Master's Degree in Specialized Economic Analysis

“Implications of U.S. Monetary Policy Normalization on International Capital Flows. Evidence from South Korea”

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ABSTRACT IN ENGLISH:
In this thesis, we provide evidence on the transmission of U.S. monetary policy shocks to the Korean economy. First, we show that there are spillovers of U.S. monetary policy shocks to Korean domestic credit and real economic conditions. We find a drop in credit supply, an increase in lending rate, risk premia and a drop in asset prices in response to U.S. monetary policy shocks. Thereafter, we calculate the response of different capital inflows and outflows to identify which capital flows are likely to transmit the monetary policy shock. In line with the theory, we find that portfolio debt securities and especially short term banking flows drop significantly in response to U.S. monetary policy shocks.

KEYWORDS IN ENGLISH:
Monetary policy, capital flows, U.S., Korea.

ABSTRACT IN CATALAN
En aquesta tesi, proporcionem evidència de la transmissió dels xocs de la política monetària dels EUA a l'economia coreana. En primer lloc, ens mostrem que hi ha efectes secundaris dels xocs de la política monetària dels EUA al crèdit nacional coreà i condicions econòmiques reals. Trobem una baixada en l'oferta de crèdit, un augment en la taxa d'interès, primes de risc i una disminució en les preus dels actius en resposta als xocs de la política monetària dels Estats Units. Per tant, calculem la resposta de diferents entrades i sortides de capital per identificar quins fluxos de capital són propensos a transmetre el xoc de la política monetària. En consonància amb la teoria, trobem que els títols de deute en cartera i especialment els fluxos bancaris a curt termini cauen significativament en resposta als xocs de la política monetària dels Estats Units.

KEYWORDS IN CATALAN:
Política monetària, fluxos de capital, EUA, Corea.
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Abstract

In this thesis, we provide evidence on the transmission of U.S. monetary policy shocks to the Korean economy. First, we show that there are spillovers of U.S. monetary policy shocks to Korean domestic credit and real economic conditions. We find a drop in credit supply, an increase in lending rate, risk premia and a drop in asset prices in response to U.S. monetary policy shocks. Thereafter, we calculate the response of different capital inflows and outflows to identify which capital flows are likely to transmit the monetary policy shock. In line with the theory, we find that portfolio debt securities and especially short term banking flows drop significantly in response to U.S. monetary policy shocks. Foreign direct investment does not seem to react significantly, except for its most liquid part, i.e. reinvestment of earnings. Policies may include counter-cyclical capital buffers to stabilize the banking system or incentives by the government to make foreigners hold on to long term debt securities.
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1 Introduction

In a Global Financial Stability report, the International Monetary Fund (2017) shows that accommodative monetary policy in Advanced Economies since 2010 has been an important push factor for capital inflows to Emerging Market Economies (EMEs). Low interest rates in the U.S. incentivize investors to search for higher yields elsewhere which has lead to capital inflows, credit growth and a decline in yields in EMEs. The report also states that the normalization of U.S. monetary policy is expected to reduce capital inflows. While a gradual normalization may not be as severe, rapid increases in risk aversion may be challenging for countries with external financing needs. In December 2015, the Federal Reserve implemented its first increase in the federal funds rate since 2008 and has continued to do so gradually. In 2018, the Fed has already increased interest rates twice by 25 basis points to a range of 1.75% to 2.00% and market participants expect one to two further increases in the interest rate this year (NY Times 2018, Bloomberg 2018). An EME that has already witnessed pressure on the value of its currency due to this external shock is Argentina. However, Argentina is argued to be also relatively vulnerable due to high external debt and inflation (Economist 2018). The experience of Argentina is not unique. It has become an important topic to understand how susceptible small open economies are to the normalization of U.S. monetary policy.

Since the Asian financial crisis, Korea has implemented economic reforms and has shown robust continued economic growth as well as low unemployment rates. During the 2008/2009 financial crisis it was the only advanced economy that did not experience a severe recession. Even though GDP growth slowed down over the last twenty years it is still high for an advanced economy, averaging three percent since the end of the Great Recession. Korea managed to grow with low sovereign debt levels and high fiscal reserves, giving it room to maneuver in case of negative shocks to its economy. After the Asian financial crisis, Korea switched to a flexible exchange rate regime, according to the exchange rate regime classification by (Ilzetzki et al. 2017) and a fairly open capital account as indicated by the de jure measure of capital account openness by Chinn & Ito (2006) and the de facto measure of financial integration by Lane & Milesi-Ferretti (2007)(See Figure 6, on page 24 in our Appendix).

However, Korea’s dependence on international operating chaebols\(^1\) for much of its economic activity poses risks, as it renders the economy susceptible to outside shocks. For example, a high dollarization in many of Korea’s large industries, like ship building, makes the country exposed to currency risk. A higher demand for foreign exchange hedging by Korean exporters lead to the buildup of high external short-term debt levels in the Korean banking system (Ryoo et al. 2013). Moreover, Korea experienced significant swings in capital flows over the years, especially during the financial crisis in 2008 (Choi 2014). The recent decision by the Bank of Korea to keep interest rates low in spite of several rate hikes by the Federal Reserve further increases the probability of capital outflows. In a country report, the International Monetary

\(^1\) A large industrial conglomerate that is run and controlled by an owner or family in South Korea.
Fund (2018) mentions high capital flow and currency volatility as key challenges for Korean Monetary Policy. The report further notes that Korea should commit to its flexible exchange rate to reassure markets that it is willing to limit the pass through of U.S. rate hikes onto domestic interest rates. However, recent research even suggests that the flexible exchange rate may not be enough anymore to insulate from such spillovers (Rey 2016). Even if Korea benefits from being financially integrated and shows a robust economic outlook, the dependence of its banking system on short-term external debt may makes it vulnerable to U.S. monetary policy shocks. We want to evaluate the extent to which Korea may be vulnerable to the U.S. monetary policy normalization.

The debate on the consequences of U.S. monetary policy normalization fits into a broader academic discussion on the transmission channels of U.S. monetary policy. Rey (2016), Passari & Rey (2015) study how U.S. monetary policy shocks transmit to the domestic financial and real conditions of other economies. In our analysis, we follow the approach of Rey (2016) and study how U.S. monetary policy shocks affect the lending rate, risk premia, credit supply and asset prices in Korea. We find that U.S. monetary policy shocks increase the lending rate, the external finance premium, and lead to a fall in credit issued by the domestic banking system. Asset prices and industrial production also drop. In general, this seems to be evidence that a U.S. monetary policy shock leads to a contraction in domestic credit conditions in Korea. In a second step, we use a granular dataset on different types of capital inflows and outflows to study which capital inflows and outflows are particularly susceptible to U.S. monetary policy shocks. This may be indicative of which capital flows transmit U.S. monetary policy shocks. Consistent with the analysis of our first step, portfolio debt securities and bank loan capital flows are most prone to U.S. monetary policy shocks. We conclude our analysis with policy recommendations on how Korea can make its domestic credit conditions more resilient by targeting these specific types of capital flows. The structure of the paper is as follows: Section 1 opens, Section 2 provides a review of the relevant literature, Section 3 presents the empirical analysis, Section 4 reports our main results, Section 5 the policy implications of our findings and Section 6 concludes.

2 Literature Review

Firstly, we provide an overview of the process of financial integration in Korea. Secondly, we highlight how U.S. monetary policy may be a driver of capital flows to Korea. We do this by reviewing the literature on the transmission channels of U.S. monetary policy shocks to domestic credit conditions in other economies.

2.1 Financial Integration

A widely used measure of financial integration is based on the work of Lane & Milesi-Ferretti (2007) who assemble a cross-country dataset on gross liabilities and assets covering the period 1970-2011. Their dataset includes information on international investment positions of direct
investment, portfolio equity and external debt (Kose et al. 2009). Figure 1 shows that the external debt liabilities play a major role in Korea’s international investment position, constituting around 30 percent of GDP in 2011. Portfolio equity and direct investment have become more relevant from 2000 onwards. Foreign investors hold their assets vis-a-vis Korea in the form of bonds or loans. On the asset side, debt, equity and direct investment seem to be more or less equally relevant. The gross stock of liabilities consisted of around 70 percent of GDP in Korea in 2011, while the asset side amounts to about 35 percent of GDP, which indicates that Korea is a net debtor to the rest of the world.

**Figure 1:** Korean External Assets (left) and Liabilities (right) in Percent of GDP

The complimentary flow variables to external assets and liabilities are capital flows, which are recorded in the financial account of a country’s balance of payments statistics. Net capital flows can be understood as an exchange of assets for goods and services. Gross capital flows can be separated into capital inflows by foreigners and capital outflows of residents. The advantage of focusing on gross capital flows is to take into account the fact that foreigners have different investment incentives than domestic agents (Broner et al. 2013). Gross capital flows can also better account for the amount of international lending, borrowing and intermediation in international financial markets (De Gregorio 2014). In order to disentangle the different investment incentives of foreigners and residents, and the drivers of international financial transactions, we focus on the response in gross capital flows in our analysis.

Capital flows can be distinguished between direct investment, portfolio investment and other investment. Direct investment involves a transaction in which the investor gains substantive ownership over an enterprise. Portfolio investment does not entail ownership and can be divided into equity and portfolio debt. Equity flows involve a purchase of a company’s shares by investors, and portfolio debt securities refer to corporate or government bonds. Other investment consists of bank flows and trade credit. Within other investment we focus on the former, given that these flows are more relevant to our analysis.

Source: Updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007).
2.2 Determinants and Consequences of Capital Flows

The literature distinguishes between push and pull factors to capital flows. Interest rates in advanced economies are viewed as important push factors whereas economic growth, institutional quality or the domestic financial system of a country are pull factors (Koepke 2015, Calvo et al. 1993). Different types of capital flows exhibit a different sensitivity to push factors. Direct investment is more stable, attracted by a country’s economic fundamentals, and can be beneficial for economic growth as it may be associated with technological spillovers. Portfolio debt or banking flows tend to be unstable and pro-cyclical. Portfolio debt tends to be affected by global push factors whereas banking flows both by pull and push factors. (Kose et al. 2009, Eichengreen et al. 2018).

Several researchers argue that debt flows are particularly susceptible to changes in global push factors. These flows also affect a country’s domestic credit conditions and may cause financial stability risks (Ostry et al. 2010, International Monetary Fund 2017). In a cross-country sample, Lane & McQuade (2014) show that credit growth is significantly related to net debt flows, but not net equity flows. De Gregorio (2014) states that “FDI and portfolio equities tend to be more supportive for economic growth, while this is not the case for banking flows. This could be because financial crises come mostly from distortions in the banking sector (p. 280).”

Drawing on the experience of the Asian financial crisis in the 1990s, Korea had large ratios of short term foreign debt (primarily owned by foreign banks and firms) to international reserves. The mixture of a steep rise in short term liabilities and the limited availability of liquid assets left the country exposed to a change in investor confidence and capital account reversals (Rodrik & Velasco 1999). Because of the capital account reversal, many financial institutions in Korea faced significant difficulties in meeting their external short term debt liabilities. The withdrawal of resources of domestic creditors as well resulted in a further shortage of liquidity. This led to costly asset liquidation and deflation. Ryoo et al. (2013) also observe a buildup of short term debt liabilities before the financial crisis of 2008, which left Korea vulnerable to the external shocks from the financial crisis.

However, debt flows should not have adverse consequences per se, as they may contribute to a country’s economic growth path by financing projects (UNCTAD 2015). It may rather be a combination of debt flows driven by changes in global push factors and a country’s institutional framework that may make the country exposed to financial stability risks from capital inflows (Ostry et al. 2010, Broner & Ventura 2016).

Related to the global drivers of capital flows and credit growth, Rey (2015) developed the concept of the global financial cycle. Rey (2015) and Passari & Rey (2015) show that gross capital inflows and outflows around the world co-move over time and are negatively associated with global market risk aversion, proxied by the VIX. They also find that credit and leverage around the world are associated with global risk as well as a large cross-section of risky asset prices around the world (Miranda-Agrippino & Rey 2018). Other studies show that extreme
movements in capital flows such as capital surges are significantly associated with global risk (Forbes & Warnock 2012), and that most extreme episodes of capital flows are driven by debt flows (Forbes & Warnock 2013).

In Table 1 (see Appendix A), we calculated pairwise correlations between capital inflows and the VIX as a proxy for global risk, to present further evidence of the relationship between the global financial cycle and gross capital flows to Korea. The correlation matrix shows that loans through the banking system and portfolio debt security inflows are significantly negatively associated with the VIX over our sample period, 1999-2012. The correlation between short term loan inflows and portfolio debt inflows with the VIX is -0.3677 and -0.1605 respectively. By further disentangling our capital inflow variables, we find that the two correlations are driven by short term loans and long term debt securities.

2.3 U.S. Monetary Policy and the Global Financial Cycle

In a second step, Rey (2016) and Passari & Rey (2015) establish a link between U.S. monetary policy and the global financial cycle as the U.S. dollar is an important funding and investment currency worldwide. Rey (2016) and Passari & Rey (2015) argue that U.S. monetary policy can affect the net worth of investors, intermediaries and firms globally. Thereby, U.S. monetary conditions can be transmitted across borders via global intermediaries and affect credit conditions in other economies. They suggest that there could be an international credit channel that propagates the global financial cycle.²

Borio & Zhu (2012) suggest a risk-taking channel where monetary policy affects the attitude of market participants towards taking on risk. Rajan (2006) argues that lower nominal interest rates can incentivize financial market participants such as insurance companies or fund managers to take on more risk and search for higher yields, and even politicians in EMEs can have a political economy motive to use risky short-term debt flows to stimulate growth in the short-term. Bruno & Shin (2015) find evidence for an international risk-taking channel of monetary policy through the banking system and bank leverage. A lower interest rate also decreases the cost of debt on the liability side of financial intermediaries, which makes it attractive to increase the leverage ratio (Adrian & Shin 2009). Morais et al. (forthcoming) present evidence for an international bank lending channel of monetary policy as foreign banks increase their credit supply to Mexican firms in response to foreign policy rate shocks. Baskaya et al. (2018) show that capital flows driven by global risk appetite significantly affect domestic credit conditions in Turkey especially through internationally exposed domestic banks.

Concluding, the literature indicates that U.S. monetary policy can propagate the global financial cycle and affect domestic credit conditions in other economies via global intermediaries. Different types of capital flows capture different financial transactions and are prone to a differ-

²In a domestic context, Bernanke & Gertler (1995) argue that financial frictions in credit markets can enhance the effect of monetary policy as it affects the balance sheet of agents and thereby their external finance premium.
ent degree to changes in U.S. interest rates. Hence, we want to analyze not only how domestic credit conditions in Korea are driven by U.S. monetary policy, but also how susceptible different types of capital inflows and outflows are to these shocks. Some of them are more likely to transmit spillovers to local credit conditions more than others.

3 Empirical Analysis

In this section, we explain how we measure the effect of U.S. monetary policy shocks to Korean real and financial variables and capital flows. There is a distinction between a systematic component of the policy rate and unexpected changes in monetary policy. Gerko & Rey (2017) point out that most of the movements in the policy rate is due to a systematic component. They define a monetary policy shock as an unanticipated movement in monetary policy, exogenous to the other variables in the model and uncorrelated with other structural shocks. They argue that a monetary policy shock can be described as changes in central bank preference, a change in expectations about future policy, or future economic developments (Gerko & Rey 2017). To identify how capital flows respond to US monetary policy shocks, we follow the strategy adopted by Rey (2016), and outline how the approach contrasts with earlier identification methods in a VAR.

First, we set up the structural VAR and outline how U.S. monetary policy shocks are identified using short run restrictions (Cholesky decomposition). We contrast this identification strategy with the proxy structural VAR introduced for example by Mertens & Ravn (2013), and used by Gertler & Karadi (2015). This methodology uses an external variable as an instrument to identify structural shocks. We show how we can use this methodology to analyze U.S. monetary policy spillovers. Finally, we present our contribution to this approach. We impose zero restrictions on coefficients to eliminate a feedback loop from Korean variables to the federal funds rate.

3.1 Structural VAR

First, we set up the structural VAR as follows:

$$\Psi Y_t = \sum_{i=1}^{p} \Phi_i Y_{t-i} + \epsilon_t$$  (1)

In our specification $p = 6$. Including many lags can be problematic as the VAR can quickly become heavily parameterized. Given that we have 161 datapoints per variable we include six lags. In doing so, we differ from the approach of Gerko & Rey (2017) who use twelve lags. $Y_t$ is a vector of six variables. The vector includes the monetary policy indicator in the U.S. and five real and financial variables in Korea. For the policy indicator, Gertler & Karadi (2015) use the 1-year government bond rate instead of the funds rate because they argue that this policy variable captures an additional shock to forward guidance (p. 50). Rey (2016) uses the 1-year rate and the federal funds rate. In our analysis, we use the federal funds rate because it
performed relatively better in the proxy structural VAR framework in terms of the first stage of the instrument (see section 3.2). This was surprising to us, but it could be related to the fact that we include Korean control variables and rely on a shorter sample period. The Korean variables include industrial production ($IP_t$), a housing purchase price ($HPPI_t$) or consumer price ($CPI_t$) index, the corporate bond spread ($CBS_t$) as a proxy for the external finance premium, the lending rate ($i_t$) and the sixth variable changes with the specification ($x_t$). In our baseline VAR, we use credit supply by the Korean banking system, and then different types of capital inflows and outflows as the sixth variable. We obtained the data on the policy variable and our instrument from the dataset of Gertler & Karadi (2015) and use the international financial statistics provided by the IMF and Korean central bank statistics as datasources for our Korean variables. (See Appendix D for a detailed description of our data sources). The vector $Y_t$ for our baseline VAR is defined as follows:

$$Y_t = [FFR_t \ IP_t \ HPPI_t \ CBS_t \ i_t \ x_t]^\top$$

The structural shocks to each variable are denoted by $\epsilon_t$. The shocks are assumed to be uncorrelated and the variance normalised to one, so $E(\epsilon_t\epsilon_t') = I$. The elements in matrix $\Psi$ denote the contemporaneous relationship between the variables, while $\Phi$ denotes the effect of the own lags as well as the other lags on the current value of each variable. Due to the matrix $\Psi$, the variables in $Y_t$ are contemporaneously correlated and we cannot estimate the coefficients via OLS consistently. That is why we have to transform the structural VAR into the reduced form VAR by multiplying both sides by $\Psi^{-1}$.

$$Y_t = \sum_{i=1}^{p} \Psi^{-1}\Phi_i Y_t + \Psi^{-1}\epsilon_t$$

$$Y_t = \sum_{i=1}^{p} A_t Y_t + \Psi^{-1}\epsilon_t$$

$$Y_t = \sum_{i=1}^{p} A_t Y_t + u_t$$

$A_t = \Psi^{-1}\Phi_t$ and the reduced form error term $u_t = \Psi^{-1}\epsilon_t$. The covariance matrix is defined as $E(u_tu_t') = \Psi^{-1}E(\epsilon_t\epsilon_t')\Psi^{-1} = \Psi^{-1}I\Psi^{-1}$. We can estimate $A$ with OLS consistently. In order to calculate how each of the Korean variables in $Y_t$ respond to a structural shock to U.S. monetary policy denoted by $\epsilon_{mt}$ in $\epsilon_t$, we need to estimate the matrix $\Psi^{-1}$. In order to be able to refer to columns and elements more easily within $\Psi^{-1}$, we define $\Psi^{-1}$ to be equal to $\Psi^*$ out of convenience, $\Psi^{-1} = \Psi^*$. The coefficients in $\Psi^*$ are defined via the variance-covariance matrix of the reduced error term, $\Psi^*\Psi^{*'} = \hat{\Sigma}$. However, we do not have enough degrees of freedom to estimate the full matrix $\Psi^*$ since the variance-covariance matrix is symmetric. In order to identify $\Psi^*$, the common approach is to use the Cholesky decomposition on the estimated covariance matrix.

$$PP' = \hat{\Sigma}$$
Where $P$ is a lower triangular matrix and $\Psi^* = P$. As $P$ pins down the coefficients in $\Psi^*$, we can calculate the response of the variables in $Y_t$ to a structural shock to U.S. monetary policy. As $P$ is a lower triangular matrix, $\Psi^*$ is also lower triangular. Hence, the Cholesky decomposition is equivalent to imposing short-run restrictions. We assume that the first variable in $y_t$ does not respond contemporaneously to structural shocks to the other five variables. The second variable only responds to shocks to the first variable, but not to shocks to the latter four variables, and so on. That is why this identification method requires an assumption on the ordering of the variables. Typically, slow moving variables are ordered first such as industrial production, while fast moving variables are ordered last such as interest rates. However, in a financial context this might not be warranted as variables tend to move together. The decision on the ordering itself may require strong assumptions, the impulse responses of the VAR may be sensitive to the ordering and the identification strategy has been subjected to criticism.

### 3.2 Proxy Structural VAR

The approach we follow is a proxy Structural VAR method used for example by Gertler & Karadi (2015) and Passari & Rey (2015). We want to identify the coefficients in the matrix $\Psi^*$. Instead of using the Cholesky decomposition on the estimated variance-covariance matrix, this approach follows another route and avoids imposing short-run restrictions. As we are only interested in how Korean variables respond to a structural shock to U.S. monetary policy, we only need to identify the column $\psi^{*,m} \in \Psi^*$ that refers to the response of the variables $Y_t$ to a structural shock to U.S. monetary policy.

$$ Y_t = \sum_{i=1}^{p} A_t Y_t + \psi^{*,m} \epsilon_t^m $$

In order to identify $\psi^{*,m}$, we use an external instrument approach as in Gertler & Karadi (2015). The external instrumental variable strategy requires a variable that can proxy structural shocks to U.S. monetary policy $\epsilon_t^m$. This variable should be uncorrelated with the structural shocks to the other variables. The instrument $Z_t$ must be correlated with the monetary policy shock: $E[Z_t \epsilon_t^m] = \theta$. It must also be uncorrelated with any other structural shock to the other variables, $E[Z_t \epsilon_t^q] = 0$. Intuitively, the instrument is a noisy proxy for the U.S. monetary policy shock. Gertler & Karadi (2015) use the movement of three month ahead Federal Funds futures (FF4) in a 30 minutes window around monetary policy announcements during FOMC meetings to identify monetary policy shocks. Federal Funds Futures reflect market opinion on the average daily federal funds effective rate for a given month and these futures can be used to hedge against changes in short-term interest rates.

If these futures move around FOMC meetings, this can capture an unanticipated change in monetary policy as all prior expectation of monetary policy changes should be priced in. Any change in these futures during monetary policy meetings may capture an unanticipated U.S. monetary policy shock hitting the economy. Such a high frequency identification of monetary
policy shocks was pioneered for example by Gürkaynak et al. (2005), and Gertler & Karadi (2015) use such a measure to identify structural shocks to monetary policy in a structural VAR analysis. Gertler & Karadi (2015) aggregate the change in the FF4 around FOMC meetings up to a monthly time series. We rely on their time series and combine it with our variables in the VAR.

We draw upon Gertler & Karadi (2015) to now explain how one can use the instrument to identify the column $\psi^{*\cdot m}_q$. First, we estimate the reduced form VAR. Then, we use the reduced form residuals $\hat{u}_t$, where $\hat{u}^{m}_t$ denotes the residual of the federal funds rate and $\hat{u}^q_t$ the residuals of the other variables. First, we regress $\hat{u}^{m}_t$ on the FF4 time series of Gertler & Karadi (2015) to extract the variation in the residual explained by the instrument, i.e. the proxy for the U.S. monetary policy shock $\epsilon^m_t$. In the second stage, we regress the other residuals $\hat{u}^q_t$ on the fitted values of the residual $\hat{u}^{m}_t$. The coefficient in this regression gives us the ratio of the response in the other variables relative to a response in the U.S. policy variable to a U.S. monetary policy shock. The second stage regression is defined as follows:

$$\hat{u}^q_t = \psi^{*\cdot q} \psi^{*\cdot m} \hat{u}^{m}_t + \zeta_t$$

(5)

To partition this ratio, one has to use the estimated covariance variance matrix of the reduced form error term, $\hat{\Sigma}$. This approach allows us to identify the response on impact in each Korean variable $\psi^{*\cdot q}$ to a U.S. monetary policy shock. We find that approach attractive compared to imposing short-run restrictions. We avoid the assumption of imposing a particular ordering. It is appealing to draw on a variable external to the VAR that is credibly associated with U.S. monetary policy shocks and to apply it as an external instrument to identify $\psi^{*\cdot q}$.

3.3 Proxy Structural VAR with Zero Restrictions

Nevertheless, the approach is not without criticism (see for example Ramey (2016)). We focus on one particular caveat that we encountered during our empirical analysis. This issue seems to be especially relevant when one uses the identification strategy to study U.S. monetary policy spillovers to other small open economies and hence may be relevant for Rey (2016).

When we estimate the reduced form VAR in the way described above, we introduce a feedback effect where the included Korean control variables affect the federal funds rate. Because of this, the residuals $\hat{u}^{m}_t$ differ with the specification. Even if the Korean variables plausibly have no effect on the federal funds rate, they may well be correlated. Since we regress $\hat{u}^{m}_t$ on the instrument, the instrument gains or loses power depending on the control variables we include.

We propose to estimate the VAR so that the coefficients measuring the effect of the Korean variables on the federal funds rate are set to zero. We set all coefficients for all lags $p=1,...,6$ to
zero that capture the effect of the Korean variables on the federal funds rate.

\[
A_p = \begin{bmatrix}
\alpha_{11} & 0 & 0 & 0 & 0 & 0 \\
\alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} & \alpha_{26} \\
\alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} & \alpha_{36} \\
\alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} & \alpha_{46} \\
\alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} & \alpha_{56} \\
\alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & \alpha_{66}
\end{bmatrix}
\] (6)

The lagged federal funds rate still affects the Korean variables as $\alpha_{21}$ until $\alpha_{61}$ are not set to zero. As all coefficients in the first row are zero except $\alpha_{11}$, we restrict the federal funds rate to be explained only by its own lags. Therefore, we expect the variation in the residual of the federal funds rate to be unaffected by the control variables and constant across specifications. The F-Statistic should also be constant across specifications. We present our results for this model in section 4.4.

4 Empirical Results

We first present results from our baseline VAR where we measure the response of Korean real and financial variables to a U.S. monetary policy shock. We exchange the sixth variable with our respective capital inflows and outflows variables to analyze which capital flows are relatively more responsive to U.S. monetary policy. This allows us to disentangle different investment incentives between foreigners and residents and also between different intermediaries. We compute the cumulative response of capital flows due to a monetary policy tightening to get a better understanding of the economic magnitude.

4.1 Part 1: Baseline VAR

We include in our baseline VAR the lending rate and the amount of loans issued by commercial and specialized banks to measure the impact on the Korean banking system and the corporate bond spread AA-class as a proxy for the external finance premium. We control for industrial production and asset prices, and we also test for the effect on consumer prices and the exchange rate.

The corporate bond spread increases, reflecting an rise in the external finance premium, as a consequence of higher borrowing cost. Industrial production and consumer prices seem to fall after some time, even though the responses are not very robust. Loans issued by commercial banks drops significantly as well as asset prices, which relate to the presence of financial frictions. A US tightening could result in a decrease in the net worth of private agents, financial intermediaries and firms. A reduction in liquidity and the decrease in loans can cause a decline in aggregate demand. This creates a contractionary environment. For instance, banks’ credit rationing affects private agents’ borrowing capacity, as a consequence of the decreased value of their collateral, and raises their borrowing costs resulting in higher lending rates.
4. EMPIRICAL RESULTS

4.2 Part 2: Responses of Gross Capital Flows

So far, we presented evidence that U.S. monetary policy has an effect on domestic credit conditions, asset prices and real variables in Korea, consistent with the findings of Rey (2016), Passari & Rey (2015). There seems to be evidence for an international credit channel of U.S. monetary policy to Korea. As a next step, we look at the response of different capital inflows and outflows to better understand the transmitters of this channel and to take account of the investment incentives of different agents. We look at foreign direct investment, portfolio investment, and other investment. We disentangle the respective flow variables into more granular subcategories controlling for the standard macroeconomic variables. We expect FDI to remain relatively stable, while portfolio and banking flows should react significantly, due to their higher sensitivity to global push factors (Eichengreen et al. 2018). Most of our graphs for the capital flow responses to a U.S. monetary policy shock are included in Appendix B.

4.2.1 Liability-side

Other Investment

Other investment denotes inflows to the Korean banking sector. We focus on loans, which constitute the largest share (61% of other investment inflows from 1999-2012), and is the driving force behind the effect in banking sector inflows. As can be seen in figure 11 on page 29, a U.S. tightening leads to an initial increase and to a statistically significant decrease in gross inflows with a lag of about 5 months. We observe the same in the case of short term loans. Long term loans increase on impact, albeit insignificantly. The results are overall inconclusive, but it seems that a U.S. tightening tends to decrease loans granted to Korean banks by foreigners. This would be consistent with the argument in Ostry et al. (2010) that debt flows are susceptible to changes in global push factors, which can be explained through different channels. An increase in the U.S. policy rate decreases the value of domestic banks’ long term assets. This change in asset values reduces the banks’ net worth, and collateral, rendering them more borrowing constrained.
It would also lead to a reduction in their leverage (Adrian & Shin 2009). This phenomenon may be attributable to an increase in a bank’s risk aversion as a result of the higher perceived liquidity risk. This could in turn motivate banks to rebalance their portfolios away from short term debt in favor of longer term positions, in order to avoid "rollover difficulties" (Ryoo et al. 2013). While short term loans react significantly, response of long term loans is not significant. The driving force behind the drop in other investment seems to be the drop in short-term loan capital flows. These findings are consistent with our baseline VAR that highlighted the drop in credit supply and increase in lending rates. It also validates the claim that the Korean banking system has accumulated high external short-term debt (Ryoo et al. 2013, Choi 2014).

**Foreign Direct Investment**

FDI responds more strongly to pull factors and economic fundamentals. As shown in figure 13 on page 30, we find no effect on gross inflows, which is in line with the theory that the incentives for FDI investment are strategically driven. The potentially most liquid part of FDI, namely reinvestment of earnings, drops slightly and significantly. This would be consistent with the idea that foreign investors reallocate their most liquid assets within FDI to advanced economies.

**Portfolio Investment**

Portfolio investment includes debt and equity inflows. Our findings are aligned with predictions of the theory: as can be seen in figure 3, portfolio debt responds more strongly to the shock than equity and there appears to be a decrease in gross inflows as a result of a U.S. monetary policy shock. Gross portfolio investment inflows decrease significantly on impact, and the effect is negative up to about four periods. Aggregate debt securities witness a significant drop up to the fourth month.

Most of the effect seems to be driven by a drop in debt securities, especially long term debt. Assuming that foreign investors’ risk aversion increases, the latter rebalance their portfolios towards short term debt. Broner et al. (2013) make an argument related to this finding. If there is an increase in the risk aversion of foreign investors, they demand a higher compensation for long-term bonds as these bonds have a higher price risk. In return, there is a shift towards short-term bonds. We observe a drop in equity securities of smaller magnitude. The return to equity investment mostly depends on expected dividends and stock price developments. Even if equity is not directly affected by U.S. interest rates, a contractionary environment sends a negative signal to investors, thus there could be indirect spillovers to stock markets and a fall in equity inflows.

**4.2.2 Asset-side**

Our results on the asset-side are less intuitive, given that we observe a decrease in assets across capital outflows. In theory, we would expect an increase in assets following a US tightening as Korean investors have an incentive to make use of higher yield opportunities.

**Other Investment**
4. EMPIRICAL RESULTS

Figure 3: VAR Results for Portfolio Investment (Liabilities)

As depicted in figure 12 on page 29, other investment outflows decrease, albeit insignificantly. Most of the effect is driven by a reduction in loans, despite being also insignificant. Most of the variation in loans is attributable to short term loans, which also decrease on impact even if insignificantly. Long term loans hardly respond to the shock. While the effect is marginally positive, it is not significant. We find that loans by Korean banks to foreigners decrease, interestingly similarly to a decrease in loans of global banks to Korean banks. However, this decrease is insignificant.

Foreign Direct Investment
There is hardly any response in any of the direct investment subcategories to the monetary policy shock, with the exception of a marginally significant drop in debt after 3 months. Reinvestment of earnings does not react significantly. The VAR results can be seen in figure 14 on page 30. Korean residents do not seem to change their FDI positions in response to U.S. tightening.

Portfolio Investment
As exhibited in figure 10, we observe a significant drop in portfolio outflows between month 3 and 5, as well as a decrease on impact of both equity and debt securities, which becomes marginally significant only around period 5. The response of short term debt securities displays higher volatility. It appears that both long and short term debt securities decrease on impact, although insignificantly. Given a tightening in the US we would expect an increase of overseas investments by Korean residents, reflecting the availability of higher return investment opportunities. our VAR results state that there is no positive relationship between portfolio debt, equity and U.S. monetary policy. The observed negative effects may be driven by balance sheet effects,
tightening financial constraints and the contractionary environment. Apart from that, the stock variable portrays a complimentary pattern (Figure 5). The graph shows a sustained increase in portfolio investment outflows, and this effect is increasing for the years 2012-2017. In Appendix C, we include graphs on the evolution of the other types of stock variables. Analogous dynamics can be observed for other investment and foreign direct investment. A potential reason for this discrepancy between the VAR results and the dynamics of the stock variables may be that the surge in outflows materialized mostly after the sample period of our VAR.

The dynamics illustrated in the graphs are aligned with the general perception of analysts. In Reuters (2018), it is noted that residents are taking advantage of favourable exchange rates to increase their exposure in overseas assets and capital is flowing out of Korea into overseas bonds and equity. In Bloomberg (2018), the author comments that in their search for higher return investment opportunities, Korean institutional investors such as the National Pension Service revealed its plans to boost overseas investment to 40 percent of its assets by 2022 from 27 percent in 2016.

**Figure 4:** Portfolio Investment, Equity and Debt (Stock Variable, in US$ Millions)

![Portfolio Investment, Equity and Debt (Stock Variable, in US$ Millions)](image)

Source: IMF, Balance of Payment Statistics

### 4.3 Forecast of Capital Flow Responses due to Monetary Policy Tightening

To get a better overview of the economic magnitude that U.S. monetary policy tightening has on capital flows, we calculate the cumulative response of the capital flow variables. At the moment, markets expect four interest rises over 2018. To be conservative, we assume three interests hikes of 25 bp each by the Federal Reserve in 2018. To get cumulative responses, we take the point estimates we obtained from the VAR and re-scale them to match a 25 bp shock. In the next step we cumulate the rescaled point estimates to get the magnitude of a shock over time.

In our hypothetical forecasts we assume three shocks, each at the beginning of the quarter. That is, one shock at the beginning of Q1 2018, the next in Q2 2018 and the last at the beginning of Q3 2018. Even if this does not reflect the actual timing of policy changes, we start in Q1 2018 to connect the forecast to the stock variables we have up to Q4 2017. Doing this allows us to give a better overview over the magnitude of the changes compared to the size of the
4. **EMPIRICAL RESULTS**

We calculate the lower and upper bound by using the point estimates from the 90 percent confidence bands we obtained from the VAR. Therefore, the overall magnitude of three U.S. monetary policy shocks at the end of Q3 2018 to each variable are calculated the following: At the end of Q3 2018 we have the cumulative effect over nine months from the first shock at the beginning of Q1 2018. Furthermore, the second shock from the beginning of Q2 2018 has a cumulative effect over six months. At last, the most recent shock from the beginning of Q3 2018 has a cumulative effect over three months.

\[
J = \sum_{j=1}^{3} j + \sum_{j=1}^{6} j + \sum_{j=1}^{9} j
\]

(7)

With \(J\) being the overall shock and \(j\) the monthly point estimates, obtained from the impulse response function. Calculating with three expected rate raises we get an effect between 0.2 and one percent of GDP. These numbers are in line with estimates by the *International Monetary Fund* (2017). They find a drop between 0.1 and 1.5 percent of annual GDP in gross inflows to different emerging market economies over a two year horizon due to a U.S. monetary tightening. We forecast a one percentage point drop for total portfolio inflows, a 0.6 percentage points drop for total debt securities, as well as a 0.23 percent increase in short term debt securities, and a 0.91 percent fall in long term ones (always in percent of annual GDP). The results are depicted in figure 5 and forecast on selected other investment inflows are shown in figure 11 on page 29 in the Appendix.

**Figure 5:** Forecasts of Portfolio Investment Positions (Liabilities) in % of Annual GDP

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3 As we have no stock variable for the two bottom graphs, we focus only on the change in percent of GDP.
4.4 Robustness Checks

We extend our empirical analysis using two alternative VAR models outlined in section 4.1 and 4.3. We present results using the Cholesky decomposition as identification strategy which assumes short-run restrictions. As already argued, such an identification strategy is not viable in the context of financial markets and the identified structural shocks may be sensitive to the ordering. Furthermore, we use a proxy structural VAR model with our extension where we set the coefficients that describe the effect of the control variables on the federal funds rate to zero to eliminate the feedback effect (see equation (5) in section 4.3). We compare the results of these three models for our capital flow variables in the portfolio investment category. Furthermore, our results could be driven by the financial crisis. Therefore, we perform a robustness check where we exclude the months of financial turbulence. Table 5 shows the results of our robustness checks.

Different VAR Specifications

The columns (1) to (3) in Table 5 show the different point estimates using the three different VAR models. Column (1) refers to the identification strategy using the Cholesky decomposition, (2) to our baseline proxy structural VAR, and (3) to the proxy structural VAR with zero restrictions. We take the impulse response functions for all three models and calculate the cumulative effect over nine months of a 25 bp U.S. monetary policy tightening. Since the Cholesky decomposition requires an assumption on the ordering of the variables, we have ordered the federal funds rate first which assumes that the U.S. interest rate does not respond contemporaneously to structural shocks of the Korean variables. $FFR_t$ refers to the federal funds rate, $IP_t$ to industrial production, $CPI_t$ to the consumer price index, $CBS_t$ to the corporate bond spread, $i_t$ to the lending rate, and $x_t$ is the capital flow variable of interest.

$$Y_t = \begin{bmatrix} FFR_t & IP_t & CPI_t & CBS_t & i_t & x_t \end{bmatrix}^T$$

Table 5 shows that the results are qualitatively similar to our results obtained using the proxy structural VAR with the external instrument (column (2) and (3)). With the exception of portfolio investment equity inflows, the cumulative effects obtained by using the Cholesky decomposition are consistently smaller than the cumulative effects of the proxy structural VAR. The difference between the standard proxy structural VAR and the VAR with zero restrictions is less pronounced. The cumulative effects obtained using the VAR with zero restrictions are smaller than the cumulative effects of the proxy structural VAR.

Focusing on the VAR with zero restrictions, the residuals of the federal funds rate $\hat{u}_t^{zm}$ do not differ across specifications, as expected. As $\hat{u}_t^{zm}$ is constant, we find that the instrument has the same power explaining the variation of $\hat{u}_t^{zm}$ regardless of the specification. The F-Statistic increases relative to most of our other specifications and stays constant at 17.4673. The feedback loop from the Korean control variables to the federal funds rate is likely driven mostly by correlation of the control variables to U.S. variables that affect the federal funds rate. This introduces some noise in our analysis and limits the power of the instrument. Imposing
zero restrictions on the VAR removes this unwanted feedback loop and increases the power of the instrument compared to most of our specifications.

Excluding the Financial Crisis
To see how much our results are driven by the financial crisis we follow Gertler & Karadi (2015), exclude the months from July 2008 until June 2009 from our sample and rerun our analysis. The results are depicted in column (4) in Table 5. Qualitatively, the results point in the same direction as the results of the specifications (1) to (3). The cumulative effect of the three debt security variables are especially similar. For equity, the results differ substantially, which can be partly explained by the fact that the decision to invest in equity is mostly driven by factors other than the interest rate. Furthermore, the F-Statistic drops down to 7.0794 for the case of equity, which casts doubt on the result.

Overall, it seems that excluding the financial crisis lowers the F-Statistic. In the years preceding the financial crisis, monetary policy shocks were less frequent and tended to be smaller. Consequently, the instrument loses some power to explain the variation in the federal funds rate during those years. This changed during the crisis as monetary policy became less foreseeable and the shocks to monetary policy became larger. The time series of the instrument seems to support this theory in the sense that the size of the instrument increases during the years of the financial crisis. Because of the way the instrument is measured, it is susceptible to be more powerful in times of exceptional monetary policy. We rerun our analysis using the zero restriction proxy structural VAR without the financial crisis. This gives us a better view of the magnitude of the drop in the power of the instrument. Using this specification, the F-Statistic drops from 17.463 to 13.4279, which is still well above 10.

5 Policy Implications
We focus on the results of other investment, portfolio investment, and foreign direct investment inflows given that our findings are more robust, and in line with the theory. Our most relevant results are a significant response in short term portfolio debt security inflows and short term loan inflows as well as a drop in reinvestment of earnings. As already pointed out in our literature review section, many authors suggest that an increase in short term debt can entail financial stability risks. Rodrik & Velasco (1999) argue that “the ratio of short term debt to reserves is a robust predictor of financial crises”, while Furman & Stiglitz (1998) write: “The ability of this variable, by itself, to predict the crises of 1997, is remarkable”. Therefore, we suggest three different sets of policy measures to deal with the significant reaction in these inflows: counter-cyclical capital buffers, subsidies for foreign investors to hold long term debt and equity, and finally currency and capital controls.

Within the category other investment, it seems that the subcategory driving our results are short term loans as they react most strongly to U.S. monetary policy shocks and significantly after some time. We indeed observe a significant drop in short term loans with a lag of five
periods. This result is consistent with our baseline VAR, where we find a drop in loans provided by Korean banks, an increase in the lending rate and a drop in asset prices which suggests tightening domestic credit conditions. This is also in line with the idea that short term debt inflows are pro-cyclical. Given the argument that short-term debt can entail financial stability risks and the fact that the Korean banking system has accumulated high external debt levels (Ryoo et al. 2013), our first conclusion is to focus on the drop in short-term debt.

Among the policy tools available to achieve this, Korea may increase its counter-cyclical capital buffer (CCyB). This is calculated as the weighted average of the buffers in place in jurisdictions where banks operate. It is an extension of the capital conservation buffer. To compute it, the Basel Committee on Banking Supervision (BCBS) provides guidelines by comparing the gap between the ratio of aggregate private sector credit to GDP and its long term trend, as well as the ratio of residential property prices to rentals and their long term trend. It could be useful to compliment credit to GDP gaps with other indicators such as the ratio of short term liabilities to available liquid assets. Indeed, strong growth in credit alone does not necessarily entail “excess” growth and rising systemic risk, and therefore many jurisdictions have integrated new indicators to make their CCyB assessments. To date, Korea has announced a Counter-cyclical capital buffer of 0.00 % in 2016, and has not raised it since. For example, other jurisdictions have raised their CCyB, including Hong Kong, which increased it to 2.5 % in January 2018 from the current 1.875 %. It could therefore be advisable for Korea to increase the CCyB to limit the effect the pro-cyclicality of short term loans inflows and to ensure that their domestic banking system is resilient to a U.S. monetary policy tightening.

Moving on to portfolio investment inflows, we observe a rebalancing towards short term debt securities. We see a significant drop in long term debt securities and a smaller increase in short term debt securities. This is consistent with the view that an increase in risk aversion by investors makes long term debt securities more expensive and implies a shift towards short term debt securities (Broner et al. 2013). We also observe a significant drop in equity inflows. This may be a reason for concern. Depending on the level of the short term debt to liquid assets ratio, we would suggest two alternatives. As the Korean central bank has chosen to keep interest rates low and foreign investors may shift their funds abroad, borrowing constraints for Korean firms tighten. Given that the government has insofar maintained a prudent level of fiscal spending, it could provide tax subsidies to firms to incentivize them to issue more long term debt. Should it be the case that this measure is not effective, as a last resort we would advise Korea to implement currency and capital controls on inflows. This would enable to limit the potentially destabilizing effects of short-term capital flows described previously by restricting flows directly. This measure was successfully implemented in the past already. A notable example is that of Malaysia in the mid 1990s. In that case, large short-term capital inflow increases posed a threat to the country’s macroeconomic stability. The Malaysian government therefore imposed a prohibition on the sale to non residents of a wide range of short term securities. These restrictions were subsequently extended to cover swap transactions in the currency market and
Concerning FDI, formulating policy recommendations given our results may be challenging. We already observe that the corporate bond spread, i.e. the external finance premium, rises in response to a monetary policy tightening in the US. If, in addition to that, reinvestment of earnings drops, then corporates in Korea might not only face tightening external financing constraints, but also lack additional internal re-financing opportunities. There are many factors determining whether earnings are repatriated or not, such as comparative investment opportunities domestically and abroad, or the relative profitability of Korean firms (Lundan 2006). The simplest way to tackle the increasing repatriation of earnings due to the US monetary policy normalization is taxation: currently, all three types of earnings (dividends, interest, and royalty payments) are subject to a withholding tax of 20% for non-residents with countries Korea does not have a bilateral tax agreement with according to PwC (2018). For countries with which such an agreement exists, withholding taxes are generally lower.

Thus, it would make sense to create disincentives for the repatriation of earnings through a moderate increase in withholding taxes. If feasible, the increase in taxes could be targeted, i.e be made country specific, as is already the case for countries that have a tax agreement with Korea. But the main trade-off that Korean policy-makers need to bear in mind is that while higher taxation might lead to less repatriation of earnings, it could in also lead to lower FDI inflows due to lower net return on investments. In general, given the attractiveness of Korea as a FDI target country due to a highly skilled workforce, high quality infrastructure and high household income (Santander 2018), we think that there might be room for a moderate withhold tax increase without decreasing the attractiveness of Korea as a FDI target country for foreign investors.

The following table presents an overview of our policy recommendations for Korea based on our VAR results and the forecasts of portfolio investment positions in figure 5.

**Table 1: Policy Matrix**

<table>
<thead>
<tr>
<th>Effects</th>
<th>Other Investment</th>
<th>Portfolio Investment</th>
<th>FDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebalancing towards LT loans</td>
<td>×</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rebalancing towards ST debt</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Drop in Reinvestment of Earnings</td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Policies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCyB increase</td>
<td>×</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LT debt incentives</td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Capital Controls</td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Moderate increase in withholding taxes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6 Conclusion

We have shown that U.S. monetary policy has important spillover effects on Korean domestic credit supply, lending rates, and risk premia of Korean corporates. Our findings are consistent with the view put forward by Rey (2016), Passari & Rey (2015) that U.S. monetary policy can entail an international credit channel and affect domestic credit conditions in other economies.

In the second step of our analysis, we find indicative evidence that foreign investors respond to a U.S. monetary policy shock with a decrease in short term banking inflows and a shift from long term debt securities towards short term debt securities. The drop in short term debt banking inflows may explain the tightening credit conditions in the banking system. A shift towards short term debt may be related to the increase in the external finance premium of Korean corporates. In general, it seems that the contractionary environment and tightening credit conditions in Korea are related to a retrenchment of debt related capital inflows of foreigners. Our results on the response of capital outflows to U.S. monetary policy shocks are contrary to what we expected. We find no significant increase in capital outflows even though we expected an increase in overseas investments by Korean investors to make use of higher yield opportunities. The stock variable of portfolio investment in figure 4 indicates that the increase in overseas investments by Korean residents materialized after the sample period of our VAR.

Korea is a financially integrated economy, whose key industries are highly dollarized, and the presence of the aforementioned spillovers suggest that there are relevant policy implications to be drawn from our findings. We present different measures that Korea could adopt to insure its macroeconomic and financial conditions from a US normalization: a potential implementation incentive schemes to rebalance towards long term debt such as tax breaks, an increase in the counter-cyclical capital buffer (CCyB), or currency and capital controls. However, it must be mentioned that our analysis has some limitations, and this reduces the scope for generalization of our findings. Firstly, our estimation results do not capture the increase in assets that has been occurring in recent years. We argue that this is because the surge in outflows materialized in periods outside our observation sample. Moreover, our forecasts for the cumulative effects are based on the assumption of three hikes in the federal funds rate in 2018, in Q1, Q2 and Q3.

The analysis started here can be meaningfully extended. On the methodological part, the proxy structural VAR is an interesting tool to analyze spillover effects, but may need to take account of feedback effects and use as we suggested zero restrictions. Furthermore, one can make use of time varying coefficients in the VAR. Moreover, increasing the sample horizon to better capture the effects of the recent period of loose monetary policy could be a first step in that direction. A similar analysis using local projections would be interesting, given that the latter methodology imposes less restrictions on the data. Moreover, further research needs to be carried out on the effects and implications of U.S. monetary policy on developing countries’ real and financial conditions.
7 References


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8 Appendix

8.1 Appendix A: Figures and Tables

Figure 6: Korean Currency per U.S. Dollar (left) and De Jure/De Facto Measure of Financial Integration (right)

Notes: On the left side, we plot the log of the exchange rate in terms of the Korean Won per U.S. Dollar. On the right side, we plot two measures of financial integration. On the left vertical axis, the de jure measure by (Chinn & Ito 2006), on the right axis, the de facto measure by (Lane & Milesi-Ferretti 2007)
Table 2: Correlation Log(VIX) and Gross Capital Inflows

<table>
<thead>
<tr>
<th></th>
<th>Other Investment</th>
<th>Direct Investment</th>
<th>Portfolio Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall Loans</td>
<td>Short Term Loans</td>
<td>Overall Debt</td>
</tr>
<tr>
<td>Correlation</td>
<td>-0.343</td>
<td>-0.3677</td>
<td>-0.0406</td>
</tr>
<tr>
<td>P-Value</td>
<td>0</td>
<td>0</td>
<td>0.6078</td>
</tr>
<tr>
<td></td>
<td>Overall Debt</td>
<td>Equity</td>
<td>Reinvestment of Earnings</td>
</tr>
<tr>
<td>Correlation</td>
<td>-0.0406</td>
<td>0.0026</td>
<td>-0.1273</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.6078</td>
<td>0.9734</td>
<td>0.1064</td>
</tr>
<tr>
<td></td>
<td>Overall Debt</td>
<td>Short Term Debt</td>
<td></td>
</tr>
<tr>
<td>Correlation</td>
<td>-0.1475</td>
<td>-0.0104</td>
<td>-0.1693</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.061</td>
<td>0.8951</td>
<td>0.0312</td>
</tr>
</tbody>
</table>

Table 3: Nine months cumulative effect of a 25 bp US monetary policy tightening on portfolio investment inflows using different VAR identifications and excluding the financial crisis.

<table>
<thead>
<tr>
<th>Cumulative effect ((J = \sum_{j=1}^{9})</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Inflows</td>
<td>-0.0172</td>
<td>-0.2143</td>
<td>-0.1759</td>
<td>-0.3055*</td>
</tr>
<tr>
<td>Equity</td>
<td>0.028</td>
<td>-0.0674</td>
<td>-0.0218</td>
<td>-0.13*</td>
</tr>
<tr>
<td>Debt Securities</td>
<td>-0.0774</td>
<td>-0.2347</td>
<td>-0.2222</td>
<td>-0.211</td>
</tr>
<tr>
<td>S.T. Debt Securities</td>
<td>0.06</td>
<td>0.0901</td>
<td>0.0859</td>
<td>0.0646*</td>
</tr>
<tr>
<td>L.T. Debt Securities</td>
<td>-0.1552</td>
<td>-0.353</td>
<td>-0.3269</td>
<td>-0.2688</td>
</tr>
</tbody>
</table>

Column (1) refers to the Cholesky Decomposition, (2) to the proxy structural VAR, (3) to the zero restrictions proxy structural VAR, and (4) to the proxy structural VAR excluding the financial crisis. * denotes the specifications where the F-statistic is below 10, with 7.0794 being the lowest. We compare the cumulative point estimates of different VAR identification methods. The estimates reflect the cumulative effect over nine months of a 25 bp tightening by the federal reserve. Using the Cholesky Decomposition consistently gives smaller estimates than when we use a proxy structural VAR. The results from the proxy VAR with zero restrictions are similar, but consistently smaller, than the results of the proxy structural VAR without zero restrictions. The results from the proxy structural VAR excluding the financial crisis are similar to the other results except for Equity and Gross Inflows. Nevertheless, for theses variables the F-Statistic is also very weak.
**Figure 7:** Other Investment (Stock Variable, in US$ Millions)

Source: IMF, Balance of Payment Statistics

**Figure 8:** Foreign Direct Investment (Stock Variable, in US$ Millions)

Source: IMF, Balance of Payment Statistics

**Figure 9:** Portfolio Investment (Stock Variable, in US$ Millions)

Source: IMF, Balance of Payment Statistics
8.2 Appendix B: Additional VAR Results for section 4.2

Figure 10: VAR Results for Portfolio Investment (Assets)

Notes: Monthly data over the period 1999:01 to 2012:06. The instrument (Fed Funds futures FF4) used lasts from 2000:01 to 2012:06. The F-stats are 12.78 for Gross Outflows, 8.65 for Equity, 13.96 for Debt Securities, 14.36 for Short Term Debt Securities, and 13.29 for Long Term Debt Securities. We computed 90% confidence intervals.
**Figure 11:** VAR Results for Other Investment (Liabilities)

Notes: Monthly data over the period 1999:01 to 2012:06. The instrument (Fed Funds futures FF4) used lasts from 2000:01 to 2012:06. The F-stats are 14.10 for Gross Inflows, 17.43 for Loans, 16.75 for Short Term Loans, and 14.37 for Long Term Loans. We computed 90% confidence intervals.

**Figure 12:** VAR Results for Other Investment (Assets)

Notes: Monthly data over the period 1999:01 to 2012:06. The instrument (Fed Funds futures FF4) used lasts from 2000:01 to 2012:06. The F-stats are 13.56 for Assets, 14.34 for Loans, 13.63 for Short Term Loans, and 12.99 for Long Term Loans. We computed 90% confidence intervals.
Figure 13: VAR Results for Foreign Direct Investment (Liabilities)

Notes: Monthly data over the period 1999:01 to 2012:06. The instrument (Fed Funds futures FF4) used lasts from 2000:01 to 2012:06. The F-stats are 14.47 for Gross Inflows, 17.15 for Equity, 11.47 for Reinvestment of Earnings, and 14.81 for Debt Instruments. We computed 90% confidence intervals.

Figure 14: VAR Results for Foreign Direct Investment (Assets)

Notes: Monthly data over the period 1999:01 to 2012:06. The instrument (Fed Funds futures FF4) used lasts from 2000:01 to 2012:06. The F-stats are 14.49 for Gross Outflows, 13.92 for Equity, 14.24 for Reinvestment of Earnings, and 18.49 for Debt Instruments. We computed 90% confidence intervals.
Figure 15: Forecasts of Selected Other Investment Positions (Liabilities) in % of Annual GDP

Figure 16: Forecast of Other Investment, Short Term Loans (Assets) in % of Annual GDP

Source: Own calculations; data from IMF, Balance of Payment Statistics
8.3 Appendix D: Datasources

We obtained the federal funds rate from Gertler & Karadi (2015). In their analysis they instrument the one year government bond yield. In turn, we use the federal funds rate in our sample as it gives us a higher F-Statistic than the one year U.S. yield. Industrial production and Consumer Price Index are indices from the IMF International Financial Statistics Database and are in log scale. Corporate Bond Spread are calculated as a difference between 3-Year AA-Corporate Bond Yield and the 3-Year Treasury Bond Yield, obtained from the Bank of Korea. Lending Rate is also obtained from the IMF International Financial Statistics Database. The lending rate is the depository corporations’ rate that usually meets the short- and medium-term financing needs of the private sector. Gross Domestic Product is from the IMF World Economic Outlook and in measured in billion US dollars.

Portfolio investment inflow and outflow variables: debt securities, short term debt securities, long term debt securities, aggregate inflows, aggregate outflows, and equity are from the Bank of Korea’s Economic Statistics System, and are measured in million US dollars. The stock variables debt securities, and equity are from the IMF Balance of Payment Statistics, also measured in million US dollars.

FDI inflow and outflow variables debt instruments, reinvestment of earnings, and equity are from the Bank of Korea’s Economic Statistics System, and are measured in million US dollars. The stock variables are also from the IMF Balance of Payment Statistics, which is in million US dollars.

Other investment inflow and outflow variables loans, short term loans, and long term loans are from the Bank of Korea’s Economic Statistics System, and are measured in million US dollars. The stock variables are also from the IMF Balance of Payment Statistics, which is million US dollars.