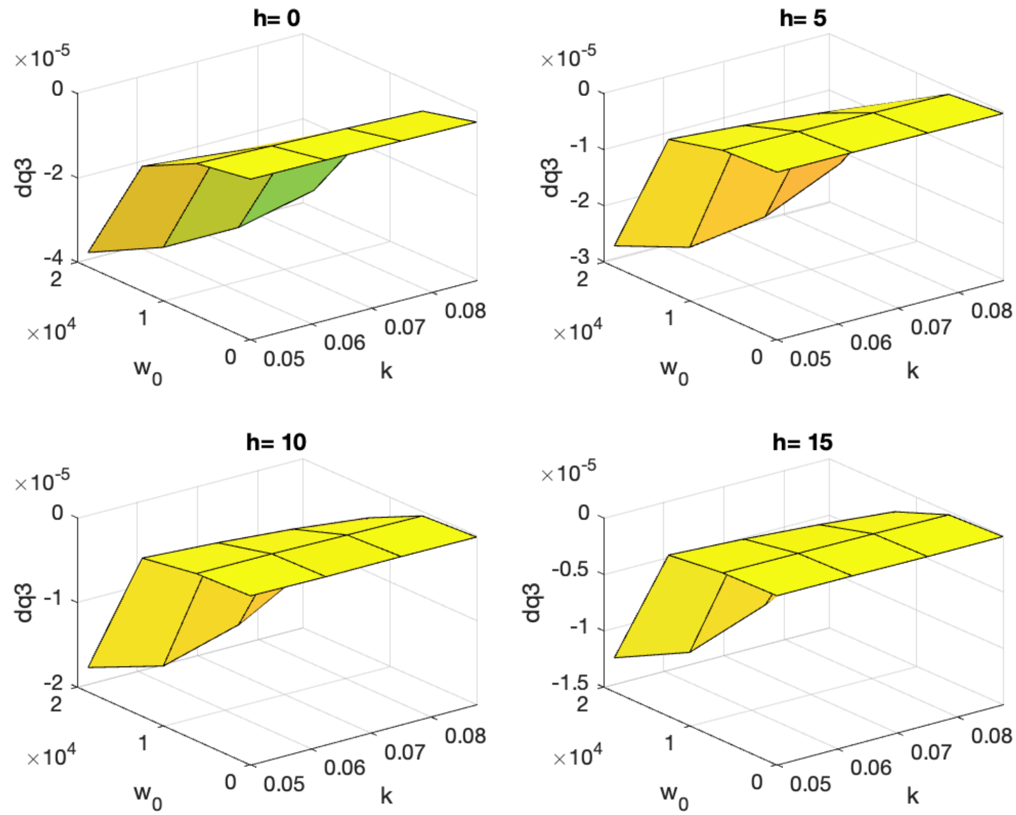


Figure C.9: Numerical value of $\frac{\partial^3 q}{\partial h \partial k \partial w_o}$ over a range of k, w_0, and h values

The corresponding numerical derivative values are reported below, and they confirm that the signs are negative:

	$k(1)$	$k(2)$	$k(3)$	$k(4)$
$w_0(1)$	-1.9741e-06	-2.1224e-06	-2.3012e-06	-2.5013e-06
$w_0(2)$	-4.0062e-06	-4.5092e-06	-5.0284e-06	-5.6362e-06
$w_0(3)$	-1.0399e-05	-1.2163e-05	-1.4172e-05	-1.6436e-05
$w_0(4)$	-3.6602e-05	-4.0057e-05	-4.0028e-05	-3.5896e-05

(a) $h = 0$

	$k(1)$	$k(2)$	$k(3)$	$k(4)$
$w_0(1)$	-2.4764e-07	-2.5628e-07	-3.1305e-07	-3.5146e-07
$w_0(2)$	-6.4387e-07	-8.2103e-07	-1.0036e-06	-1.2359e-06
$w_0(3)$	-3.0113e-06	-4.0374e-06	-5.3808e-06	-7.004e-06
$w_0(4)$	-2.635e-05	-3.0144e-05	-2.8223e-05	-2.2215e-05

(b) $h = 5$

	$k(1)$	$k(2)$	$k(3)$	$k(4)$
$w_0(1)$	-6.0174e-08	-1.3858e-07	-9.883e-08	-1.398e-07
$w_0(2)$	-2.9178e-07	-2.9861e-07	-4.1461e-07	-4.9794e-07
$w_0(3)$	-1.3211e-06	-1.8519e-06	-2.5764e-06	-3.5967e-06
$w_0(4)$	-1.7114e-05	-1.9282e-05	-1.6742e-05	-1.181e-05

(c) $h = 10$

	$k(1)$	$k(2)$	$k(3)$	$k(4)$
$w_0(1)$	-3.3936e-08	-2.9613e-08	-7.6015e-08	-6.4549e-08
$w_0(2)$	-1.5659e-07	-1.8141e-07	-2.0681e-07	-2.8094e-07
$w_0(3)$	-7.2116e-07	-1.0591e-06	-1.5369e-06	-2.1496e-06
$w_0(4)$	-1.1972e-05	-1.3251e-05	-1.0815e-05	-7.2775e-06

(d) $h = 15$

Table C.3: Numerical value of $\frac{\partial^3 q}{\partial h \partial k \partial w_o}$

The intuition behind the negative triple interaction is as follows: high k effectively makes the firm "risk-averse", high w_0 shifts the firm's internal wealth to a more "risk-averse" region of the "utility curve", and h represents how costly it is to hedge risk. Figure C.10 shows that absolute risk aversion, $A(w) = -\frac{P''(w)}{P'(w)}$, increases in w, suggesting that firms with high internal funds are more risk averse than those with low internal funds.

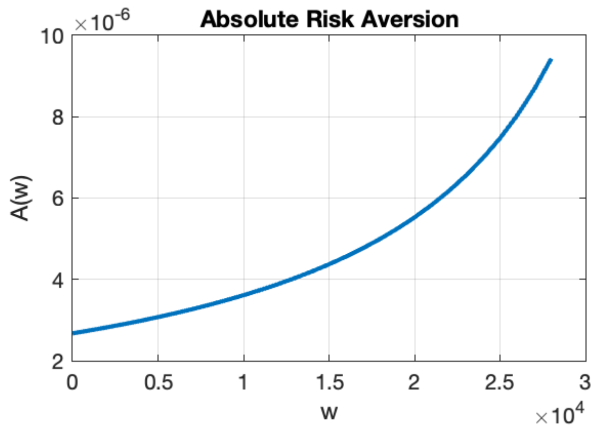


Figure C.10: Absolute Risk Aversion vs. Internal Fund ($\gamma_C = 1.1$)

In fact, stronger external financing friction and higher internal funds jointly increase the firm risk aversion; for any given level of internal funds, risk aversion is higher when external financing friction is stronger. This is presented in Figure C.11. Therefore, higher risk aversion from internal funds would reinforce the effects of hedging friction (h) and financing friction (k).

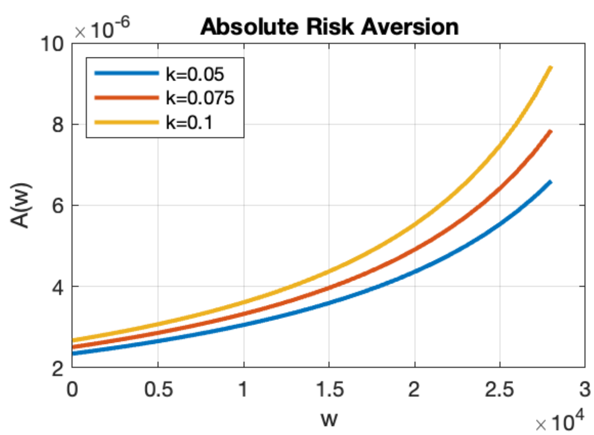


Figure C.11: Absolute Risk Aversion vs. Internal Fund and External Financing Friction ($\gamma_C = 1.1$)

However, note that the negative sign on the triple derivative, is not robust to all choices of functions and parameters. For instance, with a higher value of $\gamma_C = 2$, the triple derivative can be positive. This is because the absolute risk aversion may decrease in w depending on the choice of parameters, such as γ_C, which determines the convexity of the cost function $C(e)$. If γ_C is large, the triple interaction can be positive because firms with lower w_0 become more risk averse as shown in the figure below:

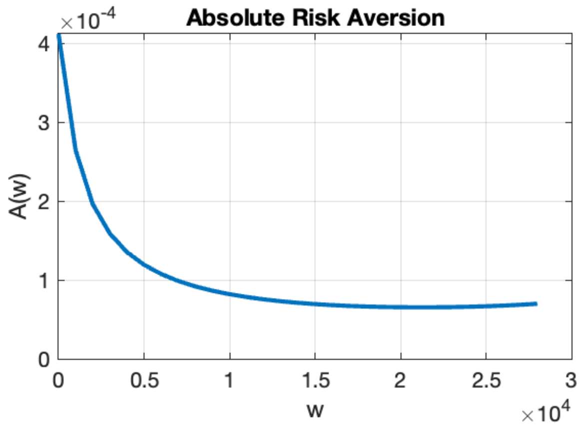


Figure C.12: Absolute Risk Aversion vs. Internal Fund ($\gamma_C = 2$)

That both results can be obtained from this setting depending on the parameters suggests that there are two countervailing forces. On one hand, firms with sufficiently large internal funds may be more "risk averse". This is because of asymmetry in risk-return tradeoff across favorable versus unfavorable realizations of the exchange rate. While the firm loses in an unfavorable state, it does not gain as much in a favorable state because it already has sufficient funds for investment. (See Figure C.1.) On the other hand, firms with less internal funds may be more "risk averse", as they face even steeper external financing costs from an unfavorable realization of the exchange rate. Therefore, the risk aversion increases in internal funds when the convexity of external financing cost, γ_C, is relatively small.

Internet Appendix to
"Real Consequences of Shocks to Intermediaries Supplying Corporate Hedging Instruments"

IA.A Background

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

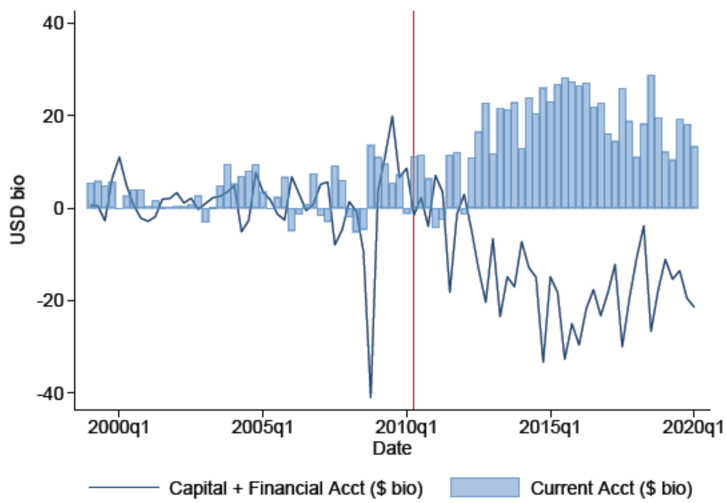


Figure IA.A.1: **Balance of Payments** Korea's balance of payments. The vertical line indicates the imposition of the regulation.

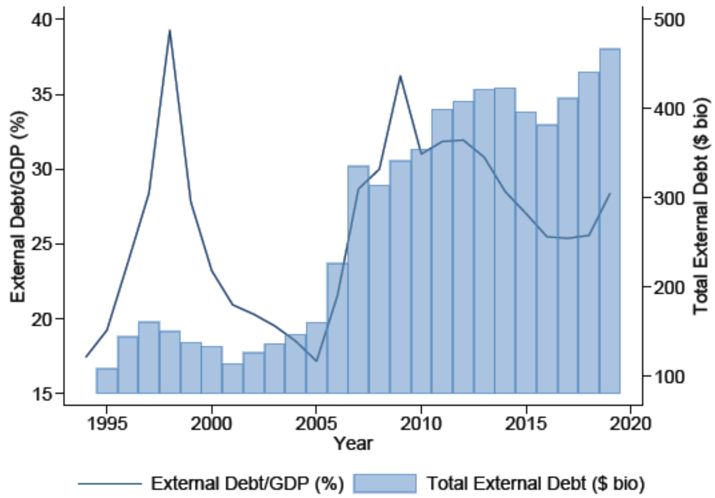


Figure IA.A.2: **Total External Debt** Korea's total external debt in billions of USD (bar) and external debt as a percentage of GDP (line).

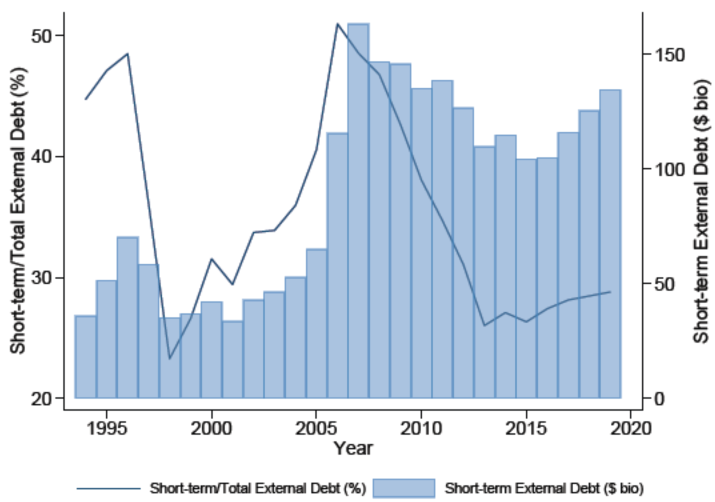


Figure IA.A.3: **Short-term External Debt** Korea's total short-term external debt in billions of USD (bar) and share of short-term external debt in percentage (line).

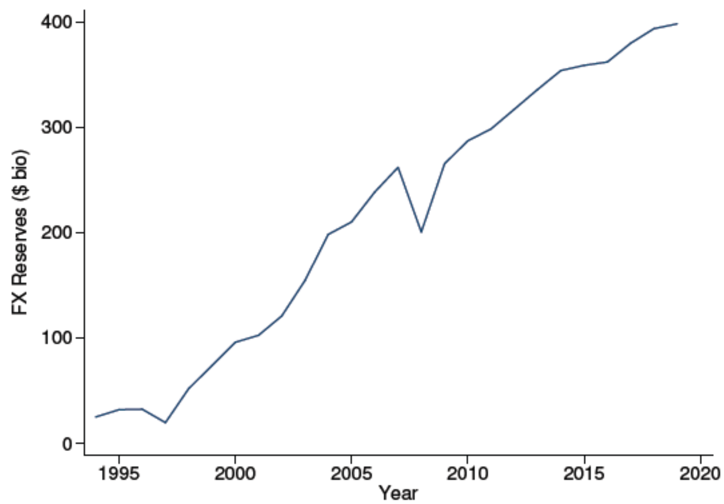


Figure IA.A.4: **FX Reserves** Bank of Korea's FX reserves in USD billion.

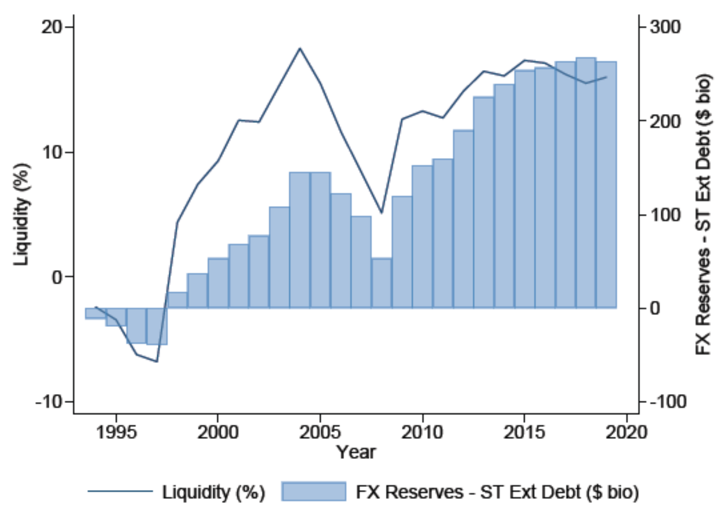


Figure IA.A.5: **FX Liquidity** Korea's FX reserves less short-term external debt in billions of USD (bar), and liquidity (line), defined as (FX Reserves - Short-term External Debt)/GDP.

IA.B Cash Flow Illustration

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

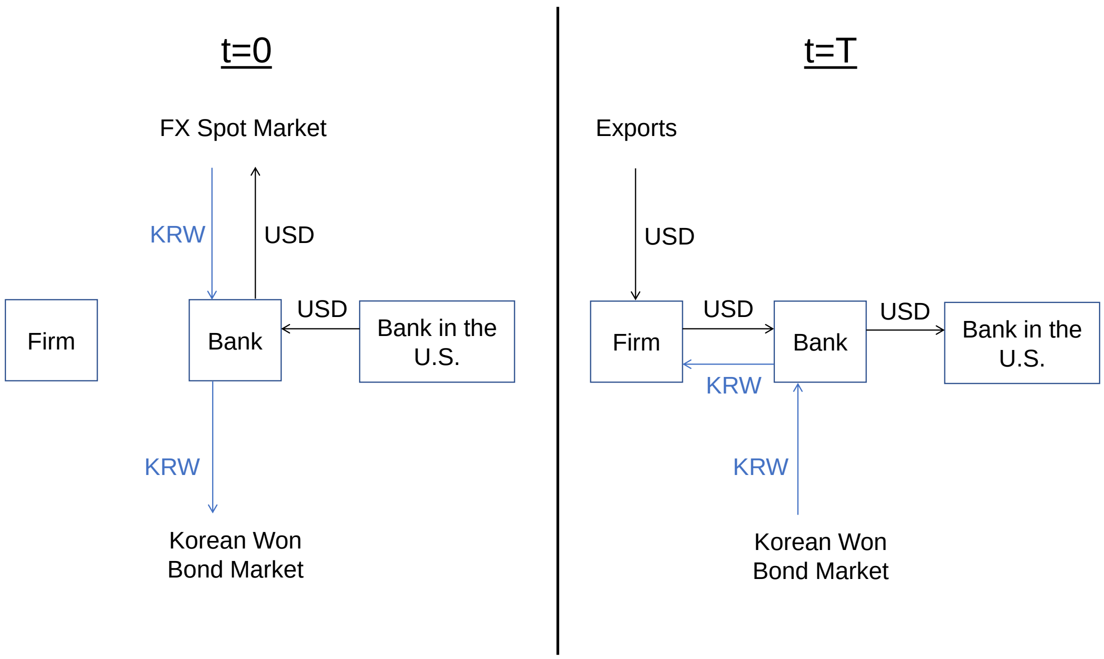


Figure IA.B.1: **Cash Flow Illustration** Consider the following transactions: (1) On $t = 0$ date, a firm (exporter) sells USD forward with maturity T to a bank. This does not involve any cash flows on $t = 0$ as it is a forward contract. On the same date, the bank borrows USD from its parent bank in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

IA.C Bank Names

	Bank	Full Name	Parent Country	Note
1	ANZ	Australia and New Zealand Bank	Australia	
2	BankComm	Bank of Communications	China	
3	BNP	BNP Paribas	France	
4	BNYMellon	BNY Mellon	US	
5	BOA	Bank Of America	US	
6	BOC	Bank Of China	China	
7	CCBC	China Construction Bank	China	
8	CIG	Credit Agricole Corporate and Investment Bank	France	
9	CS	Credit Suisse	Swiss	
10	DB	Deutsche Bank	Germany	
11	DBS	DBS	Singapore	
12	HSBC	HSBC	GB	
13	ICBC	Industrial and Commercial Bank of China	China	
14	ING	ING	Netherlands	
15	JPM	JP Morgan Chase	US	
16	Mellat	Mellat Bank	Iran	
17	MitsuiSumitomo	Mitsui Sumitomo	Japan	
18	Mizuho	Mizuho Bank	Japan	
19	MorganStanley	Morgan Stanley	GB	
20	MUFG	Mitsubishi UFJ	Japan	
21	Scotia	Scotia Bank	Canada	
22	SocGen	Societe Generale	France	
23	StateStreet	State Street	US	
24	UOB	United Overseas Bank	Singapore	
25	Yamaguchi	Yamguchi	Japan	
26	ABNRBS*	Royal Bank of Scotland	UK	RBS acquired ABN Amro in 2007 and RBS closed in 2014.
27	Barclays*	Barclays	UK	Closed in 2017.
28	GS*	Goldman Sachs International Bank	UK	Closed in 2017.
29	UBS*	UBS	Switzerland	Closed in 2017.
30	Busan	Busan Bank	Korea	
31	Citi	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.

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

IA.D Bank FXD Position before Regulation

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

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

IA.E Robustness Result on DiD

The figure below presents the results of specification (4) with the inclusion of closed banks, demonstrating that the findings are robust regardless of whether closed banks are included or excluded. The coefficient is not significantly different from 0 before the regulation but turns negative after the imposition of regulation and declines further as the regulation gets tighter.

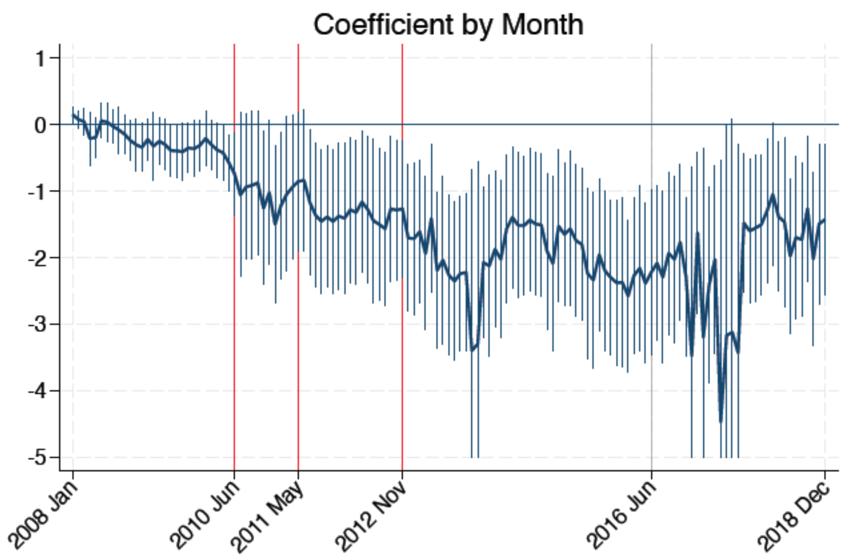


Figure IA.E.1: **Coefficient by Month: Robustness**

IA.F Summary Statistics of Subsamples

This section reports the summary statistics of subsamples.

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

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

	Full Sample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,619.693	5947.10	2,277.264	8795.78	1,231.489	3287.01	-1045.78	(-0.80)
FXDNet/Assets	-0.056	0.14	-0.052	0.15	-0.058	0.13	-0.01	(-0.25)
Sales (USD mio)	1,208.244	3400.29	1,500.800	4455.40	1,035.530	2601.87	-465.27	(-0.67)
FXDNet/Sales	-0.058	0.21	-0.037	0.21	-0.071	0.21	-0.03	(-0.88)
Number of Banks	2.288	2.21	2.531	2.14	2.145	2.25	-0.39	(-0.98)
Leverage	0.467	0.17	0.500	0.16	0.448	0.18	-0.05	(-1.74)
Gross Profit Margin	0.218	0.17	0.213	0.19	0.222	0.16	0.01	(0.29)
FC Asset Share	0.099	0.12	0.091	0.12	0.103	0.11	0.01	(0.56)
FC Liab Share	0.198	0.20	0.246	0.19	0.169	0.21	-0.08*	(-2.20)
Export Share	0.455	0.31	0.427	0.32	0.473	0.30	0.05	(0.79)
Export Hedge Ratio	0.357	0.68	0.385	0.67	0.339	0.70	-0.05	(-0.34)
FCL Hedge Ratio	0.295	0.46	0.314	0.45	0.283	0.47	-0.03	(-0.38)
Cash/Assets	0.080	0.07	0.074	0.07	0.083	0.08	0.01	(0.70)
Borrowings/Assets	0.195	0.14	0.208	0.15	0.187	0.13	-0.02	(-0.83)
Interest Exp/Assets	0.015	0.01	0.017	0.01	0.015	0.01	-0.00	(-1.11)
Observations	132		49		83		132	

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

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,378.542	3554.30	1,325.730	3535.54	1,404.095	3591.85	78.37	(0.10)
FXDNet/Assets	-0.163	0.20	-0.164	0.18	-0.162	0.21	0.00	(0.06)
Sales (USD mio)	1,082.764	2722.87	1,071.161	2615.15	1,088.378	2794.43	17.22	(0.03)
FXDNet/Sales	-0.208	0.30	-0.184	0.25	-0.219	0.32	-0.03	(-0.58)
Number of Banks	1.859	1.14	1.833	1.05	1.871	1.19	0.04	(0.15)
Leverage	0.487	0.19	0.500	0.17	0.481	0.20	-0.02	(-0.45)
Gross Profit Margin	0.199	0.14	0.210	0.19	0.194	0.12	-0.02	(-0.44)
FC Asset Share	0.131	0.12	0.124	0.12	0.135	0.12	0.01	(0.42)
FC Liab Share	0.166	0.21	0.205	0.19	0.148	0.21	-0.06	(-1.29)
Export Share	0.563	0.27	0.522	0.28	0.586	0.27	0.06	(1.00)
Export Hedge Ratio	0.595	0.79	0.661	0.81	0.558	0.79	-0.10	(-0.57)
FCL Hedge Ratio	0.413	2.69	1.011	4.55	0.103	0.48	-0.91	(-1.09)
Cash/Assets	0.093	0.08	0.085	0.08	0.097	0.08	0.01	(0.65)
Borrowings/Assets	0.193	0.13	0.206	0.14	0.186	0.13	-0.02	(-0.65)
Interest Exp/Assets	0.015	0.01	0.015	0.01	0.014	0.01	-0.00	(-0.05)
Observations	92		30		62		92	

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

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	1,487.513	3745.06	1,325.730	3535.54	1,580.850	3891.48	255.12	(0.30)
FXDNet/Assets	-0.162	0.20	-0.164	0.18	-0.161	0.22	0.00	(0.08)
Sales (USD mio)	1,160.832	2869.75	1,071.161	2615.15	1,212.566	3030.44	141.41	(0.22)
FXDNet/Sales	-0.208	0.30	-0.184	0.25	-0.221	0.33	-0.04	(-0.57)
Number of Banks	1.817	1.03	1.833	1.05	1.808	1.03	-0.03	(-0.11)
Leverage	0.477	0.19	0.500	0.17	0.464	0.19	-0.04	(-0.86)
Gross Profit Margin	0.204	0.14	0.210	0.19	0.200	0.12	-0.01	(-0.29)
FC Asset Share	0.130	0.12	0.124	0.12	0.134	0.12	0.01	(0.36)
FC Liab Share	0.178	0.22	0.205	0.19	0.163	0.23	-0.04	(-0.89)
Export Share	0.564	0.27	0.522	0.28	0.588	0.27	0.07	(1.04)
Export Hedge Ratio	0.597	0.80	0.661	0.81	0.560	0.80	-0.10	(-0.54)
FCL Hedge Ratio	0.457	2.84	1.011	4.55	0.118	0.53	-0.89	(-1.07)
Cash/Assets	0.096	0.09	0.085	0.08	0.103	0.09	0.02	(0.94)
Borrowings/Assets	0.192	0.13	0.206	0.14	0.184	0.13	-0.02	(-0.71)
Interest Exp/Assets	0.014	0.01	0.015	0.01	0.014	0.01	-0.00	(-0.32)
Observations	82		30		52		82	

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

	FullSample		Exposed		Non-Exposed		Difference	
	mean	sd	mean	sd	mean	sd	b	t
Assets (USD mio)	541.577	1589.81	529.287	1357.29	549.057	1730.51	19.77	(0.05)
FXDNet/Assets	-0.120	0.13	-0.141	0.14	-0.106	0.12	0.03	(1.08)
Sales (USD mio)	481.355	1218.33	521.483	1483.71	456.929	1041.86	-64.55	(-0.20)
FXDNet/Sales	-0.144	0.19	-0.146	0.15	-0.142	0.21	0.00	(0.10)
Number of Banks	1.878	1.05	1.893	1.07	1.870	1.05	-0.02	(-0.09)
Leverage	0.454	0.18	0.482	0.16	0.437	0.19	-0.05	(-1.11)
Gross Profit Margin	0.210	0.15	0.218	0.19	0.206	0.12	-0.01	(-0.29)
FC Asset Share	0.134	0.13	0.127	0.13	0.137	0.13	0.01	(0.33)
FC Liab Share	0.183	0.22	0.215	0.20	0.164	0.24	-0.05	(-1.01)
Export Share	0.546	0.27	0.518	0.28	0.562	0.27	0.04	(0.67)
Export Hedge Ratio	0.519	0.78	0.574	0.75	0.486	0.80	-0.09	(-0.47)
FCL Hedge Ratio	0.097	0.44	0.143	0.47	0.067	0.43	-0.08	(-0.69)
Cash/Assets	0.098	0.09	0.084	0.08	0.106	0.09	0.02	(1.02)
Borrowings/Assets	0.195	0.13	0.215	0.14	0.182	0.13	-0.03	(-0.99)
Interest Exp/Assets	0.014	0.01	0.015	0.01	0.014	0.01	-0.00	(-0.72)
Observations	74		28		46		74	

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

IA.G Net FXD Buying Firms and Selling Firms

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

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

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

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

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

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

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

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

t statistics in parentheses

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

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

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

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

t statistics in parentheses

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

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

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

t statistics in parentheses

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

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

IA.I Robustness Results on Firm Profitability

This section reports robustness results regarding the impact of regulation on firm profitability by examining firms' earnings before interests and taxes (EBIT).

	(1) Full Sample	(2) Full Sample	(3) Exporter	(4) Exporter	(5) Non-exporter	(6) Non-exporter
Exposed	-0.0169	-0.0157	-0.0339**	-0.0320*	0.00725	0.00595
	(-1.46)	(-1.31)	(-2.13)	(-1.83)	(0.49)	(0.38)
Constant	0.0226***	-0.136	0.0258**	-0.167	0.0166	-0.101
	(2.64)	(-1.44)	(2.15)	(-1.24)	(1.60)	(-0.69)
FirmControls	N	Y	N	Y	N	Y
N	148	148	92	92	56	56
RSqr	0.0116	0.0489	0.0352	0.0805	0.00419	0.0768

t statistics in parentheses

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

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

	(1) Full Sample	(2) Full Sample	(3) Exporter	(4) Exporter	(5) Non-exporter	(6) Non-exporter
Exposed	-0.0174	-0.0163	-0.0320*	-0.0310	0.00296	0.00230
	(-1.39)	(-1.22)	(-1.85)	(-1.56)	(0.18)	(0.13)
Constant	0.0209**	-0.110	0.0225*	-0.127	0.0178	-0.107
	(2.20)	(-0.83)	(1.71)	(-0.53)	(1.51)	(-0.58)
FirmControls	N	Y	N	Y	N	Y
N	132	132	82	82	50	50
RSqr	0.0120	0.0437	0.0310	0.0680	0.000642	0.0704

t statistics in parentheses

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

Table IA.I.2: **Impact on Firm Earnings by Net FXD Position, Fully Disclosed Firms** The regressions in this table examine the impact of the regulation on firm earnings. The outcome variable is the change in earnings before interests and taxes (EBIT) scaled by assets. Independent variable *Exposed* is 1 if the firm's main FXD counterparty bank is constrained. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.

	(1)	(2)
	EBIT/Asset	EBIT/Asset
High Hedge=1 × Exposure	-0.0204	-0.0202
	(-1.38)	(-1.22)
Exposure	-0.00585	-0.00698
	(-0.56)	(-0.54)
High Hedge=1	0.0279	0.0292
	(1.66)	(1.56)
Constant	-0.00374	-0.234
	(-0.34)	(-0.91)
FirmControls	N	Y
N	74	74
RSqr	0.0881	0.127

t statistics in parentheses

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

Table IA.I.3: **Impact on Firm Earnings** The outcome variable is the change in earnings before interests and taxes (EBIT) scaled by assets. The independent variable $Exposure_j$ is the weighted average shock of 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 seven industry dummies. All variables are defined in the Appendix.

IA.J Robustness Results on Credit Channel

This section reports robustness results regarding the credit channel.

	(1) LogExport	(2) LogExport
High Hedge=1 × Exposure	-0.199*	-0.164*
	(-1.97)	(-1.83)
Exposure	0.0506	0.0825
	(0.78)	(1.52)
High Hedge=1	0.138	0.0256
	(1.30)	(0.28)
Change in LogBorrowing	-0.0160**	-0.0149**
	(-2.55)	(-2.63)
Constant	0.215**	-1.366
	(2.60)	(-1.00)
FirmControls	N	Y
N	74	74
RSqr	0.112	0.349

t statistics in parentheses

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

(a) High Hedge vs. Low Hedge Firms

	(1) LogExport	(2) LogExport
Exposure × Export Hedge Ratio	-0.186***	-0.250***
	(-4.30)	(-3.14)
Exposure	-0.0460	-0.0497
	(-0.96)	(-0.93)
Export Hedge Ratio	0.0792	0.143**
	(1.19)	(2.12)
Change in LogBorrowing	-0.0197***	-0.0198***
	(-2.88)	(-2.70)
Constant	0.305***	-1.360
	(6.33)	(-1.03)
FirmControls	N	Y
N	74	74
RSqr	0.273	0.505

t statistics in parentheses

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

(b) Continuous Hedge Ratio

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

	(1)	(2)	(3)	(4)
	Borrowing/Asset	Borrowing/Asset	Interest Exp/Asset	Interest Exp/Asset
Exposed	0.00660	0.00915	-0.00123	-0.00123
	(0.48)	(0.60)	(-1.23)	(-1.12)
Constant	0.00168	0.0345	-0.000663	-0.00136
	(0.21)	(0.30)	(-0.87)	(-0.14)
FirmControls	N	Y	N	Y
N	92	92	92	92
RSqr	0.00258	0.108	0.0119	0.0704

t statistics in parentheses

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

Table IA.J.2: **Impact of Exposure on Borrowing Quantity and Cost, All Exporters** The regressions in this table examine the impact of exposure to regulation on borrowing quantity and cost. The outcome variable is the change in borrowings scaled by assets in columns (1) and (2), and the change in interest expenses scaled by assets in columns (3) and (4). Independent variable $Exposed_j$ is a dummy variable that takes a value of 1 if firm j's FXD counterparty bank was exposed. Firm controls include log size, net FXD notional (scaled by sales) before the shock, foreign currency liability share, and seven industry dummies. All variables are defined in the Appendix.