The Federal Reserve's Tightening, Risk Management, Default Likelihood and Firm Value: Evidence from Korean Banking Industry

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Abstract

I examine the relationship between the Federal Reserve's tightening, a bank's foreign currency risk management, default likelihood, and bank value. Using a unique dataset of banks' currency maturity gaps, I find that the Fed's tightening is positively associated with a bank's currency duration gap. I also find that a bank's currency duration gap is significantly negatively correlated with the likelihood of defaults on its foreign currency debts but positively associated with its bank value. The empirical results suggest that emerging market banks prioritize foreign currency liquidity risk management over the improvement of the market value of net worth, particularly during the Fed's tightening period. Lastly, I document that banks time the currency market even when they are ostensibly hedging their currency risk.

Keywords: foreign currency, duration gap, risk management, speculation, hedge, default likelihood, firm value, monetary policy

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1. Introduction

Banks are inherently exposed to interest rate risk through their financial intermediation, which necessitates mismatches in the maturities of their assets and liabilities in order to enhance their profits. Typically, banks finance funds through short-term instruments at lower costs and invest them in long-term assets to increase their returns. This balance sheet mismatch, however, frequently results in a sharp decline in a bank's profitability in the event that a monetary policy shock occurs. For instance, during the recent Federal Reserve's monetary policy tightening, several financial institutions encountered declining profitability and deteriorating capital adequacy ratios.[1] Silicon Valley Bank, Signature Bank, and First Republic Bank in the United States failed in March 2023 as a result of Fed's interest rate increases. As interest rates rose, the value of the banks' assets decreased, which might have led to depositors' bank runs.[2] However, monetary policy affects bank balance sheets and profitability differently.[3]

Moreover, banks are exposed to not only domestic interest rate risk but also foreign interest rate shocks by operating with foreign currencies and holding assets and liabilities in those currencies.[4] Banks that engage in foreign currency transactions are exposed to foreign exchange rate risk as well as foreign interest rate risk. Foreign exchange rate risk arises from the mismatch between the amounts of assets and liabilities in foreign currency holdings, while foreign interest rate risk results from the mismatch in the maturities of assets and liabilities in foreign currencies.

[1] Federal Reserve raises the target range for the federal funds rate or engages in quantitative tightening by reducing its securities holdings during its monetary policy tightening.
[2] For example, Silicon Valley Bank suffered $1.8 billion losses as a result of the sale of its bonds.
[3] Kashyap and Stein (1995) show that the loan and security portfolios of small and large banks respond differentially to monetary policy changes.
[4] Grammatikos, Saunders, and Swary (1986) analyze U.S. banks' foreign currency positions and show that they are exposed to exchange rate risk as well as interest rate risks.

Banks borrow foreign currencies on a short-term basis and invest them in longer-term assets, including loans and bonds. In particular, banks in emerging markets finance dollars in the short term by borrowing directly from banks in advanced countries or issuing dollar floating-rate notes, which they then lend to domestic firms in the long term. The Federal Reserve's monetary policy stance has a substantial impact on these banks' operations in foreign currencies.[5] As the Fed raises interest rates, the cost of borrowing in dollars rises as well. The returns on longer-term assets, on the other hand, do not vary quickly since they are typically fixed for the long term. As a result, the foreign currency profitability of emerging market banks is typically exacerbated by the Fed's tightening. Furthermore, the dollar liquidity in emerging markets is typically restricted during the Fed's tightening period as global capital is repatriated from the riskier emerging markets. Consequently, emerging market banks' dollar debt roll-over risks increase. If they do not appropriately manage the roll-over risk, the banks' default risk will soar.

The literature also suggests that if a bank's foreign currency exchange rate and interest rate risks are not fully diversified away, they should hedge it in order to increase its market value. For instance, Diamond (1984) implies that banks can reduce the cost of delegated monitoring by diversifying internally, and if banks do not diversify away risks, they should avoid taking them. Simth and Stulz (1985) show that firms can increase their market value through hedging. Froot, Scharfstein, and Stein (1993) demonstrates that hedging reduces the cost of external financing and financial distress cost. Banks implement foreign currency risk management in two ways. First, banks typically use derivatives to manage foreign exchange rate risk. A bank may hedge a long (short) spot position in a foreign currency by taking short (long) positions in derivatives.[6] Second,

[5] The Federal Reserve's policy has a significant effect on the foreign currency operations of banks, as over 80% of foreign currency transactions and investments involve U.S. dollars.

[6] Banks may buy (sell) foreign currency forwards contracts or purchase call (put) options to take a long (short) position in derivatives.

banks engage in on-balance-sheet risk management to hedge foreign currency interest rate risks. The previous studies measure a bank's exposure to foreign exchange rate and interest rate risks by regressing its market value or stock returns on foreign exchange rates and interest rates.[7] However, in order to study how banks respond to changes in the Federal Reserve's monetary policy stance, it is essential to examine a bank's on-balance-sheet and off-balance-sheet risk management strategies.[8] Banks increase (decrease) the duration of their liabilities (assets) to hedge the interest rate risk. If the average duration of liabilities exceeds that of assets, the value of liabilities decreases faster than that of assets as interest rates increase. Banks generally employ their duration gaps, or the difference between the average asset duration and the average liability duration, to effectively manage interest rate risk. Specifically, if banks expect interest rates to rise, they decrease their duration gaps. On the other hand, banks may increase their duration gaps when they anticipate a decline in interest rates.

This study investigates emerging market banks' foreign exchange rate and interest rate risk management by raising two primary research questions: (i) Are banks' foreign exchange rate risk management practices significantly affected by exchange rate changes? More specifically, I examine whether banks are actually hedging their foreign exchange rate risk or attempting to time the market as the exchange rate changes. (ii) Do banks aggressively hedge foreign currency interest rate risk on their balance sheets to manage price risk, or do they prioritize managing liquidity and roll-over risk? Do banks also take the risk by timing the market?

These questions are intimately related to the effects of the Federal Reserve's monetary policy. A bank's foreign exchange rate and interest rate risk management practices are influenced

[7] For example, see Flannery and James (1984), Choi, Elyasiani, and Kopecky (1992), Choi and Elyasiani (1997), and Schrand (1997).

[8] Purnanandam (2007) and Esposito et al. (2015) analyze a bank's asset-liability maturity gap and the use of derivatives to examine its interest rate hedging strategy.

by the Federal Reserve's monetary policy shifts in two distinct ways. First, the Federal Reserve's tightening tends to drive up the dollar exchange rates in emerging markets.[9] If banks speculate in spot currency markets, their foreign currency spot long position will increase as the dollar exchange rate rises.[10] In contrast, if banks hedge exchange rate risk, they will employ derivatives to minimize their foreign currency composite position, which is the sum of spot and derivative positions. Moreover, if banks engage in hedge timing, their composite position will increase as the exchange rate rises, even if they take derivative positions in the opposite direction of spot positions.

Second, the Federal Reserve's monetary policy stance affects a bank's duration gap in foreign currency. During the Federal Reserve's tightening, banks that attempt to improve their foreign currency net worth, which is the difference between the total value of assets and that of liabilities in foreign currency, will reduce their duration gap as foreign currency interest rates rise. However, if banks focus more on managing foreign currency liquidity risk and debt roll-over risk, they will reduce the liability duration faster than the asset duration in foreign currency as the Federal Reserve tightens policy.[11] As a result, the foreign currency duration gap would increase. In contrast, during the Federal Reserve's easing, banks attempting to raise their net worth may increase the foreign currency duration gap by increasing average asset duration faster than average liability duration in foreign currency. However, if banks prioritize managing foreign currency liquidity and roll-over risk, they will raise dollar long-term debts faster than short-term liabilities, aided by enhanced dollar liquidity in Eurodollar credit markets. In addition, if banks engage more in dollar liquidity and roll-over risk management, they will increase long-term dollar debts faster

[9] In emerging markets, exchange rates are typically quoted in local currency per U.S. dollar.

[10] Foreign currency spot long positions are typically calculated by subtracting the amount of liabilities from assets denominated in a foreign currency.

[11] To reduce the liability duration in foreign currency, banks may aggressively borrow foreign currency for the short term and reduce long-term debts. In addition, banks are more likely to reduce their long-term dollar debts to deal with credit crunch and rising borrowing costs during the Federal Reserve's tightening. However, Due to the dollar liquidity pressure, banks may find it difficult to reduce long-term assets relative to short-term assets.

than long-term dollar assets. As a result, banks' foreign currency duration gaps may decline during the Federal Reserve's easing period. Therefore, the relationship between a bank's foreign currency duration gap and dollar interest rates depends on a bank's risk management strategy. Finally, the following question naturally arises: Can banks increase bank value by increasing the foreign currency duration gap? If banks can effectively reduce the likelihood of default on foreign currency debts by increasing the duration gap during the Federal Reserve's tightening, they may enhance their market value.

Using a unique data set from all Korean banks, I investigate banks' foreign currency exchange rate and interest rate risk management practices in response to variations in the dollar exchange rate and interest rate stemming from the U.S. Federal Reserve's monetary policy stance. My data set includes information on a bank's foreign currency asset-liability maturity gaps, foreign exchange spot and derivative positions, use of derivatives for hedging purposes, foreign currency debt credit ratings, and bank market values. Since 1999, the Federal Reserve has changed its monetary policy stance eight times, shifting from tightening to easing or from easing to tightening, as illustrated in Figure 1. There were four rounds of easing and four rounds of tightening. The most recent round of tightening began in March 2022 and concluded in September 2024[12]. I categorize the sample period from 1999 to 2023 into two parts: the Federal Reserve's tightening period and the easing period.[13] Figure 1 also demonstrates that the effective federal funds rate (EFFR) is closely tied to the Fed's target policy interest rate. Additionally, the EFFR is strongly correlated with commercial banks' three-month dollar CD rates, which represent dollar short-term interest

[12] The Federal Open Market Committee (FOMC) determined to cut the target range for federal funds rate by 50 basis points from 5.25% – 5 .50% to 5% – 5.25% on September 19, 2024.
[13] The details of the Fed's monetary policy changes are displayed in Table 10.

rates in the money market.[14]

First, I find that a bank's foreign currency spot position is significantly positively associated with the foreign exchange rate.[15] As the dollar appreciates, banks appear to increase (decrease) their foreign currency long (short) spot position. Banks typically hedge their spot positions by taking forward positions in the opposite direction. Strikingly, I find that a bank's foreign currency composite position may also be significantly influenced by exchange rate changes, as illustrated in Figure 2. This finding is meaningful in that banks are speculating in the market when they decide on their foreign currency spot positions, while they are still timing the market even when they hedge their spot positions.[16]

Second, I discover that the increase in the foreign interest rate exacerbates a bank's foreign currency profitability.[17] Banks typically borrow foreign currency on a short-term basis, with interest rates reset every three to six months. Banks, on the other hand, are unable to promptly modify their interest rates on foreign currency loans and securities because the maturities of these assets are usually long term, and their interest rates are more often than not fixed. As a result, as foreign currency borrowing interest rates increase, so do foreign currency lending returns, but not to the same extent as borrowing costs, resulting in lower net interest returns. As illustrated in Figure 3, banks' net returns on foreign currency loans decrease (increase) as foreign currency borrowing costs increase (decrease). Furthermore, the net returns on foreign currency loans decline during the Fed's tightening period and rise during the easing period.

Third, I find that banks' foreign currency duration gap is significantly positively correlated

[14] The effective federal funds rate (EFFR) is calculated as a volume-weighted median of overnight federal funds transactions by the Federal Reserve Bank of New York.
[15] I use the Korean won (KRW) per U.S. dollar (USD) exchange, KRW/USD, as a proxy for the foreign exchange rate.
[16] Baker and Wurgler (2002) and Faulkender (2005) contend that firms are timing the market when they make capital structure decisions. Chance and Kim (2018) show that firms time the currency market even when they try to hedge.
[17] Freixas (2008) also contends that a bank's net profit margin decreases as interest rates rise.

with foreign currency interest rates. Figure 3 also demonstrates that foreign currency duration gaps rise during the Fed's tightening period and fall during the Fed's easing period. I measure a bank's foreign currency duration gap using its foreign currency asset-liability maturity gaps over multiple time intervals.[18] This finding is striking as banks typically increase (decrease) their asset durations more rapidly than their liability durations when interest rates fall (rise), which leads to an increase in the market value of their net worth. In other words, banks that are motivated to enhance their market value should reduce the duration gap when interest rates rise, according to theory.[19] However, this general approach may not be necessarily applicable to the foreign currency operating strategies of emerging market banks. The management of their liquidity risk and debt roll-over risk in foreign currency is of greater importance than merely enhancing profitability because, as the 1998 Asian Financial Crisis demonstrated, the Federal Reserve's tightening frequently resulted in a credit crunch and liquidity drain in the global money market.

Fourth, I discover that the likelihood of default on a bank's foreign currency debts diminishes as the bank's foreign currency duration gap increases. This is because the bank's foreign currency duration gap has a significant positive relationship with its foreign currency liquidity and roll-over risk management. The effect of a bank's risk management on the likelihood of a foreign currency default is more apparent during the Fed's tightening period than during the easing period. In addition, I also find that banks that more actively manage their credit default risk can reduce the likelihood of their foreign currency defaults to a greater extent than the those that manage such risk less actively. For example, banks may enhance their foreign currency credit

[18] A stringent risk management policy in Korea mandates that banks disclose their foreign currency maturity gaps across seven categories on a quarterly basis: within one week, within one month, within three months, within six months, within one year, within three years, and exceeding three years.

[19] If interest rates increase and the duration gap is positive, the value of assets decreases faster than the value of liabilities, and thereby the bank's net worth decreases.

ratings by one to two notches by implementing active credit risk management. Finally, I find that a bank's market value is significantly positively correlated with its foreign currency duration gap as well as credit risk hedging. Banks enhance their bank value by actively hedging foreign currency liquidity and roll-over risks using duration gap management, as well as actively managing credit default risks. Prior studies also document that hedging increases firm value.[20]

This paper contributes to the literature in several ways. First, I find that banks are speculating in currency markets and engaging in hedge timing even if they ostensibly attempt to be hedging their currency exposure. The existing studies rarely investigate whether banks hedge or speculate on their currency exposure. Second, I also find that emerging market banks' foreign currency duration gaps are significantly influenced by the Federal Reserve's monetary policy stance and are positively associated with the dollar interest rates. To the best of our knowledge, this is the first study that documents this striking correlation between the foreign currency duration gap and interest rates. Third, this study relates a bank's duration gap management to foreign currency liquidity risk management and the likelihood of defaults. I find that banks can reduce the likelihood of foreign currency defaults by actively engaging in risk management, particularly during the Fed's tightening period. Fourth, this study finds that banks can increase their market value by active credit risk management and liquidity risk management using the duration gap.

The remainder of the paper is structured in the following manner. Section 2 reviews prior research on risk management and duration gap. Section 3 presents a conceptual framework for analyzing foreign currency duration gap, the likelihood of defaults, risk management, and bank value. Section 4 provides empirical methods and data descriptions. In Section 5, I present empirical findings, followed by conclusions in Section 6.

[20] For example, see Smith and Stulz (1985), Allayannis and Weston (2001), and Graham and Rogers (2002), and Carter, Rogers, and Simkins (2006).

2. Literature Review

2.1 Should firms hedge?

Firms have no incentives to hedge themselves in a frictionless world suggested by Modigliani and Miler's (1958). However, firms must deal with the costs of taxes, insolvency, and financial distress in the real world. Firms hedge in order to diminish such costs by stabilizing their cash flows. Previous studies have developed theoretical frameworks that explain why hedging reduces costs and thus, increases market value. Smith and Stulz (1985) demonstrate how firms use hedging to reduce tax expenses, avoid financial distress, and improve debt capacity. Froot et al. (1993) show that if a firm's cash flow variability is expensive, hedging can reduce the cash flow variability and enable it to invest in profitable projects, resulting in an increase in its firm value.[21] Numerous empirical studies demonstrate that firms benefit from hedging through reduced cash flow variability, thereby enhancing market value.[22] Hedging reduces cash flow variability and the costs of underinvestment, bankruptcy, and tax liabilities. Mayers and Simth (1982) show that hedging with insurance lowers the bankruptcy costs and tax liabilities. Nance, Smith, and Smithson (1993) demonstrate that firms with a greater growth options profit more from hedging through the reduced agency costs.[23] Geczy, Minton, and Schrand (1997) find that firms facing tight financial constraints but with greater growth potential are more inclined to hedge in order to minimize the risk of missing out on valuable opportunities.[24] In addition, many studies have shown that hedging

[21] In addition, Breeden and Viswanathan (2016) suggests that hedging is employed by higher-ability managers to lock-in superior performance in areas where they have an advantage and remove risks over which they have no control. Myres (1977) contends that risky debt affects a firm's market value by promoting a suboptimal investment strategy.
[22] Also, the literature suggests firms' extensive use of derivatives for hedging. Bodnar, Hayt, and Marston (1998) demonstrate that more than 80% of large firms employ derivatives. Mian (1996) finds that more than 500 firms publish information on hedging activities, and more than 200 companies are considered as derivative users. Hentschel and Kothari (2001) show that a substantial number of the major firms are active participants in derivatives markets.
[23] Berkman and Bradbury (1996) find that derivative use is positively related to the value of a firm's growth options.
[24] Additionally, Haushalter (2000) investigates the relationship between risk management and firms' leverage and financing costs. Rountree, Weston, and Allayannis (2008) show that cash-flow volatility is inversely related to firm

increases firm value. Bessembinder (1991) shows that hedging increases firm value by reducing underinvestment and agency costs. Allayannis and Weston (2001) find a positive correlation between firm values and derivatives use. Graham and Rogers (2002) argue that hedging increases firm value through increasing debt capacity and tax benefits. Carter, Rogers, and Simkins (2006) find a positive correlation between airline fuel hedging and firm value. Nelson, Moffitt, and Affleck-Graves (2005) examine a firm's stock performance and find that hedged firms outperform others by 4.3 percent per year. Mackay and Moeller (2007) documents that a risk management program significantly increases a firm's value. Cornaggia (2013) discovers a positive correlation between hedging and agricultural productivity. Pérez-González and Yun (2013) find that the use of weather derivatives significantly increase firm value.[25]

2.2 Should firms take risks, and do they time the market?

Stulz (1996) argues that a firm must adopt a risk management strategy to use its comparative advantage in assuming risks. Thus, firms may employ risk-taking as a strategy to enhance their value if they possess a comparative advantage. Stulz (2013) also contends that if a company has a comparative advantage in bearing certain risks, it should retain them and focus on managing those risks, while transferring others to investors or other counterparties. In addition, Schrand and Unal (1998) show that firms can generate economic profit by taking on core-business risks that they are superior at handling. Thus, firms can enhance their value by implementing coordinated risk management strategies that hedge homogeneous market risks, while also assuming core business risks. Also, empirical studies contend that firms are speculating rather than

value, implying hedging adds value. Campello, Lin, Ma, and Zou (2011) demonstrate that hedging lowers the cost of borrowing and simplifies the investment process. Bartram, Brown, and Conrad (2011) argue that derivatives lower total and systematic risk and increases firm value. DeMarzo and Duffie (1995) show hedging improves the information quality of earnings and firm value.

[25] By contrast, Jin and Jorion (2006) find that hedging has little effect on the market values of oil and gas firms. Guay and Kothari (2003) show that a firm's derivative portfolio adds just a small amount of value to a company.

hedging. For example, Baker and Wurgler (2002), Allayannis, Brown, and Klapper (2003), Faulkender (2005), Manchiraju, Pierce, and Sridharan (2014), Cheng and Xiong (2014) contend that firms speculate rather than hedge when they make financial decisions or use derivatives. Brown (2001) and Beber and Fabbri (2012) demonstrate that a firm's risk management strategy is influenced by a variety of dynamic factors, such as past returns or hedge results. Furthermore, the literature shows that firms use hedge timing in their core business risk management in the gold mining industry, as well as in currency risk management. Tufano (1996), Adam and Fernando (2006), and Brown, Crabb, and Haushalter (2006) contend that gold mining firms are hedge timing by using their comparative advantage in the gold market. Chance and Kim (2018) show that firms speculate in the currency market, while timing the market even when they attempt to hedge.

2.3 Banking risk management and monetary policy shocks

Few corporate risk management studies investigate the relationship between a firm's risk-taking and firm value due to a lack of reliable data. Banking literature attempts to cope with this problem by using a bank's risk-taking and risk management. Kim (2023) evaluates a bank's risk-taking activities by assessing currency carry trades and accesses its risk management activities by estimating the ratio of allowances to loan losses to non-performing loans.[26] Purnanandam (2007) analyze the effects of macroeconomic shocks on a bank's interest rate risk management using derivatives and asset-liability management. Esposito et al. (2015) argue that banks manage interest rate risk exposure through on-balance-sheet restructuring. Miranda-Agrippino and Rey (2020) and di Giovanni et al. (2022) analyze the impact of Federal Reserve monetary policy shocks on the Global Financial Cycle and domestic credit market conditions in an emerging market.[27]

[26] Jin, Kanagaretnam, and Lobo (2018) also contend that banks employ allowances for loan losses to protect themselves from loan losses, and loan loss allowance decisions reflect risk management activities.
[27] Shin (2005) and Cowan, Hansen, and Herrera (2005) examine the financial crisis as the result of monetary policy shocks. Adrian and Shin (2010) document that banks adjust balance sheet sizes actively and leverage is procyclical.

3. Analytical Framework for Bank Foreign Currency Risk Management and Duration Gap

3.1. Bank foreign exchange rate risk exposure and risk management

Currency trading and lending are the two primary sources of profit that banks derive from foreign currency operations. Bank traders participate in intraday interbank currency trading to profit by timing the foreign exchange market. Banks also attempt to generate unrealized FX gains by maintaining currency positions. The foreign currency ("FC") operations of a bank establish its currency spot position. The value of a long currency spot position increases as the currency strengthens or as the value of assets in the currency increases. The value of a short currency position increases as the currency weakens or as the value of liabilities in the currency increases. Thus, the currency spot position of a bank at time t (ς_t) is determined by subtracting its currency liabilities from its currency assets:

$$\varsigma_t = FCA_t - FCL_t \tag{1}$$

where FCA_t and FCL_t represent the bank's total foreign currency assets and liabilities at time t, respectively. The spot position fluctuates on a daily basis as a consequence of FX trading, lending, and borrowing activities. Furthermore, changes in the exchange rate have a direct impact on the value of the spot position assessed in the domestic currency. Consequently, the fluctuation in the exchange rate affects the net profit of a bank:

$$\pi_t = \left(\varsigma_t\right)\Delta e_t \tag{2}$$

where π_t and Δe_t represent the bank's net profit and the change in exchange rate at time t, respectively.[28] If a bank has a positive spot currency position, it will experience a net loss if the

[28] The exchange rate (e) represents the price of a unit of foreign currency in local currency.

exchange rate falls. Conversely, a bank with a negative spot position will face a net loss if the exchange rate rises.

A bank can implement two strategies to mitigate its exposure to spot currency risk. First, banks can eliminate their spot currency exposure by setting their spot position to zero. To implement this natural hedging strategy, banks match the quantity of currency assets with that of currency liabilities on their balance sheet. Second, banks can use derivatives to hedge their currency spot exposure as well. A bank's derivative position should be taken in the opposite direction from its currency spot position:

$$\left(\varsigma_t\right)\delta_t < 0 \tag{3}$$

where δ_t represents the bank's currency derivative position at time t. Consider a bank that hedges a positive spot position with a negative derivative position. If the exchange rate falls, the bank may experience a net loss from its spot position while profiting from its derivative position. Alternatively, the bank may generate a profit from its spot position if the exchange rate increases, while it will incur a net loss from its derivative position. Consequently, the net income of a bank that implements a derivative hedging strategy depends on its currency composite position, which is the sum of its spot position and derivative position:

$$\gamma_t = \varsigma_t + \delta_t \tag{4}$$

where γ_t represents the bank's currency composite position at time t. A bank that fully hedges its currency exposure maintains a zero composite position, whereas a bank that partially hedges currency exposure maintains a composite position of either positive or negative. Therefore, a bank that has a non-zero composite position is indeed engaging in speculation in the foreign exchange rate market. In order to time the market, banks may endeavor to maintain a positive

composite position as the exchange rate tends to increase, while they may attempt to maintain a negative composite position as the exchange rate tends to decrease.

3.2. Bank FC interest rate risk exposure and risk management

Consider a bank that provides foreign currency loans. The bank borrows foreign currency from another international bank before making a loan in that currency. The bank's profit from a loan comes from the net interest margin on the loan, which is the difference between the loan's return and the cost of funding it. Assume that the bank borrows *L* units of a foreign currency at the interest rate of $\boldsymbol{i_{N1}^{B}}$ for N_1 days, then lends it at the interest rate of $\boldsymbol{i_{N2}^{L}}$ for N_2 days, where N_2 is greater than N_1. If the exchange rate in N_1 days is e_1, the bank's profit from the FC loan in N_1 days is

$$\pi_{N_1} = L\left(i_{N_2}^{L} - i_{N_1}^{B_1}\right) e_1 \frac{N_1}{360} \tag{5}$$

where $\boldsymbol{i_{N_2}^{L} - i_{N_1}^{B_1}}$ indicates a net interest return on the loan ("NIM"). The bank strives to increase the NIM to maximize profits. To increase the NIM, banks typically lend in the longer-term and borrow in the shorter-term. This asset-liability maturity mismatch strategy increases profits while exposing the bank to interest-rate risk. If the bank's borrowing interest rate in N_1 days rises to $\boldsymbol{i_{N_1}^{B_2}}$, where $\boldsymbol{i_{N_1}^{B_2} > i_{N_1}^{B_1}}$, its NIM decreases to $\boldsymbol{i_{N_2}^{L} - i_{N_1}^{B_2}}$. Since the loan interest rate is fixed at an initial level, this increase in borrowing cost hurts the bank's profitability. The bank's profitability is adversely affected by this increase in borrowing costs, as the loan interest rate is initially set at a specific level, i.e., $\boldsymbol{i_{N_2}^{L}}$. In this tightening climate, a shorter maturity loan is preferable because the interest rate can be reset sooner. In addition, the value of an asset with a

longer maturity decreases more than that with a shorter maturity.[29] Therefore, banks endeavor to reduce the average asset maturity if the interest rates rise while other conditions remain constant.

If interest rates rise, the value of liabilities decreases as well. Liabilities with longer maturities see a greater drop in value compared to those with shorter maturities. Thus, banks strive to lengthen the average term of their liabilities in the event of rising interest rates, assuming all other variables stay unchanged. In sum, during a tightening era when interest rates rise, banks benefit from reducing the maturity of their assets and extending the maturity of their liabilities. On the other hand, during an easing era when interest rates fall, banks have a preference for extending the maturity of their assets and shortening the maturity of their liabilities. Therefore, banks adjust the average maturities of their assets and liabilities on their balance sheets.

In particular, banks use the duration gap, which is the difference in average asset and liability maturities, to manage their exposure to interest rate risk. The duration gap ("Dgap") is defined as follows:

$$Dgap_t = D_{A,t} - \left(\frac{TL_t}{TA_t}\right) D_{L,t} \tag{6}$$

where $D_{A,t}$ and $D_{L,t}$ denote the asset and the liability durations, respectively, and TL_t/TA_t represents the ratio of total liabilities to total assets at time t. A bank's asset (liability) duration is calculated using the weighted average maturity of its assets (liabilities).

If interest rates increase by Δi, a bank's net worth decreases by approximately the duration gap x total assets.[30]

[29] The value of an asset is calculated as the sum of the present values of cash flows generated from the asset. The present value of a cash flow is the discounted value obtained by dividing the cash flow by (1 + interest rate)^N where N is the number of periods till payment. If interest rates increase, the present value of cash flows with longer maturities falls more than those with shorter maturities.

[30] Denote an interest rate by i and a duration by D. According to bond duration theory, when interest rates increase by

$$\frac{\Delta NW_t}{TA_t} = -Dgap_t \frac{\Delta i}{1+i} \tag{7}$$

where *NW* is the net worth, which is the difference between total assets total liabilities, and *i* is the interest rate at time t. Equation (7) suggests that the net asset value of a bank decreases as interest rates increase, and vice versa. Hence, when a bank anticipates an increase in interest rates, if favors a shorter duration gap. Conversely, a bank may endeavor to decrease its duration gap if it expects a decrease in interest rates.

A bank's asset duration and liability duration are defined as

$$\begin{aligned} D_{A,t} &= \frac{\sum_{t=1}^{T} tA_{t-1,t}}{TA_t} \\ D_{L,t} &= \frac{\sum_{t=1}^{T} tL_{t-1,t}}{TL_t} \end{aligned} \tag{8}$$

where $A_{t-1,t}$ and $L_{t-1,t}$ are the amounts of assets and liabilities that mature between t - 1 and t periods. The duration gap can be rewritten as:

$$\begin{aligned} Dgap_t &= \frac{\sum_{t=1}^{T} tA_{t-1,t}}{TA_t} - \left(\frac{TL_t}{TA_t}\right)\frac{\sum_{t=1}^{T} tL_{t-1,t}}{TL_t} \\ &= \frac{\sum_{t=1}^{T} tA_{t-1,t}}{TA_t} - \frac{\sum_{t=1}^{T} tL_{t-1,t}}{TA_t} \\ &= \frac{\sum_{t=1}^{T} t\left(A_{t-1,t} - L_{t-1,t}\right)}{TA_t} \end{aligned} \tag{9}$$

Δi, the bond's value decreases by D x $\Delta i/(1+i)$ x bond price. Thus, the percent change in bond value is equal to -D x $\Delta i/(1+i)$. Similarly, the percent change in a bank's assets is $\Delta TA/TA = -D_A$ x $\Delta i/(1+i)$ and the percent change in its liabilities is $\Delta L/TL = -D_L$ x $\Delta i/(1+i)$. Multiplying both sides of the second equation by TL/TA yields $\Delta L/TA = -D_L$ x $\Delta i/(1+i)$ x (TA/TL). Subtract both sides from this equation: $\Delta TA/TA = -D_A$ x $\Delta i/(1+i)$. Then, $(\Delta TA - \Delta TL)/TA = -[D_A - (TL/TA)D_L]$ x $\Delta i/(1+i)$. Thus, we have $\Delta NW/TA = -Dgap$ x $\Delta i/(1+i)$, where NW represents net worth and NW = TA – TL and $Dgap = D_A - (TL/TA)D_L$.

Define a bank's T-period maturity gap ("Mgap") at time t by the difference between the amount of assets and liabilities that mature within T periods, divided by total assets:[31]

$$Mgap_{T,t} = \frac{A_{T,t} - L_{T,t}}{TA_t} \tag{10}$$

where $A_{T,t}$ and $L_{T,t}$ represent the amount of assets and liabilities maturing within T periods, respectively, at time t. If a bank has more (less) assets than liabilities maturing in T periods, its T-period Mgap is positive (negative).

A bank can increase a maturity gap for assets and liabilities maturing between t – 1 and t periods by increasing the amount of assets beyond the amount of liabilities. It can also increase its duration gap by expanding the maturity gap for assets and liabilities with longer maturities. As a result, during a tightening era when interest rates increase, banks raise longer-term liabilities more than assets, whereas during an easing time when interest rates decrease, they expand longer-term assets less than liabilities. Banks may reduce their duration gaps to naturally hedge the risk of rising interest rates on their balance sheets, while increasing them to take advantage of decreasing interest rates.

Derivative instruments, such as interest rate swaps (IRS), can be used as well by banks to hedge interest rate risk off their balance sheet. For instance, banks can reduce the volatility of funding costs by converting floating interest rates to fixed interest rates through the use of an interest rate swap. An increase in a foreign currency interest rate may have a negative impact on the profitability of a bank that borrows in that currency in two ways. First, the cost of financing the foreign currency escalates as the interest rate rises. Additionally, the exchange rate may increase in line with the increase in the FC interest rate, resulting in an increase in the quantity of

[31] A bank's T-period maturity gap differs from its T-period asset-liability (AL) mismatch. A T-period AL maturity mismatch is the difference between the quantity of assets and liabilities maturing within T periods.

foreign currency interest expenses that are evaluated in domestic currency. As a result, using interest rate or currency derivatives is particularly beneficial to the domestic banks during the tightening period when the interest rates rise. Banks can expand their FC loans by hedging both FC interest rate and exchange rate risks. However, increasing a bank's loan portfolio also increases the likelihood of loan default. One method of managing a bank's credit default risk is to raise its allowances for loan losses ("ALLs") relative to its non-performing loans (NPLs'). Banks can utilize ALLs as a safeguard against the negative impact of a decline in asset quality.

4. Empirical Methods and Data

4.1. Measurement of variables

The measurements of the independent variables, dependent variables, and control variables employed in empirical models are detailed in this subsection. The dependent variables are the default likelihood measures and bank value, while the independent variables are FC interest rates and risk management measures. The duration gap serves as both an independent and dependent variable.

(1) Duration gap

The duration gap of a bank can be calculated by subtracting the product of its total liabilities to total asset ratio and the average liability duration from the average asset duration, as indicated in equation (6) in Section 3. Unfortunately, the durations of a bank’s foreign currency assets and liabilities are not typically disclosed. In some instances, however, banks may disclose their FC maturity gaps for specific asset and liability maturities, as described in equation (9) above. Suppose that a bank reveals the amount of its total FC assets and FC maturity gaps over seven different categories: one week, one month, three months, six months, one year, three years, and greater than

three years. Therefore, the maturities can be stated as T = 7, 30, 90, 180, 360, 1,080, or any value more than 720, measured in bank days. In this case, we may use equation (9) mentioned earlier to calculate the duration gap: $Dgap_t = \sum_{t=1}^{T} \frac{t\left(A_{t-1,t} - L_{t-1,t}\right)}{TA_t}$ where $A_{t-1,t}$ and $L_{t-1,t}$ denote FC assets and liabilities maturing between t - 1 and t periods. I can rewrite equation (9) as:

$$Dgap_t = \sum_{t=1}^{T} tMgap_{t-1,t} \tag{11}$$

where $Mgap_{t-1,t}$ denotes the asset-liability maturity gap for assets and liabilities maturing between t - 1 and t periods. Therefore, the asset-liability maturity gaps between t-1 and t can be used to calculate the duration gap. More specifically, the duration gap is the time-weighted average of those maturity gaps. To determine the duration gap, we first calculate the difference in maturity gaps between two closet periods, such as one week and one month, one month and three months, three months and six months, and so on. Next, we calculate the sum of the product of each maturity (t) and the difference in maturity.[32]

(2) Default Likelihood

Moody's, Standard & Poor's (S&P), or Fitch assign credit ratings to foreign currency debts that banks issue. These credit rating agencies closely monitor the banks' creditworthiness and assess their capacity to repay FC debts. As a result, the credit ratings assigned by these three agencies provide a relatively accurate indication of the likelihood of default for the banks' foreign currency debts. The rating scales of the three agencies are slightly different. Moody's assigns the

[32] Assets and liabilities do not typically mature exactly at the end of a period. Their maturities are more likely to be evenly distributed over every period. In that situation, we can utilize the average of t - 1 and t as the time weight. For example, we can choose (30 - 7)/2 = 10.5 as t for the maturity gap between one week and one month, and (90 - 30)/2 = 30 for the maturity gap between one month and three months. Assuming a seven-year average for the longest-term maturity gap, we may assign time weights of 3.5, 10.5, 30, 45, 90, 360, and 2.520 days to each of the seven categories.

highest credit rating of Aaa, while S&P and Fitch assign AAA. Subsequently, Moody's rating scales descend in the following order: Aa, A, A, Baa, Ba, B, Caa, Ca, and C. S&P and Fitch's scales are lower in the following order: AA, A, BBB, BB, B, CCC, CC, and C. To quantify these alphabetic credit ratings, we assign numerical index values to each rating scale: 9 for Aaa and AAA, 8 for Aa1 and AA+, 7 for Aa2 and AA, …., 0 for Baa3 and BBB-, -1 for Ba1 and BB+, -2 for Ba2 and BB, and so forth, as illustrated in the legend of Table 3. We then calculate the credit rating score ("CR score") for each bank quarter by averaging the index values.

$$CR\ score_{i,t} = \sum_{i=1}^{3} CR\ index\ value_i \tag{12}$$

where *i* indicates Moody's, S&P, or Fitch.

(3) Market value measure

I employ Tobin's Q to evaluate the market value of a bank. The formula for calculating a bank's Tobin's Q, as recommended by previous studies,[33] is as follows:

$$\text{Tobin's Q} = \frac{\text{Market value of common stock + preferred stock + debts}}{\text{Book value of total assets}} \tag{13}$$

(4) Risk management measures

Derivatives are employed for both hedging and speculating in the market. Thus, a bank's risk management efforts may not be best measured by the total amount of derivatives it uses. In order to measure a bank's risk management activities, I evaluate the amount of derivatives it utilizes exclusively for hedging purposes. More specifically, I measure a bank's market risk

[33] For example, refer to Allayannis and Weston (2001) and Chung and Pruitt (1994).del

management by dividing the amount of currency and interest rate derivatives, such as forwards, futures, swaps, and options, by its total assets.

$$Marekt\ risk\ hedge = \frac{\text{Derivatives for hedging purposes}}{\text{Total assets}} \tag{14}$$

I also measure a bank's credit default risk management using the ratio of its allowance for loan losses (ALLs) to nonperforming loans (NPLs) for a specific period.

$$Credit\ risk\ hedge = \frac{ALLs}{NPLs} \tag{15}$$

(5) FC interest rate and exchange rate measures

Since the dollar is the predominant currency in the bank's international finance and foreign exchange transactions, I use U.S. dollar interest rates to represent foreign currency interest rates.[34] The Federal Reserve's monetary policy decisions are the most significant factor that influences the short-term dollar interest rate. Short-term dollar interest rates that reflect the effects of the Federal Reserve's monetary policy stance include the Fed's target for the federal funds rate ("FF Target"), the effective federal funds rate ("EFFR"), and the dollar interest rate on bank certificates of deposit ("CD rate"). The federal funds rate is the overnight interest rate at which banks lend their reserves to one another. The Federal Open Market Committee (FOMC) sets the target range for the federal funds rate as a monetary policy tool. EFFRs represent the market's average federal funds rate. I refer to the upper range of the Fed's target for the federal funds rate as the FF Target, and the 3-month CD rate as the FC Interest Rate. A bank's foreign currency operations and risk management are significantly influenced by the foreign exchange rate. I use the Korean won to the U.S. dollar (KRW/USD) divided by 1,000 as a proxy for the FC exchange rate (“Exchange Rate”).

[34] Recent data from the Bank of Korea reveals that the U.S. dollar constitutes almost 90 percent of the foreign exchange transactions conducted by Korean banks.

(5) Control variables

A bank's duration gap, the likelihood of default, and bank value may be affected by its size through economies of scale. I include the log of a bank's total assets (*Size*) to control for its influence on the dependent variables.[35] The dependent variables may also be influenced by a bank's liquidity. Thus, a bank's liquidity ratio, which is computed by dividing its total liquid liabilities maturing in three months by its total liquid assets maturing in three months (*Liquidity*). In addition, I employ a bank's non-performing loan (NPL) ratio, which is calculated by dividing non-performing loans by total loans, to control for the quality of its assets (*Asset Quality*).[36] To control for the effects of a bank's profitability on the dependent variables, I employ its return on assets (*ROA*) as well. In order to account for the effects of a bank's risk management activities on the dependent variables, the ratio of the use of derivatives for hedging purposes to total assets (*Market Risk Hedge*) is used as a control variable in certain regressions. Furthermore, the real GDP growth rate of South Korea for over a quarter is used (*GDP Growth*) is employed to account for the effects of domestic macroeconomic environment. Finally, the foreign exchange rate between the Korean won and the U.S. dollar, divided by 1,000, (*Exchange Rate*) is utilized as a control variable to incorporate the impact of external shocks on the dependent variables.

4.2. Hypotheses and Empirical Design

First, I analyze the foreign currency risk management of a bank. If banks engage in proactive currency risk hedging on the balance sheet, the changes in exchange rates should not have a substantial impact on their foreign currency spot position. Although a bank is exposed to

[35] In addition, the dependent variables may also be affected by the growth rate of a bank's loans and its leverage, which is represented by the ratio of total debts to total assets. The regression models in this study do not include these variables as control variables due to a potential significant correlation between the size and these variables.

[36] Non-performing loans indicates those for which the borrowers have not made scheduled payments for a minimum of 90 days.

spot exchange rate risks, if the FC spot position of the bank is hedged by derivatives, changes in the exchange rate should not have a significant impact on the composite position of the bank. Thus, I develop our second hypothesis on a bank's currency risk management as follows: *Hypothesis 1: A bank's foreign currency positions are significantly associated with exchange rate changes.*

I investigate the pairwise correlations between the exchange rates, forward position, composite position, and FC spot position of a bank. Next, I implement fixed-effects panel regressions to account for the banks' time-invariant confounding factors.[37] I utilize fixed-effects models to analyze panel data that comprises 1,955 quarterly observations on 38 sample banks over 24-year time periods from 1999 to 2023. This approach, as recommended by previous studies, helps to control for unobservable factors that remain constant over time and may be related to explanatory variables. Specifically, I employ the following fixed effects model:

$$y_{i,t} = \beta_1 X_{i,t} + \sum_{j=2}^{J} \beta_j CV_{j,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t} \quad (16)$$

where $y_{i,t}$, $X_{i,t}$, and $CV_{j,t}$ represent the dependent variable, the independent variable, and the control variables for i^{th} bank at time t, respectively.[38] The dependent variable is *FC position*, which represents a bank's foreign currency spot position, forward position, and composite position, scaled by total assets. The independent variable is the foreign exchange rate, *exchange rate*, which is the KRW/USD rate divided by 1,000. The control variables include the size, liquidity, asset quality, ROA, derivative hedge, and GDP growth.

Second, I examine a bank's foreign currency interest rate risk management by using the

[37] When analyzing bank panel data, unobserved time-invariant confounders such as a bank's location, reputation, the risk management and operating expertise of its staffs, and the relationships with its customers.

[38] In addition to the control variables described above, I employ the IRD dummy to control for quarter fixed effects. These are used to capture other unobserved common macroeconomic shocks such as monetary policy shocks and financial cycle shocks that can affect sample banks.

duration gap of its FC assets and liabilities. If a bank predicts an increase in the FC interest rate, it may prefer a shorter FC duration gap. Conversely, if a bank anticipates a reduction in FC interest rates, it may favor a larger FC duration gap. Korean banks typically borrow a foreign currency at a floating interest rate that is reset every three or six months, whereas their FC loan interest rates are generally fixed for a long-term period. Thus, as the Federal Reserve tightens its monetary policy, a bank's foreign currency borrowing costs increase at a faster pace than its FC lending returns. As a result, net returns on a bank's FC loans fall during the Fed's tightening period. Additionally, the Fed's tightening may result in a credit crunch that may make it difficult for a bank to roll over its FC borrowings or issue new FC debts. The local currency values of FC debts also increase. Therefore, if a bank faces an increase in foreign currency interest rates, the bank may attempt to extend its FC duration gap by reducing its debts, which are specifically long-term borrowings, faster than its FC assets. However, if a bank is confronted with a declining FC interest rates and experiences a rise in the net return on its FC loans, it is more inclined to decrease its FC duration gap by growing its FC borrowings at a faster pace than FC assets.[39] As a result, when the FC interest rate increases, the FC duration gap of a bank also widens. I formulate the following hypothesis to investigate the relationship between a bank's FC duration gap and FC interest rates.

Hypothesis 2: A bank's FC duration gap is significantly positively associated with FC interest rates.

In addition, I investigate whether there is a significant correlation between the likelihood of default on a bank's foreign currency debts and its FC duration gap. If a bank increases its FC duration gap by reducing its FC debts during the Fed's tightening period, it may decrease the

[39] When a bank expands its foreign currency loans, the bank's foreign currency borrowings also increase. However, the bank's foreign currency loans are typically of a longer duration, while its foreign currency borrowings are normally short-term, lasting for three to six months.

probability of default on its FC debts. On the other hand, if a bank increases its FC duration gap by growing its FC assets faster than FC debts during the Fed's easing period, it may raise its FC profitability and lower the likelihood of default on its FC debts. Furthermore, I examine whether a bank's risk management activities indeed reduces the likelihood of default on its FC debts. I specifically investigate whether a bank's credit risk hedge and market risk hedge contribute to the reduction of its FC default probability. I develop the following hypothesis to investigate the relationship between a bank's FC default likelihood and FC duration gap and credit risk management. *Hypothesis 3: The likelihood of default on a bank's FC debts is significantly negatively correlated with FC duration gap and credit risk hedge.*

Finally, I investigate a bank's FC duration gap and its risk management activities are positively correlated with its bank value. If a bank increases its duration gap in order to boost FC profitability and reduce the likelihood of default, its bank value may increase as well. I test the following hypothesis on the relationship between a bank's duration gap, risk management, and bank value. *Hypothesis 4: A bank's duration gap and risk management activities significantly positively associated with its bank value*.

4.3. Data Description

Since the 1997 Financial Crisis, the Korean banking industry provided comprehensive information regarding a bank's financing and investing operations, liquidity and asset quality, and risk management activities. Using the information, I construct a unique bank-level data set that encompasses a bank's foreign currency positions, currency maturity gaps, and the use of derivatives for hedging purposes. These data are rarely available in other countries. I collect data for a total of 1,952 bank quarters from 1999 to 2023, including all 38 domestic commercial and

merchant banks in Korea.

A bank's business reports provide information on its foreign currency spot, forward, and composite positions, as well as its foreign currency maturity gaps and the maturities of its foreign currency assets and liabilities. Additionally, the reports include data on the bank's usage of interest-rate and currency derivatives. The business reports are published quarterly and can be accessed on the website of the Korea Federation of Banks (http://www.kfb.or.kr). The costs of a bank's foreign currency borrowings and the returns on foreign currency loans are gathered on the bank's annual reports, which are available on the Financial Supervisory Service's DART (Data analysis, retrieval, and transfer system) website (http://dart.fss.or.kr). The Korean Financial Supervisory Service's Financial Statistics Information System website (http://fisis.fss.or.kr) provides information on a bank's quarterly funding and investment activities, asset and liability balances, capital, liquidity, non-performing loans, profitability, and other accounting data. The stock prices and number of outstanding shares of a bank are obtained from its annual reports, the Korea Exchange website (http://www.krx.co.kr), and the Trading View website (tradingview.com). The effective federal funds rates, the interests on the three-month dollar certificates of deposit (CDs), and other financial and macroeconomic data in the United States are retrieved on the Federal Reserve Bank of St. Louis's website (https://research.stlouisfed.org) and the US Bureau of Labor Statistics' website (http://www.bls.gov). The Federal Reserve's targets for federal funds rate and the Fed's monetary policy data are collected on the Board of Governors of the Federal Reserve System's website (https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm).

Panel A of Table 1 provides a summary of the financial characteristics of the sample banks. During the sample period, the banks' total assets averaged $80 billion, with loans representing 40 percent of the total assets. The banks possess deposits amounting to $49.7 billion and have a total

shareholders' equity of $5.6 billion. On average, their total revenue amounts to $1.9 billion. In addition, the banks maintain an average of $11.4 billion in foreign currency assets, which includes $2.5 billion in loans. Furthermore, the banks hold $2.8 billion in foreign currency deposits and $4.9 billion in foreign currency borrowings. The average FC spot position of the banks is $-252 million, while their forward position is $344 million.

Panel B of Table 1 presents an overview of the banks' descriptive statistics for key variables. On average, sample banks exhibit a foreign currency duration gap of -0.15 months, a credit rating score of 2.92, and a Tobin's Q of 0.98. The average net return on their FC loans is 1.2%, with a liquidity ratio of roughly 133%, a nonperforming loan ratio of approximately 2.8%, a ROA of approximately 0.7%, and an ALL/NPL ratio of 194%. The average quarterly real GDP growth rate of South Korea was approximately 3.3%, while the average exchange rate between the South Korean won and the US dollar was around 1,151 during the sample period.[40]

5. Empirical Results

5.1. Exchange Rate Risk Management

The results of investigating whether a bank's foreign currency positions are significantly associated with exchange rate changes are presented in Table 2. Panel A displays the pairwise correlation coefficients between the exchange rate, FC spot position, forward position, and composite position as part of a univariate test. The estimation results indicate a significant positive correlation between a bank's currency spot position and the exchange rate. As FC interest rates rise, banks may tend to hold a larger amount of currency assets compared to liabilities, while also attempting to time the currency markets. Nevertheless, the significant negative correlation between

[40] The won/dollar exchange rate is divided by 1,000 to adjust the currency units of the Korean won.

the FC spot position and FC forward position demonstrates that banks are engaged in currency risk management. Banks hedge their FC spot positions by taking forward positions in the opposite direction. As a result, a bank's FC composite position does not have a significant association with exchange rate changes.

The fixed effects panel regression results in Panel B also suggest that a bank's currency spot position is significantly positively associated with the exchange rate, while its currency forward position is significantly negatively correlated with the exchange rate. It is also implied that a bank's composite position is not significantly correlated with the exchange rate. Therefore, it appears that banks generally hedge their currency exposure using derivatives. However, the results Panel C reveal that the FC composite position of a bank is significantly positively correlated with the exchange rate during the Fed's tightening period, but it is significantly negatively correlated with the exchange rate risk during the Fed's easing period. The results may suggest that, while banks generally endeavor to hedge their currency exposure through derivatives, they actually time the market they have a high level of confidence in the direction of exchange rate movements, such as when the Federal Reserve consistently raises or lowers interest rates.

5.2. Duration Gap and the Fed's Tightening

The correlation coefficients between a bank's foreign currency asset duration, liability duration, duration gap, and FC interest rates are presented in Panel B of Table 3, as part of the univariate test. The findings suggest that a bank's FC asset duration is positively associated with its FC liability duration, suggesting that the average maturity of a bank's liabilities increases as its average maturity of assets increases. It is also suggested that the FC duration gap of a bank is influenced by the duration of both its assets and liabilities. Furthermore, it is implied that the FC duration gap of a bank is substantially positively correlated with foreign currency interest rates.

The results of the fixed effects regressions are displayed in Table 4. The estimation results in Panel A suggest that the foreign currency duration gap of a bank is significantly positively correlated with the effective federal funds rate in Model (1), with the lagged effective federal funds rate in Model (2), and with the interest on three-month dollar certificates of deposits in Model (3). Furthermore, the regression results in Panel B of Table 4 indicate that the positive correlation between the FC interest rate and a bank's FC duration gap is more pronounced when considering 3-month *lagged* interest rates. The relationship between the interest rates and duration gap becomes more sharply pronounced as I implement more lagged interest rates, such as 6-, 12-, and 24-month lagged interest rates. Based on these results, it may be inferred that there is a delay of up to two years between the Federal Reserve's monetary policy actions, such as tightening and easing, and their effect on the foreign currency operations of emerging market banks.

In addition, Table 5 presents a comparison of the FC duration gaps and the correlation between the duration gap and the FC interest rate during the Fed's tightening period and the easing period. Panel A shows that, on average, banks' FC duration gap is -0.51 when the Federal Reserve raises interest rates, and +0.44 when the Fed lowers interest rates. This suggests that the average maturity of the banks' FC liabilities is greater than that of their FC assets during the Fed's tightening period. Conversely, the average duration of the banks' FC assets exceeds that of their liabilities during the Fed's easing period.

The fixed effects regression results shown in Panel B suggest that the relationship between the FC interest rate and a bank's FC duration gap is significant and positive during both the Fed's tightening and easing periods. This may indicate that banks are attempting to reduce the maturities of their FC debts more rapidly than those of FC assets, or they are reducing the ratio of total FC liabilities to assets by decreasing FC debts, during the Fed's tightening period, in order to increase

their negative duration gaps closer to zero. During the Fed's easing period, however, banks may further increase their positive FC duration gap by increasing the maturities of their FC assets faster than those of FC liabilities or by increasing the ratio of total FC obligations to assets by increasing FC assets. By increasing the maturity gap, a bank may decrease the probability of default during the Fed's tightening and increase profitability during the Fed's easing.[41]

5.3. Default Likelihood, Duration Gap, and Risk Management

The regression results in Table 6 suggest that a bank's FC credit rating score is significantly positively correlated with its duration gap in Model (1) and with the one-quarter lagged duration gap in Model (2). This implies that the likelihood of default on a bank's FC debts diminishes as the bank increases its FC duration gap. When the Federal Reserve increases interest rates, a bank may reduce its default risk by decreasing its FC debts. In addition, Table 6 shows that a bank's FC default likelihood is negatively associated with its size, liquidity, derivative hedging, but positively correlated with its non-performing loan ratio, GDP growth rate, and the exchange rate.

Table 7 presents the results of regressions of the FC credit rating score on risk management activities and control variables. The estimation results for Model (1) indicate that a bank's FC credit rating score is significantly positively associated with its credit risk hedging activity. This implies that a bank may significantly reduce the probability of default on its FC debts by increasing its allowance for loan losses relative to non-performing loans. The results for Model (2) imply that the interaction term between a bank's credit risk hedging and its FC duration gap is also significantly correlated with its FC credit rating score. Banks may decrease their FC default risk by increasing the FC duration gap while engaging in credit risk management. The results in Table 7 also suggest that a bank's currency and interest-rate risk hedging with derivatives may reduce its

[41] Table 4 also shows that a bank's FC duration gap correlates positively with its size but negatively with its liquidity.

FC default risk as well.

Table 8 presents the average credit rating score of the banks for two groups based on the extent of increasing duration gap and managing credit risk. The *larger duration gap* represents a bank quarter in which a bank's FC duration gap is greater than or equal to the median level, while *the smaller duration gap* represents a bank quarter with a duration gap less than the median level. The *more active risk hedge* represents a bank quarter in which a bank holds allowance for loan losses scaled by non-performing loans (ALL/NPL) greater than or equal to the median level, whereas the *less active risk hedge* represents a bank quarter with an ALL/NPL less than the median level. Panel A reports the average FC credit rating scores for all sample periods. The results suggest that the credit rating score is higher for the larger duration gap than the smaller duration gap, and for more active risk hedge than the less active risk hedge. Overall, banks may reduce their FC default risk by increasing their FC duration gap and engaging in more active credit risk hedging. The results in Panels B and C suggest that the effects of a bank's increase in its FC duration gap and credit risk hedging on the likelihood of FC default risk are more noticeable during the Fed's tightening period rather than easing period.

5.4. Duration Gap, Risk Management, and Bank Value

Table 9 displays the results of regressions of the bank value, represented by the log of a bank's Tobin's Q, on its FC duration gap, credit risk management, and control variables. The estimation results for Model (1) imply that a bank's market value is significantly positively related with its FC duration gap. In addition, the results for Model (2) indicate that the correlation between a bank's Tobin's Q and its credit risk hedging is positive and significant. The results for Model (3) also suggest that banks may increase their bank values by increasing their duration gap while implementing credit risk hedging. These results are consistent with the findings in the previous

studies. However, Table 9 shows that bank values are generally negatively affected by the exchange rate, which means stronger dollar relative to the local currency and the non-performing loan ratio.[42]

6. Conclusions

The objective of this study is to investigate the extent to which an emerging market bank's foreign currency operations and risk management activities are impacted by the Federal Reserve's monetary policy actions. Furthermore, I analyze the correlations among a bank's FC duration gap, likelihood of default, and bank value. I have discovered numerous intriguing results.

First, banks appear to speculate in the currency spot market. Banks typically attempt to hedge their currency exposure by increasing their FC spot positions and acquiring FC forward positions in the opposite direction when the exchange rate increases. However, it appears that banks time the market by maintaining a positive composite FC position when they are more confident about the exchange rate movements, such as when the Fed raises interest rates, and a negative composite position when the Fed lowers interest rates. Banks may be engaging in hedge timing in the currency market.

Second, banks attempt to increase their FC duration gap as FC interest rates rise. During the Fed's tightening period, banks increase their FC duration gap, which is negative, by reducing their FC asset duration more rapidly than FC debt duration. During the Fed's easing period, banks reduce their FC duration gap, which is positive, by increasing their FC debt duration faster than FC asset duration. This suggests that banks prioritize currency liquidity and roll-over risk management over increasing the market value of their net assets.

[42] Tobin's Q is negatively correlated with a bank's derivatives hedging. This may be because banks use more derivatives when the exchange rate increases.

Third, banks reduce the likelihood of default on their FC debts by increasing their FC duration gaps. Banks can diminish their FC default risk by reducing their FC debts faster than FC assets, especially during the Fed's tightening period. Banks can further lower their FC default likelihood by engaging in credit risk hedging, which entails boosting their allowances for loan losses relative to non-performing loans.

Fourth, banks can increase their market value by increasing their FC duration gap and engaging in credit risk hedging. According to the mean comparison analysis, active risk hedge raises a bank's FC credit rating by one to two notches.

In conclusion, the value maximization strategy of a bank for the Federal Reserve's monetary policy pivot is to actively hedge FC default risk by reducing FC debt maturities and thus increasing FC duration gap during the Fed's tightening period, while actively taking risk by increasing FC debt maturities during the Fed's easing period. Therefore, banks actively take risk when the default risk is low and vigilantly hedge when the credit crunch risk is high.

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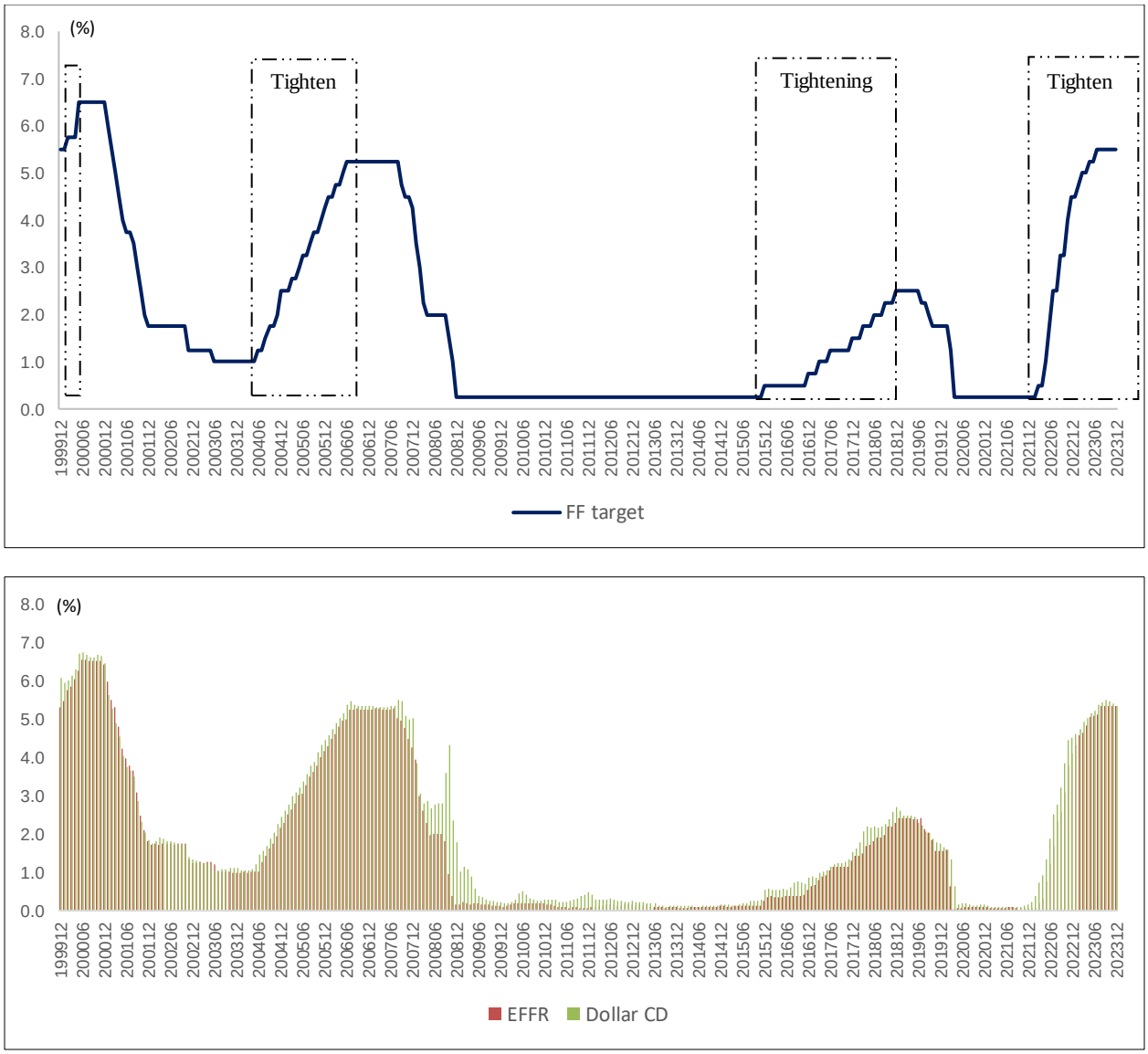

Figure 1. Federal Reserve's Monetary Policy Rate and Stance

The upper panel depicts the Fed's target for the federal funds rate (*FF target*), which is its monetary policy interest rate. The top ranges of the FF target are used for periods after December 2008. The lower panel plots the effective federal funds rate (*EFFR*) which is the overnight fed funds market interest rate at which banks lend their reserves to one another, as well as the three-month interest rate on dollar certificates of deposit (CD).

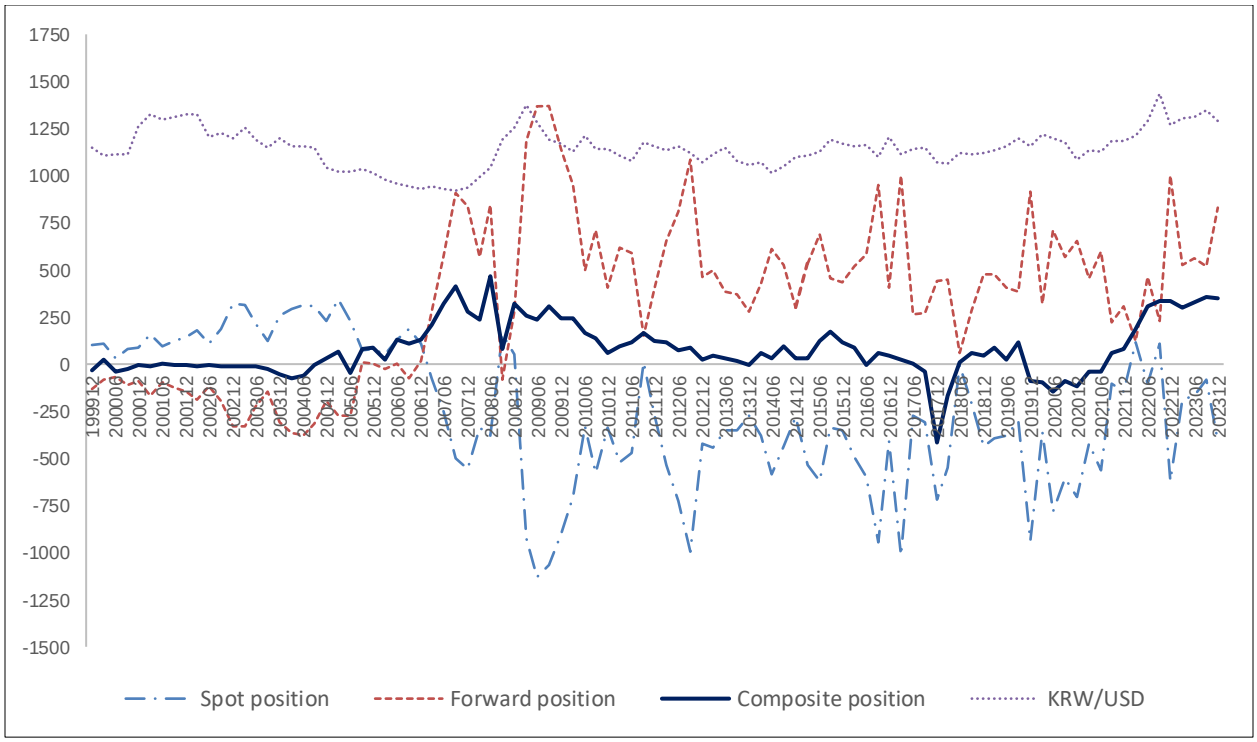

Figure 2. Foreign Exchange Rate and Foreign Currency Positions

This graph depicts the average foreign currency spot position, forward position, and composite position for sample banks, as well as the KRW/USD exchange rate. The composite position is the sum of the spot and forward positions.

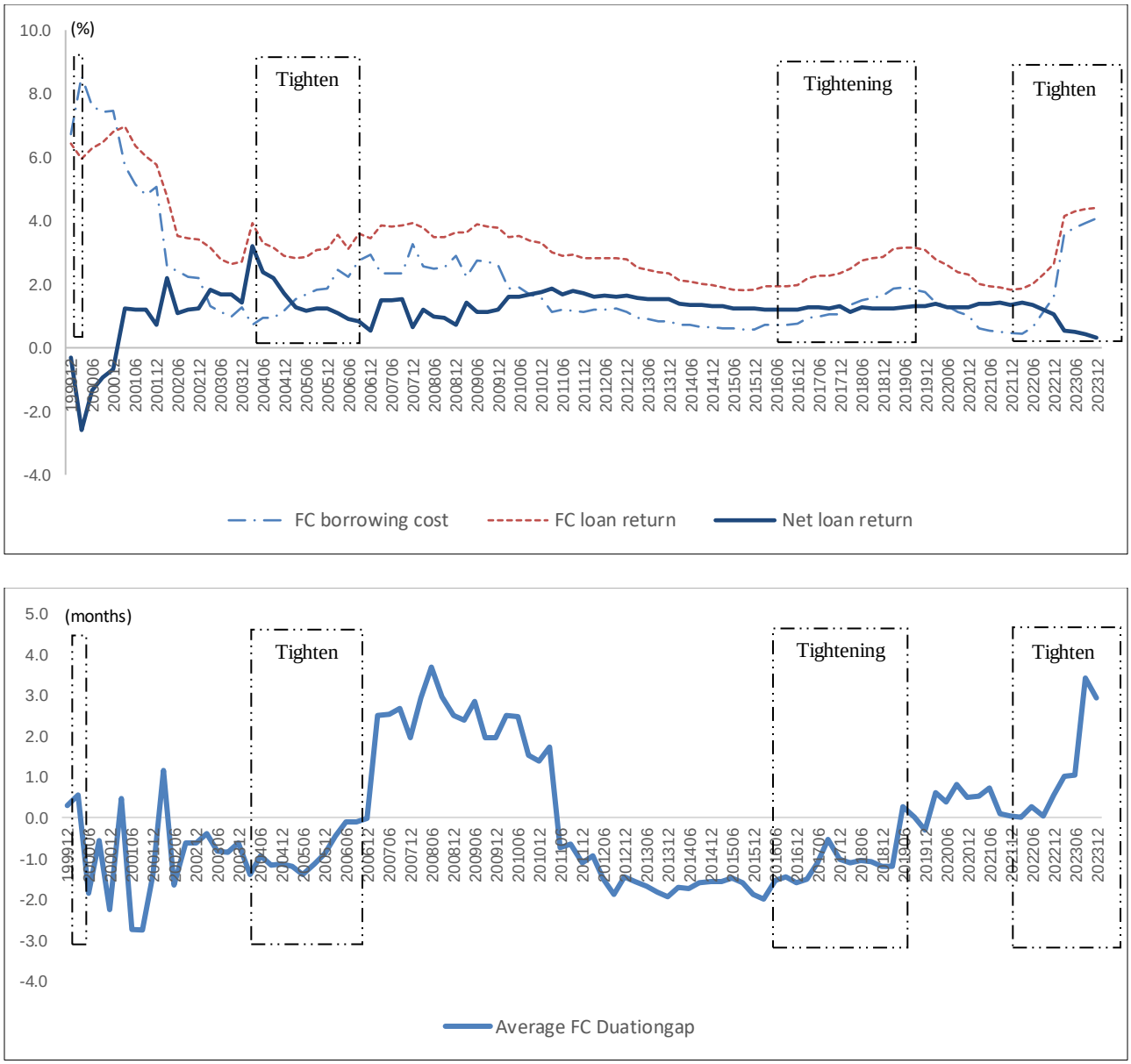

Figure 3. FC Interest Rates, Net Returns on Loans, and the Duration Gap

The upper panel depicts the average foreign currency borrowing costs, return on foreign currency loans, and net return on foreign currency loans for sample banks. The net loan return is computed by deducting the borrowing costs from the returns. The lower panel plots the average foreign currency duration gap of the banks.

Table 1. Summary Statistics

This table provides the summary statistics for financial characteristics of sample banks and variables, measured on a quarterly basis from 1999 to 2023. The sample includes 1,959 bank quarters for 38 domestic banks in South Korea. FC and LC stand for foreign currency and local currency (won), respectively. *ALL/NPL* represents the ratio of allowance for loan losses to non-performing loans. Data comes from the Financial Statistics Information System of the Financial Supervisory Service in Korea. Definitions of the variables are provided in Table 10.

Panel A: Summary Statics of Sample Bank's Financial Characteristics

(U.S. dollar millions)

Variable	Mean	Std. Dev.	% of total assets
Total assets	80,127	94,651	100.0%
Total deposits	49,701	65,665	62.0%
Total loans	32,389	43,196	40.4%
Total borrowings	18,080	28,124	22.6%
Total shareholders' equity	5,577	7,130	7.0%
Total revenue	1,932	2,667	2.4%
Earnings before interest and taxes	138	266	0.2%
FC assets	11,354	14,552	14.2%
FC deposits	2,784	5,016	3.5%
FC loans	2,521	3,590	3.1%
FC borrowings	4,852	7,393	6.1%
FC spot position	-252	1,007	-0.3%
FC derivatives position	344	1,056	0.4%
FC composite position	81	443	0.1%

Panel B: Summary Statistics of Dependent, Independent, Control Variables

Variable	Mean	Std. Dev.	Median
FC duration gap (months)	-0.147	5.723	-0.630
Credit rating score	2.919	2.091	3.500
Tobin's Q	0.983	0.044	0.978
FC net loan return	0.012	0.011	0.012
Liquidity ratio	0.013	0.009	0.012
Asset Quality	0.028	0.048	0.013
ROA	0.007	0.064	0.007
ALL/NPL	1.938	20.357	1.147
GDP growth	0.033	0.026	0.032
Exchange rate	1.151	0.105	1.150

Table 2. Exchange Rates and Foreign Currency Positions

This table shows the relationship between exchange rates and banks' foreign currency positions. Panel A reports pairwise correlation coefficients between the KRW/USD exchange rate, a bank's foreign currency (FC) spot position, forward position, and composite position. Panel B reports coefficient estimates from the following fixed effects panel regression:

$$FC\ position_{i,t} = \beta\ Exchange\ rate_{i,t} + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The dependent variable, *FC position,* represents a bank's foreign currency spot, forward, and composite positions, scaled by total assets, respectively. The spot position is computed by subtracting total FC liabilities from total FC assets and the composite position is the sum of the spot position and forward position. Panel C presents coefficient estimates for the Federal Reserve tightening period in the first column and the easing period in the second column, using the FC composite position as the independent variable. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Panel A: Correlations between Exchange Rates and Foreign Currency Positions

	Exchange rate	FC spot position	FC forward position
Exchange rate	1		
FC spot position	0.102 ***	1	
FC forward position	-0.096 ***	-0.961 ***	1
FC composite position	-0.013	-0.046 *	0.318 ***

Panel B: Effects of Exchange Rates on Foreign Currency Positions

Fixed Effects Regression			
Dependent Variables:	Spot	Forward	Composite
	(1)	(2)	(3)
Exchange rate	0.012 ***	-0.011 ***	0.000
	(4.55)	(3.96)	(0.22)
Size	-0.002 ***	0.002 ***	0.000
	(4.75)	(4.35)	(0.34)
Liquidity	0.000 ***	0.000 ***	0.000
	(2.38)	(2.36)	(0.60)
Asset quality	0.052 ***	-0.057 ***	-0.005
	(3.39)	(3.50)	(1.29)
ROA	0.015	-0.007	0.008
	(1.06)	(0.41)	(1.39)
Derivative hedge	-0.026 *	0.033 **	0.006
	(1.78)	(1.98)	(1.21)
GDP growth	0.015	-0.010	0.005 *
	(1.54)	(0.96)	(1.72)
Constants	0.002 ***	-0.002 ***	0.000
	(4.28)	(4.18)	(0.39)
MPD	0.023 ***	-0.023 **	0.001
	(2.70)	(2.55)	(0.23)
Observations	1,672	1,672	1,450
R^2	0.083	0.080	0.008

Panel C: Impact of the Fed's Tightening on Foreign Currency Position

Fixed Effects Regression Dependent Variable:	FC Composite Position	
	(1) Tightening	(2) Easing
Exchange rate	0.011 ***	-0.007 ***
	(3.51)	(3.16)
Size	-0.001 **	-0.001 **
	(2.11)	(2.31)
Liquidity	0.000 **	0.000 **
	(2.28)	(1.80)
Asset quality	-0.007	-0.016 **
	(1.02)	(2.03)
ROA	0.024 *	0.061 **
	(1.80)	(2.10)
Derivative hedge	-0.006	-0.036 **
	(0.36)	(2.25)
GDP growth	0.024 **	-0.018
	(2.58)	(2.89)
Constants	0.003	0.037 ***
	(0.44)	(3.18)
Observations	420	321
R^2	0.081	0.104

Table 3. Correlations between Duration Gap, Risk Management, and Default Likelihood

This table reports pairwise correlation coefficients. Panel A provides a correlation coefficient between a bank's net return on foreign currency (FC) loans and the FC interest rate. The FC interest rate corresponds to the rates of three-month dollar certificates of deposit. Panel B displays the correlation coefficients between the FC interest rate, a bank's FC duration gap, FC asset duration, and FC liability duration. A bank's FC asset (liability) duration is the weighted average duration of its FC assets (liabilities). The duration gap is calculated using the following formula:

Duration gap = Asset duration – (L/A)(Liability duration)

The *L/A* ratio represents the ratio of a bank's total liabilities to its total assets. Panel C exhibits the correlation coefficients between a bank's FC duration gap, a measure of its credit risk hedge, and the likelihood of its FC debt default. The *credit risk hedge* represents the amount of a bank's allowance for loan losses scaled by its non-performing loans (ALL/NPL) for a given quarter. The likelihood of a bank's FC debt default is assessed using a credit rating score, which is the average of credit rating index (CR index) value that reflect the credit ratings assigned by Moody's, Standard & Poor's, and Fitch to the bank's foreign currency debts, as outlined below:

CR index	Moody's rating	S&P, Fitch rating	CR index	Moody's rating	S&P, Fitch rating
9	Aaa	AAA	-1	Ba1	BB+
8	Aa1	AA+	-2	Ba2	BB
7	Aa2	AA	-3	Ba3	BB-
6	Aa3	AA-	-4	B1	B+
5	A1	A+	-5	B2	B
4	A2	A	-6	B3	B-
3	A3	A-	-7	Caa1	CCC+
2	Baa1	BBB+	-8	Caa2	CCC
1	Baa2	BBB	-9	Caa3	CCC-
0	Baa3	BBB-	-10	Ca1	CC+

A higher credit rating score represents a lower likelihood of default. Panel D reports the correlation coefficient between a bank's FC duration gap and its Tobin's Q. Tobin's Q measures the bank's market value. *** and ** indicate the coefficient is significant at the 1% and 5% level, respectively.

Panel A: Foreign Currency Profitability and Risk Taking

	FC loan net return
FC interest rate	-0.397 ***

Panel B: Foreign Currency Interest Rate and Foreign Currency Duration Gap

	Fed funds rate	FC duration gap	FC asset duration
FC interest rate	1		
FC duration gap	0.264 ***	1	
FC asset duration	0.183 ***	0.331 ***	1
FC liability duration	0.107 *	0.366 ***	0.634 ***

Panel C: Duration Gap, Risk Management, and Default Likelihood

	FC duration gap	Credit risk hedge
FC duration gap	1	
Credit risk hedge	0.159 ***	1
CR score	0.080 *	0.394 ***

Panel D: Duration Gap and Bank Value

	FC duration gap
FC duration gap	1
Tobin's Q	0.223 ***

Table 4. Duration Gap and the Fed Tightening

This table reports coefficient estimates from the following fixed effects panel regression:

$Duration\ gap_{i,t} = \beta\ FC\ interest\ rate_t + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}$.

The dependent variable, *duration gap,* represents a bank's duration gap of its foreign currency assets and liabilities. In Panel A, the first column reports coefficient estimates with the *effective federal funds rate (EFFR)* as the measure of foreign currency (FC) interest rate, the second column with the *lagged EFFR*, and the third column with the three-month interest rate on dollar certificates of deposit (CDs) as the FC rate. The federal funds rate is the overnight fed funds market interest rate, at which banks lend reserves to one another. Panel B shows coefficient estimates for models (1) through (4) using 3-, 6-, 12-, and 24-month lagged dollar CD rates as FC rates. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Panel A. Effects of Concurrent FC Interest Rates

Fixed Effects Regression Dependent Variable:	FC Duration Gap		
	(1)	(2)	(3)
EFFR	11.713 *		
	(1.76)		
EFFR (lagged)		17.716 **	
		(2.44)	
CD rate			15.202 **
			(2.28)
Size	1.609 ***	1.675	1.614 ***
	(5.86)	(5.98)	(5.88)
Liquidity	-0.025 ***	-0.024 ***	-0.024 ***
	(2.78)	(2.65)	(2.67)
Asset quality	-5.596	-6.665 ***	-5.989
	(1.25)	(1.44)	(1.35)
ROA	-2.397	-2.449	-2.307
	(0.46)	(0.46)	(0.44)
Derivative hedge	1.672	1.900	1.737
	(0.38)	(0.44)	(0.40)
GDP growth	-3.531	-4.049	-3.828
	(0.59)	(0.68)	(0.64)
Exchange rate	0.628	0.777	0.714
	(0.46)	(0.57)	(0.52)
Constants	-26.615 ***	-28.141 ***	-26.965 ***
	(5.88)	(6.09)	(5.94)
Observations	1,550	1,550	1,550
R^2	0.038	0.040	0.039

Panel B. Effects of Lagged FC Interest Rates

Fixed Effects Regression				
Dependent Variable:	FC Duration Gap			
	(1)	(2)	(3)	(4)
3-month lagged CD rate	20.596 ***			
	(2.92)			
6-month lagged CD rate		26.534 ***		
		(3.36)		
12-month lagged CD rate			35.254 ***	
			(3.91)	
24-month lagged CD rate				46.969***
				(5.29)
Size	1.687 ***	1.812 ***	2.119 ***	2.635***
	(6.03)	(6.25)	(6.69)	(7.45)
Liquidity	-0.023 ***	-0.022 **	-0.020 **	-0.020**
	(2.58)	(2.41)	(2.12)	(2.02)
Asset quality	-6.798	-7.580	-7.317	-5.526
	(1.50)	(1.61)	(1.56)	(1.31)
ROA	-2.471	-2.817	-3.300	-3.287
	(0.46)	(0.52)	(0.60)	(0.63)
Derivative hedge	1.899	1.962	1.662	1.339
	(0.44)	(0.45)	(0.37)	(0.28)
GDP growth	-3.738	-3.604	-4.000	-5.697
	(0.63)	(0.61)	(0.69)	(0.98)
Exchange rate	0.777	0.671	0.040	-2.171
	(0.56)	(0.48)	(0.03)	(1.41)
Constants	-28.516 ***	-30.872 ***	-36.079 ***	-43.039***
	(6.16)	(6.40)	(6.70)	(7.20)
Observations	1,550	1,550	1,550	1,550
R^2	0.042	0.045	0.051	0.059

Table 5. Robustness Test

This table reports coefficient estimates from the following fixed effects panel regression:

$Duration\ gap_{i,t} = \beta\ FC\ interest\ rate_t + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}$.

The dependent variable, *duration gap,* represents a bank's duration gap of its foreign currency assets and liabilities. The FC interest rate indicates the one-quarter lagged three-month interest rate on dollar certificates of deposit (CDs). The first column reports coefficient estimates during the Federal Reserve tightening period and the second column during the easing period. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Panel A: Foreign currency Duration Gap during Tightening vs. Easing

(in months)

	Tightening period	Easing period	Difference (Tighten – Easing)
Duration gap	-0.5095	0.4350	-0.9445 **
			(2.35)

Panel B: Fixed Effects Test during Tightening vs. Easing

Fixed Effects Regression Dependent Variable:	FC Duration Gap	
	(1) Tightening	(2) Easing
FC interest rate	32.561 ***	36.682 ***
	(6.02)	(2.62)
Size	0.523	2.098 ***
	(1.52)	(3.85)
Liquidity	-0.057 ***	0.000
	(5.85)	(0.06)
Asset quality	3.199	-26.402 *
	(0.78)	(1.86)
ROA	22.167 *	-47.926
	(1.82)	(1.61)
Derivative hedge	22.709 ***	-7.418
	(3.57)	(1.16)
GDP growth	-5.348	-2.296
	(0.86)	(0.26)
Exchange rate	3.653 ***	0.228
	(3.21)	(0.08)
Constants	-8.376	-36.854 ***
	(1.45)	(3.47)
Observations	505	740
R^2	0.395	0.043

Table 6. Duration Gap and Default Likelihood

This table reports coefficient estimates from the following fixed effects panel regression:

$$Default\ Likelihood_{i,t} = \beta\ Duration\ gap_{i,t} + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The dependent variable, *default likelihood*, is assessed using the *credit rating score*, which represents the likelihood of a bank's FC debt default. The credit rating score is calculated using credit rating index values that represent the credit ratings assigned by Moody's, Standard & Poor's, and Fitch to the bank's foreign currency debts, as described in the legend of Table 2. A higher credit rating score represents a lower likelihood of default. The first column reports coefficient estimates with the *FC duration gap* as the independent variable, while the second column uses the one-quarter *lagged duration gap* as the independent variable. The *duration gap* represents a bank's duration gap of its foreign currency assets and liabilities. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Fixed Effects Regression Dependent Variable:	Credit Rating Score	
	(1)	(2)
Duration gap	0.008 ***	
	(3.02)	
Duration gap (lagged)		0.011 ***
		(4.21)
Size	2.645 ***	2.580 ***
	(36.83)	(35.87)
Liquidity	0.007 ***	0.007 ***
	(5.91)	(6.06)
Asset quality	-18.256 ***	-20.804 ***
	(8.15)	(10.34)
ROA	-3.112	-5.384
	(0.98)	(1.58)
Derivative hedge	4.780 ***	4.472 ***
	(3.41)	(3.22)
GDP growth	-3.769 ***	-3.879 ***
	(3.20)	(3.27)
Exchange rate	-2.885 ***	-2.812 ***
	(11.47)	(11.03)
MPD	-0.242 ***	-0.233 ***
	(6.07)	(5.98)
Constants	-41.523 ***	-40.384 ***
	(34.45)	(33.74)
Observations	1,448	1,438
R^2	0.732	0.727

Table 7. Risk Management and Default Likelihood

This table reports coefficient estimates from the following fixed effects panel regression:

$Default\ Likelihood_{i,t} = \beta\ X_{i,t} + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}$.

The dependent variable, *default likelihood*, is assessed using the *credit rating score*, which represents the likelihood of a bank's FC debt default. The credit rating score is calculated using credit rating index values that represent the credit ratings assigned by Moody's, Standard & Poor's, and Fitch to the bank's foreign currency debts, as described in the legend of Table 2. A higher credit rating score represents a lower likelihood of default. The first column reports coefficient estimates with the *credit risk hedge* as the independent variable, while the second column uses the *duration gap x credit risk hedge* interaction term as the independent variable. The *credit risk hedge* represents the amount of a bank's allowance for loan losses scaled by its non-performing loans (ALL/NPL) for a given quarter. The *duration gap* represents a bank's duration gap of its foreign currency assets and liabilities. The *duration gap x credit risk hedge* interaction term is calculated by taking a bank's one-quarter lagged duration gap and multiplying it by its ALL/NPL for that quarter. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Fixed Effects Regression		
Dependent Variable:	Credit Rating Score	
	(1)	(2)
Credit risk hedge	0.271 ***	
	(5.93)	
Duration gap x Credit risk hedge		0.004 ***
		(3.06)
Size		2.591 ***
	2.569 ***	(35.96)
Liquidity	(38.62)	0.007 ***
	0.007 ***	(6.01)
Asset quality	(5.92)	-20.783 ***
	-16.495 ***	(10.31)
ROA	(10.86)	-5.481
	-3.920	(1.61)
Derivative hedge	(1.52)	4.429 ***
	4.105 ***	(3.19)
GDP growth	(3.09)	-3.911 ***
	-4.203 ***	(3.30)
Exchange rate	(3.74)	-2.811 ***
	-2.973 ***	(11.02)
MPD	(12.27)	-0.238 ***
	-0.276 ***	(6.10)
Constants	(7.03)	-40.587 ***
	-40.414 ***	(33.86)
Observations	(35.60)	1,438
R^2	0.329	0.726

Table 8. Economic Contribution of Duration Gap and Risk Management

This table reports the average credit rating score of the banks in each cell. The sample data are split into two groups based on the extent of increasing duration gap and managing credit risk. The *larger duration gap* represents a bank quarter in which a bank's FC duration gap is greater than or equal to the median level, while the *smaller duration gap* represents a bank quarter with a duration gap less than the median level. The *more active risk hedge* represents a bank quarter in which a bank holds allowance for loan losses scaled by non-performing loans (ALL/NPL) greater than or equal to the median level, whereas the *less active risk hedge* represents a bank quarter with an ALL/NPL less than the median level. *Difference* represents the difference between average credit rating score associated with a larger duration gap and that associated with a smaller duration gap, or the difference between average credit rating score associated with a more active risk hedge and that associated with a less active risk hedge. Panel A reports the average credit rating scores for all sample periods, while Panel B presents them for tightening period and Panel reports them for easing period. The table also reports results of testing whether there are significant differences in credit rating scores across larger and smaller duration gaps, as well as between more active and less active risk hedges. *** and * denote significance at 1% and 10%, respectively.

Panel A. All Sample Periods

	Larger Duration gap		Smaller Duration gap		Difference: (Larger – Smaller)	
More active risk hedge	3.6860		3.3011		0.3849	***
					(3.37)	
Less active risk hedge	2.5287		1.4676		1.0611	***
					(5.80)	
Difference:	1.1573	***	1.8335	***		
(More active – less active)	(8.07)		(12.67)			

Panel B. Tightening Period

	Larger Duration gap		Smaller Duration gap		Difference: (Larger – Smaller)	
More active risk hedge	3.9420		3.4542		0.4878	***
					(2.67)	
Less active risk hedge	2.4716		1.0086		1.4630	***
					(4.25)	
Difference:	1.4704	***	2.4456	***		
(More active – less active)	(6.37)		(9.19)			

Panel C. Easing Period

	Larger Duration gap		Smaller Duration gap		Difference: (Larger – Smaller)	
More active risk hedge	3.7523		3.2893		0.4630	***
					(2.95)	
Less active risk hedge	2.8147		1.9712		0.8435	***
					(3.86)	
Difference:	0.9376	***	1.3181	***		
(More active – less active)	(4.90)		(7.11)			

Table 9. Duration Gap, Risk Management, and Bank Value

This table reports coefficient estimates from the following fixed effects panel regression:

$Bank\ value_{i,t} = \beta\ X_{i,t} + \gamma\ Control\ variables_{i,t} + \alpha + \alpha_i + \alpha_t + \varepsilon_{i,t}$.

The dependent variable, *bank value,* represents the log of Tobin's Q for a given quarter. The first column reports coefficient estimates with the duration gap, the second column with the credit risk hedge, and the third column with the *duration gap x credit risk hedge* interaction term as the independent variables. The *duration gap* represents a bank's duration gap of its foreign currency assets and liabilities. The *credit risk hedge* represents the amount of a bank's allowance for loan losses scaled by its non-performing loans (ALL/NPL) for a given quarter. The *duration gap x credit risk hedge* interaction term is calculated by taking a bank's one-quarter lagged duration gap and multiplying it by its ALL/NPL for that quarter. Definitions of the control variables are provided in Table 10. α_i and α_t represent bank and quarter fixed effects. The t-values appear in parentheses and standard errors are heteroskedasticity robust. ***, **, and * indicate the coefficient is significance at the 1%, 5%, and 10% level, respectively.

Fixed Effects Regression Dependent Variable:	Log Tobin's Q		
	(1)	(2)	(3)
Duration gap	0.001 ***		
	(5.18)		
Credit risk hedge		0.010 ***	
		(7.24)	
Duration gap x credit risk hedge			0.001 ***
			(3.82)
Size	-0.037 ***	-0.036 ***	-0.036 ***
	(23.72)	(23.09)	(22.37)
Liquidity	0.000	0.000	0.000
	(1.36)	(0.42)	(0.71)
Asset quality	-0.278 ***	-0.154 ***	-0.255 ***
	(5.53)	(4.19)	(4.48)
ROA	0.018	0.034	0.432 ***
	(0.29)	(0.75)	(2.87)
Derivative hedge	-0.114 **	-0.106 **	-0.086 **
	(2.34)	(2.35)	(2.01)
GDP growth	0.181 ***	0.177 ***	0.162 ***
	(7.90)	(6.80)	(6.94)
Exchange rate	-0.062 ***	-0.074 ***	-0.057 ***
	(10.96)	(8.85)	(10.11)
MPD	0.004 ***	0.000	0.004 ***
	(3.74)	(0.18)	(3.57)
Constants	0.710 ***	0.692 ***	0.681 ***
	(25.26)	(23.27)	(23.71)
Observations	1,092	1,187	1,081
R^2	0.545	0.409	0.558

Table 10: Variable Definitions

FC interest rate	Measures the level of foreign currency interest rate. Specifically, the 3-month U.S. dollar CD rate is used to capture the FC interest rate.
AL maturity gap	Measures a bank's asset-liability maturity gap is the difference between the amount of a bank's interest-sensitive assets and liabilities with a specific maturity.
Asset (liability) duration	Measures the weighted average duration or maturity of a bank's assets (liabilities) for a given quarter.
Duration gap	Measures a bank's risk-taking: computed by a bank's asset duration – (L/A)(liability duration), where the L/A ratio indicates the ratio of the bank's total liabilities to its total assets for a given quarter.
Credit Rating Score	Measures the likelihood of a bank's FC debt default: assessed using a credit rating score, which is the average of credit rating index (CR index) values that reflect the credit ratings assigned by Moody's, Standard & Poor's, and Fitch to the bank's foreign currency debts, as described in the legend of Table 2. A higher credit rating score indicates a lower likelihood of default.
Credit risk hedge	Measures a firm's credit risk management: computed by the amount of a bank's allowance for loan losses scaled by its non-performing loans for a given quarter.
Tobin's Q	Measures the firm market value: [Market value of stock + Book value of debt + Book value of preferred stock] / Book value of total assets.
FC net loan return	Measures a bank's foreign currency loan profitability: computed by subtracting the average cost of borrowing foreign currency funds from the average return on loans in foreign currency for a given quarter.
Size	The log of a bank's total assets for a given quarter.
Liquidity	The ratio of the amount of a bank's total current assets due in three months to the amount of its total current liabilities due in three months for a given quarter.
Asset quality	The ratio of the amount of a bank's nonperforming loans to the total amount of its non-performing loans for a given quarter.
ROA	The ratio of the amount of a bank's earnings before interest and taxes to its total assets for a given quarter.
Derivative hedge	Measures a bank's market risk management: computed by the amount of a bank's interest rate or currency derivatives used for hedging purposes to hedge interest rate or exchange-rate risk, scaled by total assets, for a given quarter.
GDP growth	The quarterly growth rate of real GDP in Korea.
Exchange rate	The exchange rate of Korean won to U.S. dollar divided by 1,000.
MP dummy (Fed tightening)	Measures the Federal Reserve monetary policy stance: represented by a dummy variable that takes the value 1 if the Federal Reserve raises the target for the fed funds rate, and 0 otherwise.
More (less) active risk hedge	Represents a bank quarter in which a bank holds allowance for loan losses scaled by non-performing loans (ALL/NPL) greater than or equal to the median level, whereas the less active risk hedge represents a bank quarter with an ALL/NPL less than the median level.
Larger duration gap	Represents a bank quarter in which a bank's FC duration gap is greater than or equal to the median level, while the smaller duration gap represents a bank quarter with a duration gap less than the median level.
Tightening period	The quarters in which the Federal Reserve raises the target for the federal funds rate.

Table 11: The Federal Reserve Tightening

This table reports the federal funds rate changes in the Federal Reserve's monetary policy stance from November 1999 to December 2023. The FF target indicates the Fed's target (range) for the federal funds rate, which is the Fed's monetary policy interest rate.

Date	FF Target	Stance	Date	FF Target	Stance
1999.11.16	5.25%	Tighten	2007.12.11	4.25%	
2000.2.2	5.75	Tighten	2008.1.22	3.50	
2000.3.21	6.00	Tighten	2008.1.30	3.00	
2000.5.16.	6.25	Tighten	2008.3.18	2.25	
2001.1.3.	6.00		2008.4.30 – 2018. 9. 16	2.00	
2001.1.31	5.50		2008.10.7	1.50	
2001.3.20	5.00		2008.10.29	1.00	
2001.4.18	4.50		2008.12.16 – 2015. 10. 28	0 - 0.25	
2001.5.15	4.00		2015. 12. 16	0.25 - 0.50	Tighten
2001.6.27	3.75		2016. 12. 14	0.50 - 0.75	Tighten
2001.8.21	3.50		2017. 3. 15	0.75 - 1.00	Tighten
2001.9.17	3.00		2017.5.3	0.75 - 1.00	Tighten
2001.10.2	2.50		2017. 6. 14	1.00 - 1.25	Tighten
2001.11.6	2.00		2017. 12. 13	1.25 - 1.50	Tighten
2001.12.11 – 2002. 9. 24	1.75		2018. 3.21	1.50 - 1.75	Tighten
2002.11.6 – 2003. 5. 6	1.25		2018. 6.13	1.75 - 2.00	Tighten
2003.6.24 – 2004. 5. 4	1.00		2018. 9. 26	2.00 - 2.25	Tighten
2004.6.30	1.25	Tighten	2018. 12. 19	2.25 - 2.50	Tighten
2004.8.10	1.50	Tighten	2019. 1. 30 – 2019. 6. 19	2.25 - 2.50	
2004.9.21	1.75	Tighten	2019.7.31	2.00 - 2.25	
2004.11.10	2.00	Tighten	2019.9.18	1.75 - 2.00	
2004.12.14	2.25	Tighten	2019.10.30 – 2020. 1. 29	1.50 - 1.75	
2005.2.2	2.50	Tighten	2020.3.3.	1.00 - 1.25	
2005.3.22	2.75	Tighten	2020. 3. 15 – 2022. 1. 26	0 - 0.25	
2005.5.3	3.00	Tighten	2022.3.16	0.25 - 0.50	Tighten
2005.6.29	3.25	Tighten	2022.5.4	0.75 - 1.00	Tighten
2005.8.9	3.50	Tighten	2022.6.15	1.50 - 1.75	Tighten
2005.9.20	3.75	Tighten	2022.7.27	2.25 - 2.50	Tighten
2005.11.1	4.00	Tighten	2022.9.21	3.00 - 3.25	Tighten
2005.12.3	4.25	Tighten	2022.11.2	3.75 - 4.00	Tighten
2006.1.31	4.50	Tighten	2022.12.14	4.25 - 4.50	Tighten
2006.3.28	4.75	Tighten	2023.2.1	4.50 - 4.75	Tighten
2006.5.10	5.00	Tighten	2023.3.22	4.75 - 5.00	Tighten
2006. 6. 29	5.25	Tighten	2023.5.3	5.00 - 5.25	Tighten
2006. 8. 8 – 2007. 8 .10	5.25		2023.5.3	5.00 - 5.25	Tighten
2007.9.18	4.75		2023.7.26 –	5.25 - 5.50	Tighten
2007.10.31	4.50				