The role of push and pull factors in cross-border equity and bond flows

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Abstract

Push and pull factors show heterogeneous impacts on portfolio investment flows depending on portfolio type: equity flow and bond flow. These effects change after the recent global financial crisis (GFC). I examine a relationship between push and pull factors, and equity gross inflow and bond gross inflow using Korean data from 2000 to 2019. I find three results. (i) Volatility IndeX (VIX) decreases equity inflow but increases bond inflow before the GFC. After the GFC, although VIX reduces equity inflow, it no longer affects bond inflow. A role of VIX may have changed due to unconventional monetary policy implemented at the post-crisis. (ii) Before the GFC, excess return of KOSPI 200 pulls bond inflow but not equity inflow. However, excess return of post-crisis KOSPI 200 pulls both equity inflow and bond inflow. Sensitivities of flows on returns of equity indices may have soared due to increased passive investing. (iii) Lastly, prior-to-crisis currency depreciation increases equity inflow only, whereas post-crisis currency depreciation reduces bond inflow only.

JEL classifications: F21, G12, G15

Keywords: Equity flows; Bond flows; Push factors; Pull factors; Cross-border investment

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1. Introduction

Motivated by the fact that equities and bonds show different levels of risk, I study effects of push and pull factors on time-series variations of equity flow and bond flow. Because equity and bond are long or short by international investors, equity flows and bond flows are pushed or pulled. Correspondingly, there are many studies finding determinants of portfolio investment flow. However, there is little research on heterogeneous determinants of portfolio flow by portfolio type. I distinguish a portfolio flow into its two main components, equity flow and bond flow.

I investigate equity and bond flows arriving to Korea, which is a small open economy. I focus on bilateral gross inflow to Korea departing from the US, defined as US (foreign) investors' purchases of Korean (domestic) assets minus US investors' sales of Korean assets. Push factors are global economic forces which push portfolio investment from the US (foreign) to Korea (domestic). I set push factors as US real interest rate, Volatility IndeX (VIX), and real exchange rate. An economic mechanism for push factors that affect portfolio flow is how US real interest rate changes risky asset price, formalized as Global Financial Cycle in the literature. (Miranda-Agrippino and Rey, 2019) Global Financial cycle explains variations of risky asset price, because Global Financial Cycle significantly decreases after US monetary contraction, following reduction of global credit, retrenchment of capital flows, and contraction of foreign financial conditions.

Pull factors are country-specific economic forces which pull portfolio investment into Korea. I set pull factors as interest rate differential and equity indices return difference between the US and Korea. An economic mechanism for pull factors is that investors consider economic soundness of Korea relative to global economy when taking positions on Korean assets. Characteristic of financial market in a recipient is a decisive factor of how a recipient responds to push factors. Surge and sudden stop of portfolio inflows are potential causes of currency crisis in an emerging market. (Sula, 2010) An exemplary past event is the Asian Financial Crisis, when interest rate differential between Korea and US reversed in 1997, resulting in sudden stop of portfolio inflows, leading to Korean Won currency crisis.

Using the above definitions of variables, I address following questions: (i) What are the roles of push and pull factors in explaining time-series variations of equity and bond inflows?

The sub-question is: Do the effects of these factors appear to be heterogeneous between equity flow and bond flow, possibly due to different risk and return structures of equities and bonds? (ii) Do the impacts of push and pull factors change after the recent global financial crisis (GFC)? (iii) Do novel features that emerge after the GFC, such as passive equity investing and unconventional monetary policy, affect the dynamics of equity and bond inflows? To answer these questions, I use Bank of Korea Economic Statistics System database. The time-series data are monthly from January 2000 to December 2019.

I find four results for the questions (i) and (ii). First, Volatility IndeX (VIX) has heterogeneous effects between bond flows and equity flows, depending on the observed time span. Prior to the global financial crisis (GFC), VIX decreases equity inflows, while it increases bond inflows. After the GFC, VIX decreases equity inflows, however it has marginal effects on bond inflows. Second, difference in returns of equity indices is important. Before the GFC, difference in equity indices returns has marginal effects on equity inflow. In contrast, if KOSPI 200 has higher returns than S&P 500, then bond inflow increase. After the GFC, the excess returns of KOSPI 200 to S&P 500 increase both equity inflow sand bond inflows to Korea. Third, real exchange rate depreciation of domestic currency increases equity inflows, leaving bond inflows intact at prior-to-crisis. At post-crisis, however, this effect on equity inflow vanishes. Rather, bond inflows decrease due to the real exchange depreciation. Lastly, regarding interest rate, bond flows are both pushed by US real interest rate and pulled by interest rate differential.

I find two results for the question (iii). First, the role of VIX may have changed after the crisis due to unconventional monetary policy (UMP). The direct effect of UMP is more pronounced for post-crisis bond inflow than any other flows, showing that UMP purchases corporate bonds and government bonds at the aftermath of the GFC, thus increasing bond gross inflow. I examine an interaction effect between US unconventional monetary policy and VIX. There exists possibility that US unconventional monetary policy and quantitative easing moderates the adverse effect of VIX. This interaction term is not statistically significant for prior-to-crisis flows, indicating that UMP gains the explanatory power at the post-crisis world. Secondly, as passive investment gains its phenomenal popularity in the aftermath of the global financial crisis, the sensitivities of equity and bond flows on stock indices return soars.

Given the vast literature of capital flows, it is surprising how little attention has been paid to heterogeneous features of equity flow and bond flow in response to push and pull factors. I contribute to the literature by differentiating equity flow and bond flow in investigating the response of portfolio investment flows to push and pull factors. I study effects of five explanatory variables (push and pull factors) on two dependent variables (equity flows and bond flows) by two subsamples of time periods (prior-to-crisis and post-crisis), providing rich dimension of results.

Also, I explain the heterogeneous relationship regarding two new features of the post-crisis: passive equity investing and unconventional monetary policy. There is little research on effect of market beta on cross-border capital flows. This paper fills the gap in the literature by examining that market beta is an important determinant of equity flows and bond flows in the post-crisis time. The returns of stock indices play an important role with the lag of the flows, which explain the heterogeneous effects of push and pull factors over time span. In addition, while many studies examine the macroeconomic effectiveness of unconventional monetary policy on capital flows, there is little research on the interaction of unconventional monetary policy with push and pull factors. This paper contributes to the literature by explaining the time-varying effects of the factors with the new emergence of unconventional monetary policy implemented in the aftermath of global financial crisis.

2. Related Literature

This paper relates with three bodies of literature: first, studying determinants of international capital flows, second, investigating macroeconomic effectiveness of monetary policy on capital flows, third, examining features and impacts of passive equity investing.

Considerable amount of literature studies determinants of capital flows. Portes and Rey (2005) identify that information spillover on telephone calls is a novel determinant of cross-border equity flow. Ahmed and Zlate (2014) claim that interest rate differential between emerging and advanced economies causes net private capital inflows. Sarno, Tsiakas, and Ulloa (2016) suggest that portfolio flows are mainly pushed rather than pulled, using Bayesian dynamic latent factor model.

However, it is surprising how little research has been conducted on heterogeneity of equity flows and bond flows against push and pull factors. Fratzscher (2012) and Li et al. (2018) are noteworthy exceptions. Fratzscher (2012) examines the role of push versus pull factors in the global financial crisis. He argues that push factors are main drivers of capital flows during the crisis, whereas pull factors are stimulus for capital flows after the crisis. Li et al. (2018) examines that real exchange rate appreciation shows significant relationship with international bond fund flows but not with international equity fund flows.

The second related strand of literature investigates macroeconomic effectiveness of monetary policy on capital flows. Kiendrebeogo (2016) finds that US unconventional monetary policy has increases net portfolio flows to emerging markets, especially for recipients with great exchange rate flexibility, and financial openness. Miranda-Agrippino and Rey (2019) highlight that there exists a Global Financial Cycle, in which US monetary contraction reduces global credit, capital flow, and financial conditions. Jansen and Zervou (2017) claim that US monetary policy surprises account for stock returns variations during 2000-2007, which are not apparent in bond markets.

The third related body of literature studies effects of passive equity investing on capital flows. John Bogle, the founder of Exchange-Traded-Fund (ETF), claims that it is innately impossible to pick high-return stocks all the times, thus investors should buy an entire stock index. (Bogle, 2015) Due to the stock crash down in the global financial crisis, investors begin to sense the impossibility of always beating stock markets. Gradually, active equity management loses its popularity. Instead, passive equity management becomes phenomenal, due to small management fees, low tax, thus low costs, easy accessibility, and ample liquidity. ETFs account for more than 18% of US equity trading volume, exceeding 2 billion shares per day. ETFs account for 30% of equity trading by value.[*]

With the growing volume and popularity of passive equity investing, a few studies link passive equity investing with macroeconomic variables. Curran and Velic (2020) find that countries with high financial openness and volatile exchange rate show high market beta on world stock market. There are numerous studies investigating beta strategy and its returns (Lu

[*] https://www.fidelity.com/learning-center/investment-products/etf/liquidity-volume-etf

and Murray, 2019; Malamud and Vilkov, 2018; Frazzini and Pederson, 2014). However, to best of my knowledge, there are not many studies on impact of market beta on cross-border capital flows.

3. Identifications

3.1. Variable definitions, sources, and trend

Table 1 presents definitions, frequency and source of variables. Much of this paper models equity gross inflows and bond gross inflows rather than net inflows. Gross inflow is defined as purchases of domestic assets by foreign investors minus sales of domestic assets by foreign investors. I assess bilateral data for portfolio flows. Instead of aggregate-level total inflows, bilateral data allow me to clarify source and recipients, obtaining clearer identification of effects of push and pull factors. I obtain bilateral data of equity flows and bond flows from the Bank of Korea Economic Statistics System database. Equity and bond gross inflow data are monthly, ranging from January 2000 to December 2019, scaled by Korea's nominal GDP. Table 2 shows descriptive statistics of main variables including equity and bond gross inflows. The first and second rows show that equity flow exhibits higher risk than bond flow.

Net inflows are defined as the differential of gross inflows (foreigners' purchases of domestic assets minus foreigners' sales of domestic assets) and gross outflows (foreigners' sales of domestic assets minus foreigners' purchases of domestic assets). I choose gross inflows instead of net inflows because gross inflows are relevant in investigating effects of macroeconomic covariates and monetary policies on foreign investments. (Cerutti, Claessens, and Puy, 2019; Ahmed and Zlate, 2014) In case of Korea, which is a small open economy, foreign investors transact high volume of Korean equities and bonds, leading increase of significant gross inflows over the past twenty years.

Interest rate differential is defined as Korea's monetary stabilization bond rate minus US effective federal fund rate. Sixth row of table 2 presents that interest rate differential is positive in average. I use Korea' s monetary stabilization bond rate because it reduces noises of exchange rates on bond yields, also government bond accounts for most of the Korean bond market.

Difference on returns of equity indices are defined as KOSPI 200 close price return minus S&P 500 close price return. I collect close prices of KOSPI 200 and S&P 500 from Mirae Asset Daewoo securities database. Seventh row of table 2 shows that difference in equity indices return is negative in average, indicating that S&P 500 on average overperforms KOSPI 200.

Along with Li et al. (2018), I define bilateral real exchange rate as follows:

$$RER_{KRW/USD} = \frac{NER_{KRW/USD} \times CPI_{US}}{CPI_{KR}},$$

in which $RER_{KRW/USD}$ is the real exchange rate measured as Korean Won (domestic) against US dollars (foreign), and $NER_{KRW/USD}$ is the nominal exchange rate measured as Korean Won (domestic) against US dollars (foreign). An increase in the value of $RER_{KRW/USD}$ indicates depreciation of Korean Won to US dollars. A positive coeffienc estimate of $RER_{KRW/USD}$ means that KRW depreciation against USD increases portfolio inflows. Currency value of Korean Won has been volatile as the fifth row of table 2 shows that the difference between minimum and maximum is 67% of the minimum value.

In examining the indirect effect of unconventional monetary policy in explanatory power of push and pull factors, I use Taylor rule gap to measure unconventional monetary policy. Taylor rule gap is the difference between effective federal funds rate and the interest rate derived from a standard Taylor rule (1993). As an alternative, I use one-year-ahead futures rate to proxy unconventional monetary policy.

Bank of Korea presents cross-border equity flow and bond flow monthly. On contrary, raw data of all variables have daily frequency. I calculate average of daily data in the same month, to convert daily to monthly in order to match with monthly portfolio flow data. I do not use last day of a month, because doing so will leave out extreme prices and values that may become potential causes of reverses.

Figure 1 presents time-series trends of portfolio gross inflows from January 2000 to December 2019. At prior-to-GFC, portfolio inflows stay relatively stable. In the GFC, in 2007-2009, at the grey-shaded area, portfolio flows turn sharply negative, showing more than twice of the magnitude compared to 2006. At the post-GFC, portfolio flows remain volatile with large surges and plummets. Because of the distinct volatilities over time span, it is important to split

sample into prior-to-GFC and post-GFC.

In figure 2, equity investment flows and bond investment flows tend to move in opposite directions. When equity inflows rise (the blue lines), bond inflows fall (the green lines). This difference may rely on the distinct risks of equities and bonds as equities historically show high risk compared to bonds. In the crisis, bonds become popular, possibly due to compensation of stocks' high risk. In the post-crisis, equity flows and bond flows both display high volatility, which is a similar result with figure 1. In the post-crisis, bond gross inflows are more volatile than equity gross inflows. This observation matches with Ahmed and Zlate (2014), in which they find recipient country undergoes capital inflow surges due to heightened interest rate differential as a result of US unconventional monetary policy. Also, high volatility of equity flows at the post-GFC may reflect passive equity investing that has increased in volume and in value after the crisis, sensing the impossibility of consistently beating the stock market.

3.2. Econometric model

The empirical model builds on the classical portfolio theory that consists of returns and risk. I consider global economic forces that push portfolio investment from the US to Korea (push factors): (i) US real interest rate, (ii) VIX, (iii) real exchange rate. I also consider country-specific economic forces that pull portfolio investment into Korea (pull factors): (iv) interest rate differential between Korea and the US, and (v) difference in equity return indices between KOSPI 200 and S&P500.

Specifically, I construct the following regressions:

$$EF_t = \beta_0 + \beta_1 {r^*}_t + \beta_2 VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t + \beta_6 EF_{t-1} + e_t \quad \cdots (1)$$

$$BF_t = \beta_0 + \beta_1 {r^*}_t + \beta_2 VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t + \beta_6 BF_{t-1} + e_t \quad \cdots (2)$$

The left-hand side variables EF_t and BF_t are respectively equity gross inflows and bond gross inflows to Korea at time t as a fraction of Korea's nominal GDP. ${r^*}_t$ indicates US real interest rate at time t. RER_t stands for real exchange rate. $(kbr_t - effr_t)$ represents interest rate differential of Korea and the US, which is defined as Korea's monetary stabilization bond rate minus US effective federal funds rate. Y_t measures the difference in equity indices return, which is defined as KOSPI 200 close price return minus S&P 500 close

price return. β_1, β_2, β_3, β_4, and β_5 are the coefficients of interest.

I add lags EF_{t-1} and BF_{t-1} respectively in the equations (1) and (2). Adding these lags is important for three reasons. Firstly, past movements of cross-border portfolio flow typically affect current positions on asset investment. (Cerutti et al, 2019) Secondly, capital flows take time to respond to macroeconomic announcements and financial developments with some lags. Finally, lags can mitigate reverse-causality issues between portfolio flows and the factors. There may exist reverse causality of which portfolio gross inflows cause base interest rate variation. Also, it could be the case that overall state of the economy leads to changes in portfolio flows and factors altogether. Adding a lag mitigates such reverse causality issues.

e_t is the error term. The error term captures surprises, apart from the factors, which stimulate impulsive investment transactions thus portfolio flow variations. Possible examples are whimsical sentiment of individual investors, global political disputes, and natural hazards. e_t is uncorrelated with explanatory variables in economic terms because these whimsical sentiments of individual investors do not affect economic mechanisms of push and pull factors. Also, surprises are unknown at time t, thus uncorrelated with explanatory variables known at time t.

Based on the two linear regressions on the equations (1) and (2), I use Ordinary Least Squares (OLS) estimator with White Heteroskedasticity adjusted standard errors. The equation (1) seeks suggestive evidence between push factors and equity flows while the equation controls pull factors. Asymmetrically, the equation (2) studies the impacts of pull factors on bond flows while it controls the effects of push factors.

3.3. Linear model misspecification testing

It is important to test if linearity is a well-specified model for these data because linear model is the main framework. Without linear model misspecification testing, it is unsure if linearity can represent the relationship between portfolio investment flows and push and pull factors. A nonlinear factor such as the US economic cycle may cause distortion to linearity. Therefore, I perform statistical testing of linear model misspecification by employing power transforms of regressors. The testing reveals that there are *no* non-linearities in the data, with linear models being statistically significant and specified correctly.

In alignment with Baek, Cho, and Phillips (2015), I construct the models M_0 and M_1 to test linearity using power transforms of regressors. M_0 in the equation (3) is nothing but the right-hand side variables of the main models in equations (1) and (2). M_0 is a model under null hypothesis H_0. If M_0 is correct under the null, then linear model is correctly specified. M_1 in the equation (4) is the addition of M_0 and exponential power transform of M_0. M_1 is constructed in that if lambda is equal to zero, M_1 will be the same equation with M_0. If lambda does not equal to zero, then M_1 is the exponential model. If H_0 is true, the exponential term in M_1 disappears, thus M_0 is a correctly specified linear model. If H_1 is true, the exponential term in M_1 is alive thus non-linear model measures data generating process.

$$M_0 := \{\beta_0 + \beta_1 r^*{}_t + \beta_2 VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t\} \cdots (3)$$

$$M_1 := \begin{Bmatrix} \beta_0 + \beta_1 r^*{}_t + \beta_2 VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t + \\ \lambda \exp\left(\tau'\left(\widetilde{\beta_0} + \widetilde{\beta_1} r^*{}_t + \widetilde{\beta_2} VIX_t + \widetilde{\beta_3} RER_t + \widetilde{\beta_4} (kbr_t - effr_t) + \widetilde{\beta_5} Y_t\right)\right) \end{Bmatrix} \cdots (4)$$

$$H_0 : \lambda = 0 \cdots (5)$$

$$H_1 : \lambda \neq 0 \cdots (6)$$

I exclude the lags in equations (3) and (4) for two reasons. First, my interest is whether push and pull factors (main explanatory variables) have linear relationship with cross-border portfolio flows. Detrending is an important feature is an important feature to remove nonlinear bias in estimating the underlying distribution. Second, adding lag is somewhat burdensome compared to its fruits, because the lags will yield trifold identification problem. Baek, Cho, and Phillips (2015) propose quasi- likelihood ratio (QLR) test statistic can resolve this trifold identification problem.

In alignment with Cho, Ishida, and White (2011), Baek, Cho, and Phillips (2015), and Cho and Phillips (2018), I approximate the QLR test statistic to test the null hypothesis H_0:

$$\text{QLR} := n\left(1 - \frac{\text{Q}(\dot{\beta}, \dot{\lambda}, \dot{\tau})}{\text{Q}(\dot{\beta}_0, 0, \dot{\tau})}\right) \cdots (7)$$

$(\dot{\alpha}, \dot{\lambda}, \dot{\tau})$ are Quasi-Maximum Likelihood (QML) estimators using M_0 and M_1 respectively.

$$(\dot{\beta},\ \dot{\lambda}, \dot{\tau}) := argmin\ \mathrm{Q}(\beta\ ,\ \lambda\ , \tau)\ \text{ and }\ ((\dot{\beta}_0\ ,\ 0, \dot{\tau}) := argmin\ \mathrm{Q}(\beta\ , 0, \tau).\ \cdots\ (8)$$

$$\mathrm{Q}\left(\beta\ ,\ \lambda\ , \tau\right) := \frac{1}{T}\sum_{t=1}^{T}(EF_t - (\beta_0 + \beta_1 r^*{}_t + \beta_2 VIX_t + \beta_3 RER_t + \beta_4(kbr_t - effr_t) + \beta_5 Y_t) - \lambda \exp(\tau'(\widetilde{\beta_0} + \widetilde{\beta_1} r^*{}_t + \widetilde{\beta_2} VIX_t + \widetilde{\beta_3} RER_t + \widetilde{\beta_4}(kbr_t - effr_t) + \widetilde{\beta_5} Y_t))^2 .\cdots\ (9)$$

When testing the equation (2), EF_t in the equation (9) changes to BF_t. The global and local powers of QLR test are higher than those of LM test and Wald test. This competitiveness becomes superior in time-series data that show conditional heteroskedasticity. Baek, Cho, and Phillips (2015) construct the QLR test statistic in the equation (7) in which its limit distribution depends on Gaussian stochastic process. This construction lessens the modeling difficulty of trifold identification problem. Because linear model is a simplifying hypothesis that derives from the power transform model in three different ways, each have its own identification problem. Modifying the standard QLR test statistic, this new test statistic does not follow the standard chi-squared distribution, thus it requires different asymptotic critical values. The table 1 in Baek, Cho, and Phillips (2015) present asymptotic critical values with each parameter space, of which I refer to the parameter space [-0.20. 1.50] in testing my hypotheses.

I present my results in table 3. Push factors are significant for M_0 with 1% level. Pull factors are significant for M_0 with 5% level. Overall, push and pull factors exhibit linearities regarding equity and bond flows. Therefore, M_0 is a correctly specified linear model, accordingly the predictive regressions (1) and (2) are correctly specified.

4. Effects of push and pull factors on equity and bond flows

4.1. The basic specification and estimates

I begin with a specification of the estimating the equations (1) and (2). Table 4 presents the baseline results. Dependent variables EF_t and BF_t are equity gross inflows and gross bond inflows to Korea respectively, which are the net of flows between foreign investors' purchases and sales of Korean assets. The first and second columns give estimates for complete

push and pull factors. By linear model misspecification testing in Section 3.2, there is no evidence of non-linearities in the data. White heteroskedasticity-adjusted standard errors are shown in parentheses below the coefficient estimates.

All push factors have statistically significant effects on equity flow. US real interest rate and real exchange rate have positive effects. Heightened US real interest rate increases equity gross inflows by 0.131%. Real exchange rate depreciation increases equity gross inflows by 0.004%. This sign is economically intuitive as cheap stocks, which are denominated by depreciated currency, are attractive to buyers than sellers. Thus, foreign investors' purchase exceeds sales of Korean assets. VIX has negative effect on equity inflow, in which it decreases equity inflows by -1.209%. This magnitude of coefficient estimate is the greatest out of all push and pull factors at the first column. Uncertainty of bearish US stock market spills over to equity inflows to Korea, which indicates that US investors do long Korean stocks in the phase of uncertainty. This estimate gives the empirical evidence that global uncertainty scares way foreign equity investment.

In contrast to equity inflow, pull factors have statistically significant effects on bond inflow. (column (2)) Real exchange rate and interest rate differential have negative effects on bond inflow. Depreciation of domestic currency decreases bond gross inflows to Korea by -0.001%. A possible explanation is that bond is a widely used tool for hedging currency (Chinn, 2014). When an international investor predicts negative outlook on Korean Won, the hypothetical investor reduces bonds' exposure to movement of foreign currencies, by typically buying future contracts or options that move in opposite direction of Korean Won.

Increased interest rate differential pulls bond flows by decreasing the bond gross inflows of -0.189%. Excess of Korean interest rate compared to US effective federal funds rate leads to retrenchment of bond gross inflows to Korea. This result contrasts with Chuhan, Claessens, and Mamingi (1998), in which they claim bond flows to Asia are not interest sensitive. This difference exists for two reasons. First is that there exist difficulties in separating supply and demand curves for bond flows. My research shows that credit rationing is not significantly effective in fixed-income market, indicating that supply curve of bond flow is not bent backward. Second is that this paper observes updated time period with recent sample from 2000 to 2019 encompassing the recent global financial crisis.

Regarding interest rate, US real interest also pushes bond inflows. Hike of US real interest rate is associated with -0.101% decrease of bond inflows to Korea. Investors rebalance their portfolios during the boom by increasing portion of risky assets and heightening risk-compensation. This interpretation aligns with sensitivity of bond flows to equity return difference. High KOSPI 200 return compared to S&P 500 increases bond flows by 0.883% for all time. When Korean stocks show excess returns, which are proxied by high index return, foreign investors do portfolio rebalancing shifting from bond to stock. Thus, purchases of Korean bonds decrease, reducing bond gross inflows to Korea.

I address a question if effects of explanatory variables differ between equity flows and bond flows. VIX is a conspicuous push factor that has heterogeneous results between equity flows and bond flows. VIX decreases equity inflows by -1.209%, while it has marginal effect on bond inflows. Estimate of VIX on bond inflow is statistically insignificant and small in magnitude with 0.119%. Equities and bonds have heterogeneous risk structures. Bonds do not vary upon global uncertainty, VIX, which derived from US stock option. Bonds are more associated with interest rate risk and counterparty risk. Also, in the case of Korea, bonds mostly consist of government-issued bonds, thus bonds are less vulnerable to uncertainty associated with corporates and stock options. This link between VIX and cross-border equity and bond flows varies upon the observed time.

Equity return difference is a notable pull factor which has heterogeneous effects between equity flows and bond flows at the whole sample period (columns (1) and (2)). Equity return difference, proxied by KOSPI 200 close price return minus S&P500 close price return, has positive effect on bond flows, while it has marginal effects on equity flows at the whole sample period. Heightened equity return difference increases bond inflows by 0.883% with strong significance, while its effect on equity inflows 0.253% is statistically insignificant and small in economic magnitude. This link also varies upon the global financial crisis.

Lagged dependent variables can mitigate reverse causality issues. Third last row of table 4 presents that lagged flows are overall statistically significant. For equity flows, investors consider past movements of equity flows in taking current positions on equities. Dependence on past flows for bonds becomes stronger at the aftermath of the recent global financial crisis. Lags whose impacts are statistically significant, have positive effects on equity and bond flows.

4.2. Prior-to-crisis versus Post-crisis

This subsection addresses the second question of the research: Do the roles of push and push factors on cross-border equity and bond flows change after the recent global financial crisis (GFC)? Post-crisis shows more volatile portfolio inflows and outflows than prior-to-crisis, so it necessitates a sample split between the recent global financial crisis. Equities and bonds have distinct risks, while structure of risk and returns for equities and bonds both change after the GFC. Table 5 presents subsample analysis of prior-to-crisis effects and post-crisis effects. First and second columns give estimations for period before July 2009, and third and fourth columns present estimations for period after July 2009. R^2 of the regression for equity flows jumps from 0.161 to 0.294 between all time and prior-to-crisis. It even jumps higher to 0.703 at post-to-crisis. Push and pull factors capture 70% of the time-series variations in equity gross inflows after the GFC. In the case of bond flows, R^2 of the regression jumps from 0.22 at all-time to 0.551 at prior-to-crisis, and 0.593 at post-crisis.

VIX is a notable push factor of which its effects on flows change after the GFC. Before the GFC, VIX decreases equity flows, but it increases bond flows. VIX is negatively signed on -1.29% with equity flows under 1% significance, while it is positively signed in 0.88% with bond flows under 5% significance. On the other hand, post-crisis VIX has negative effect on equity flow by -1.27%, whereas its effect on bond flow is statistically insignificant. This vanished effect on bond is attributed to US unconventional monetary policy, like quantitative easing which was implemented at the aftermath of GFC.

US unconventional monetary policy is likely to change impacts of interest rate differential also. Interest rate differential, which is a pull factor, does not have statistically significant effects on both flows before GFC. However, after the crisis interest rate differential decreases both flows under 5% significance, in which heightened differential decreases equity inflow by -0.419% and bond inflow by -0.201%.

Real exchange rate is a push factor that has heterogeneous relationship with flows depending on the GFC. Several years prior to the crisis, depreciated Korean Won increases equity inflow by 0.004% while it only marginally affects bond inflow. At post-crisis, effect of real exchange rate on equity inflow fades away. Rather, real exchange rate depreciation decreases bond inflow by -0.002%. This role of real exchange rate confirms the role of interest

rate differential as determinant of cross-border portfolio investment flows. For years after the crisis, statistically significant and negative coefficient suggests that appreciated currency attracts bond gross inflows. This result reflects use of carry trades. Regarding cyclically adjusted fiscal balance, when a country has stronger fiscal position, it experiences higher bond gross inflows. Because, post-crisis period enjoys low or zero interest rate, it is easy to employ the interest differential. Carry trade refers to a position that borrows in low-yielding currency and lend in high-yielding currency.

Equity return difference is a conspicuous pull factor. It affects only prior-to-crisis bond flow and not prior-to-crisis equity flow, whereas it affects both post-crisis flows. Its positive effect on bond inflow decreases in magnitude from 2.387% to 0.945% after the GFC. At the fifth column, equity return difference has positive effect on post-crisis equity inflow by 2.763%, which is the largest magnitude out of all explanatory variables at same sample period. This result provides the empirical evidence that both equity and bond follows are sensitive on equity index return after the crisis. A key is that we are not looking at items of stocks, rather, we are looking at indices. Because picking good stocks all the time is very unlikely, investors begin to increasingly buy a whole stock index. This passive equity investing becomes bigger in both volume and in value after the GFC.

I test alternative measure of uncertainty, by using index of US Economic Policy Uncertainty (EPU), proposed by Baker et al. (2016). EPU is composed of news media references to policy uncertainty in the United states. This index is different from VIX in that while VIX is pertinent to uncertainty in financial markets regarding stock option implied volatility, EPU covers broader news released in press and includes uncertainty from other countries.

Table A.1 presents estimates of push and pull factors on cross-border equity and bond flows by using US EPU. The effects of EPU on equity inflow and bond inflow are not materially different from the effects of VIX. EPU has negative effect on prior-to-crisis and post-crisis equity inflow. EPU does affect prior-to-crisis bond inflow while it no longer affects post-crisis bond inflow. Other push and pull factors maintain same signs and similar levels of statistical significance with the regressions including VIX.

5. Role of unconventional monetary policy and passive investing

Section 5 finds results for the third question that I address: Do novel features that emerge after the GFC affect the dynamics of equity and bond inflows? I focus on two innovations in the post-crisis world: passive equity investing and US unconventional monetary policy. The two features may affect heterogeneous roles of push and pull factors after the recent global financial crisis.

5.1. Role of unconventional monetary policy in post-crisis world

I examine the role of US unconventional monetary policy in ameliorating the adverse effect of VIX on portfolio investment flows by including the interaction term between VIX and unconventional monetary policy (UMP). I use Taylor rule gap to measure US unconventional monetary policy. Taylor rule gap is defined as effective federal funds rate minus the interest rate derived from a standard Taylor rule (1993). Prior studies use Taylor rule gap to proxy unconventional monetary policy, i.e. Flageollet and Bahaji (2016), Kiendrebeogo (2016), IMF (2013), and Bernanke and Kuttner (2005).

To investigate indirect effects of unconventional monetary policy associated with VIX on cross-border flows, I include interaction terms in regressions as follows:

$$EF_t = \beta_0 + \beta_1 {r^*}_t + \beta_2 UMP_{t-1} + (\gamma_1 + \gamma_2 UMP_{t-1})VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t + e_t \quad \cdots (10)$$

$$BF_t = \beta_0 + \beta_1 {r^*}_t + \beta_2 UMP_{t-1} + (\gamma_1 + \gamma_2 UMP_{t-1})VIX_t + \beta_3 RER_t + \beta_4 (kbr_t - effr_t) + \beta_5 Y_t + e_t \quad \cdots (11)$$

The equations (10) and (11) include UMP, proxied by Taylor rule gap, as independent regressors. The equations lag UMP by one month to mitigate potential simultaneous bias. Table 6 presents the role of unconventional monetary policy. Statistical significance of the explanatory push and pull factors are consistent with the main results. As of an independent regressor, UMP shows heterogeneous effects between equity inflow and bond inflow. The direct effect of UMP is more pronounced for bond inflow than for equity inflow. Particularly post-crisis UMP increases bond gross inflow to Korea, which implies that foreign investors' purchase of Korean bonds exceeds their sale of Korea bonds. This effect leads to the

interpretation that post-crisis world purchases corporate bonds and government bonds in implementing quantitative easing.

Looking at the interaction effect between UMP and VIX, its coefficient is positive and significant for post-crisis equity flow (column (3)). This sign suggests the possibility of unconventional monetary policy and quantitative easing in moderating the adverse effect of VIX. The magnitude of interaction term indicates the mitigating effect of as much as 1.941% of the decline in post-crisis equity inflow given the one standard deviation increase in VIX if a recipient absorbs the average level of US unconventional monetary policy.

VIX decreases post-crisis equity inflow but not post-crisis bond inflow. This result amplifies by including the interaction term. At the fourth column, the interaction term between VIX and UMP is not significant to post-crisis bond inflow, suggesting that VIX does not affect bond inflow in the post crisis world, given the indirect effects of unconventional monetary policy. Equity gross inflow reduces by 1.941% per the increase of the Taylor gap. This relationship might be due to the tendency that investors prefer risky but high-return investments during prolonged low interest rates.

5.2. Alternative measure of unconventional monetary policy

As an alternative measure of unconventional monetary policy, I use US one-year-ahead futures rate to measure US Federal Reserve's UMP. This index captures monetary policy surprises. Because quantitative easing aims to decrease interest rate, UMP states decrease of one-year-ahead futures rate in the US. In the equations (10) and (11), I include lagged one-year-ahead futures rate at UMP_{t-1} instead of lagged Taylor gap.

Table A.2 presents results using one-year-ahead futures rate as unconventional monetary policy. UMP as an independent regressor has positive coefficient estimate with strong significance, implying that foreign investors purchase Korean bonds in the aftermath of the global financial crisis. The indirect effect of VIX and UMP stays consistent to the effect of Taylor gap. The size of coefficient indicates the ameliorating effect of as much as 0.599% of the reduction in post-crisis equity inflow given one standard deviation increase in VIX if Korea absorbs the average level of US unconventional monetary policy. The estimate is in positive scale, which implies that decrease of one-year-ahead futures rate, thus the successful implementation of unconventional monetary policy, hampers the decreasing rate of equity

inflow to Korea. Overall, the empirical are robust to two alternative choices of data.

6. Interpretation of the results

The empirical results show that VIX, exchange rate, US real interest rate push equity and bond inflows, also that difference in equity indices returns and interest rate differential pull equity and bond inflows. Their effects are heterogeneous depending on the global financial crisis. This section presents a stylized framework to help with the interpretation of these empirical findings. There are economic mechanisms that cause dispersion in push and pull factors. The first mechanism is Keynesian IS-LM model of which I build on the work of Kiendrebeogo (2016). This mechanism interprets results of interest rate and exchange rate related variables. The second mechanism is pertinent on Sharpe- Lintner Capital Asset Pricing Model (CAPM). This mechanism interprets time-varying effects of difference of equity indices returns.

6.1. A build-up of Keynesian IS-LM model

Keynesian IS-LM framework tells us that domestic (Korean) money supply changes domestic real interest rates, also changing real interest differential, ceteris paribus. The interest rate channel affects cross-border capital flows. The covered interest parity condition suggests that foreign (US) interest rate equals home (Korean) interest rate plus forward exchange rate premium.

$$r^* = r + \frac{NER^e - NER}{NER} \cdots (12)$$

in which * refers to foreign; r indicates domestic real interest rate; r^* indicates foreign real interest rate; NER stands for nominal exchange rate; and NER^e is the forward exchange rate. Thus, $\frac{NER^e - NER}{NER}$ is forward premium. Because Keynesian IS-LM framework tells us that domestic money supply is a decisive factor for domestic real interest rate, I can set real interest rate as a function of money supply.

$$r = f(\frac{M}{P}) \cdots (13)$$

$$r^* = f^*(\frac{M^*}{P^*}) \quad \cdots (14)$$

Replacing r and r^* in equation (12) yields:

$$f^*(\frac{M^*}{P^*}) = f(\frac{M}{P}) + \frac{NER^e - NER}{NER} \quad \cdots (15)$$

Differentiating the equations (4) and (5) yields:

$$dr = \frac{f}{f_r} \times \frac{dM}{M} \quad \cdots (16)$$

$$dr^* = \frac{f^*}{f^*_{r^*}} \times \frac{dM^*}{M^*} \quad \cdots (17)$$

In alignment with the econometric model, EF denotes equity gross inflows and bond gross inflows to Korea as a fraction of Korea's nominal GDP.

$$EF = EF(r - r^*, \dots) \quad \cdots (18)$$

Differentiating the equations (9) and (10) produces:

$$dEF = dr \times EF(RER, \dots) - dr^* \times EF(RER, \dots) \quad \cdots (19)$$

Now I can replace dr and dr^* with equations (16) and (17). Then, variations in equity inflow and variations in bond inflow are given by:

$$dEF = \frac{f}{f_r} \times \frac{dM}{M} \times EF(RER, \dots) - \frac{f^*}{f^*_{r^*}} \times \frac{dM^*}{M^*} \times EF(RER, \dots) \quad \cdots (20)$$

To investigate the sensitivities of equity and bond flows to foreign real interest rate, I differentiate the equations (11) and (12) with M^* as follows:

$$\frac{dEF}{dM^*} = \frac{f}{f_r} \times \frac{dM}{M} \times EF(RER, \dots) - \frac{f^*}{f^*_{r^*}} \times \frac{EF(RER, \dots)}{M^*} \quad \cdots (21)$$

Using equation (21) as a guiding framework, I extract the effects of interest rate and exchange rate related push and pull factors. Assume home economy does not respond to foreign monetary policy ($dM = 0$). Then, decrease of foreign interest rate, thus the increase of interest rate differential leads to increase of equity inflow and bond inflow to home economy. This relationship holds at the given level of VIX and real exchange rate (RER). Assume home

economy reacts to foreign monetary policy by emulating foreign monetary policy ($dM > 0$). Then, the increase of interest rate differential leads to increase of equity inflow and bond inflow to home. Now assume $dM < 0$. This inequality may mean that home implements policies of opposite direction against foreign monetary policy simultaneously. However, because home is a developing economy compared to foreign, home is unlikely to be motivated to risk reverses of capital flows, which may lead to home currency crisis. (Sula, 2010). Home economy may emulate foreign monetary policy but in a slower pace than foreign monetary policy, thus, in the same time period, home money supply variation is in opposite direction with foreign money supply variation. In this setting, equations (13) and (14) imply that increase of interest rate differential decreases equity inflow and bond inflow to home.

6.2. A buildup of Capital Asset Pricing Model

Central bank is not the only player in financial market. Asset investors buy stocks and bonds. As international investors long or short stock and bond, the investors push or pull equity and bond flows. To verify the economic mechanism between equity indices returns and portfolio investment flows, I modify the Sharpe-Lintner CAPM (1964) and Black's restricted CAPM (1972). Sharpe-Lintner CAPM and Black's restricted CAPM link returns of individual assets with returns of market. I extend these models to represent international capital asset pricing. It relies on the same proof of CAPM, except that the buildup model explains the relationship between home stock market return and foreign stock market return. While CAPM has considerable amount of modifications in the literature, there is little research on intranational asset returns. Specifically, the buildup model of CAPM equation is

$$E(R_h) = R_f + \beta_{\mathrm{h},*}[E(R^*) - R_f] \quad \cdots \quad (22)$$

in which h refers to home; * indicates market; R_f is risk-free interest rate, and $E(R^*) - R_f$ is the premium per unit of beta risk. R_h is the return of home stock index; R^* is the return of foreign stock index. Because foreign is assumed to be more developed than home, returns of foreign stock index spill over to returns of home stock index. Beta, $\beta_{\mathrm{h},*}$, measures sensitivity of the home return to variation in the foreign return. Econometrically speaking, $\beta_{\mathrm{h},*} = \frac{\mathrm{cov}[R_h,\ R^*]}{\mathrm{var}[R^*]}$. $\beta_{\mathrm{h},*}$ is equivalent to the amount of risk that dollars of which foreign investors spend to purchase home assets affect foreign portfolios. Higher beta indicates that home stock

index return is sensitive to foreign stock index return.

Using equation (22) as a guiding framework, I investigate the effects of stock indices returns at cross-border portfolio flows. In the aftermath of the global financial crisis, equity flow and bond flow are sensitive to returns of equity indices. Soaring equity and bond inflows are associated with excess returns of KOSPI 200 against S&P 500. Passive equity investing may have fostered sensitivities of flows on returns of stock indices.

John Bogle, the founder of Exchange-Traded-Fund (ETF) claims that it is inherently impossible to pick stocks that always overperform the stock market (2015). Rather than picking good stocks, he claims that investors should buy a stock index. ETF becomes phenomenal in both volume and value, especially after the global financial crisis, which was specific period of turmoil that investors had to undergo. ETF represents one of the most important financial innovation in the decades.

7. Conclusion

Motivated by distinct volatilities of equities and bonds, I study effects of push and pull factors on time-series variations in equity inflow and bond inflow. Push factors are US real interest rate, VIX, and real exchange rate. Pull factors are interest rate differential (Bank of Korea monetary stabilization bond rate minus US effective federal funds rate) and difference in equity indices return (KOSPI 200 return minus S&P500 return). I answer to the following three questions by using 2000-2019 data from Korea. (i) How do push and pull factors affect equity and bond gross inflows? Are these impacts different between equity flows and bond flows? (ii) Do the roles of push and pull factors change after the recent global financial crisis? (iii) Do the two novel features that emerged after the GFC, such as passive equity investing and unconventional monetary policy explain the dynamics of equity and bond inflows?

My result says as follows. First, VIX has heterogeneous effects between bond flows and equity flows, depending on the observed time span. Prior to the recent global financial crisis (GFC), VIX decreases equity inflows, while it increases bond inflows. After the GFC, VIX decreases equity inflows, however it has marginal effects on bond inflows. Second, difference in returns of equity indices are important. For years prior to the crisis, difference in

equity indices returns has marginal effects on equity inflows. In contrast, if KOSPI 200 has higher returns than S&P 500, then bond inflows increase. After the GFC, the excess returns of KOSPI 200 to S&P 500 increase both equity inflow sand bond inflows to Korea. Third, real exchange rate depreciation of domestic currency increases equity inflows, leaving bond inflows intact at prior-to-crisis. At post-crisis, however, this effect on equity inflow vanishes. Rather, bond inflows decrease due to the real exchange depreciation. Lastly, regarding interest rate, bond flows are both pushed by US real interest rate and pulled by interest rate differential.

My result responds to question (iii) as follows. First, US unconventional monetary policy may have fostered the time-varying role of VIX. Unconventional monetary policy directly affects post-crisis bond inflow with statistical significance, indicating that Federal Reserve purchases corporate bonds and government bonds at the aftermath of the GFC. I use an interaction effect between US unconventional monetary policy and VIX to examine the role of unconventional monetary policy. It may be the case that US unconventional monetary policy and quantitative easing moderates the adverse effect of VIX. This interaction term is not statistically significant for prior-to-crisis flows, indicating that UMP gains the explanatory power at the post-crisis world. Secondly, because passive investment becomes phenomenal at the post-crisis world, the sensitivities of equity and bond flows on stock indices return soars.

Figures 1 and 2. Portfolio investment flow by portfolio types

Figure 1. Portfolio investment flow to Korea

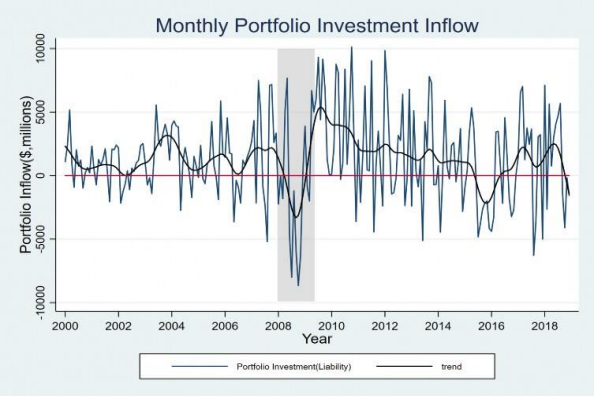
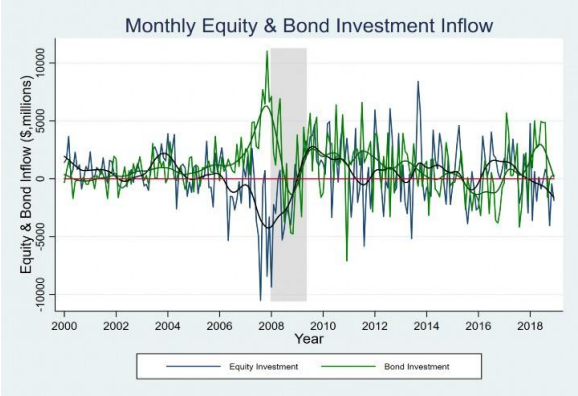


Figure 2. Equity and bond investment flow to Korea



Figures 1 and 2 show portfolio investment gross inflows which are defined as the purchases of domestic assets by foreign investors minus the sales of domestic assets by foreign investors. Gross inflows are normalized by Korea's nominal GDP and nominated in millions of US dollars. The time ranges from January 2000 to December 2019, in monthly frequency, allowing me to observe time periods before the global financial crisis. I obtain the data from Bank of Korea Economic Statistics System database.

Table 1. Variable definitions, frequency and sources.

Variable	Definition	Frequency	Source
Portfolio flow	Equity + Bond + Alternative investment, Gross inflow normalized by GDP	Monthly	Bank of Korea (BoK) Economic Statistics
Equity flow	Gross inflow normalized by GDP	Monthly	
Bond flow	Gross inflow normalized by GDP	Monthly	
VIX	Tailored to CBOE S&P 100 Index option prices. Close price.	Daily	Chicago Board Options Exchange CBOE
Real exchange rate	USD/KRW	Daily	BoK Economic Statistics
US real interest rate		Daily	Federal Reserve Bank of St. Louis FRED
Interest rate differential	Korea monetary stabilization bond rate – effective federal funds rate	Daily	BoK Economic Statistics System and FRED
Equity indices return difference	KOSPI 200 return – S&P500 return	Daily	
KOSPI 200 return	Close price	Daily	Mirae Asset Daewoo
S&P 500 return	Close price	Daily	Mirae Asset Daewoo

I calculate daily data by average to convert them to monthly data.

Table 2. Descriptive Statistics.

Variable	Obs.	Mean	Std.Dev.	Min	Max
Equity flow	240	0.16	0.96	-3.76	2.75
Bond flow	240	0.17	0.41	-1.43	1.70
US real interest rate	240	1.94	2.05	-0.96	7.03
Log_VIX	240	2.91	0.36	2.32	4.14
Real exchange rate	240	1124.40	106.36	907.40	1516.40
Interest rate differential	240	1.37	1.39	-1.54	3.61
Difference in equity indices return	240	-0.03	0.35	-1.02	0.51

Table 3. Testing linearity using power transforms of regressors

	Cross-border equity flows		Cross-border bond flows	
	QLR	p-value	QLR	p-value
Push factors	6.0	4.9**	8.1	1.0**
	(0.253)		(0.026)	
Pull factors	6.3	4.4*	7.1	1.7**
	(0.021)		(0.002)	

p< 0.1, p<0.05**.* Standard errors are shown in parenthesis below the QLR test statistic. I refer to Baek, Cho, and Phillips (2015) for p-value and asymptotic critical values.

Table 4. Effects of push and pull factors on equity and bond flows: basic specification

	(1) EF_t		(2) BF_t	
Observed time	All time (Jan 2000-Dec 2019)			
Intercept	-1.332		1.702	***
	(0.812)		(0.532)	
r^*	0.131	**	-0.101	***
	(0.051)		(0.037)	
VIX	-1.209	***	0.119	
	(0.273)		(0.131)	
RER	0.004	***	-0.001	***
	(0.001)		(0.001)	
$kbr - effr$	0.132	**	-0.189	***
	(0.066)		(0.060)	
Equity return difference	0.253		0.883	***
	(0.226)		(0.248)	
Flow (–1)	0.317	***	0.231	***
	(0.063)		(0.084)	
R^2	0.161		0.22	

p< 0.1, p<0.05**, p<0.01***.* EF_t and BF_t are dependent variables. EF_t and BF_t are respectively equity gross inflow to Korea and bond gross inflow to Korea, both scaled by Korea's nominal GDP. r^* refers to US real interest rate. RER stands for real exchange rate, defined as USD/KRW. Thus, an increase in value of RER indicates depreciation of Korean Won against US dollars. I define $kbr - effr$, the interest rate differential as Bank of Korea monetary stabilization bond rate minus US effective federal funds rate. I define equity indices return difference as KOSPI 200 close price return − S&P 500 close price return. r^*, VIX, and RER are push factors, whereas interest rate differential and equity return difference are pull factors. White heteroskedasticity adjusted standard errors are shown in parenthesis below the coefficient estimates.

Table 5. Effects of push and pull factors on equity and bond flows: Prior-to-Crisis and Post-Crisis

	(1) EF_t		(2) BF_t		(3) EF_t		(4) BF_t	
Observed time	Prior to crisis (Jan 2000- July 2009)				Post Crisis (Aug 2009- Dec 2019)			
Intercept	-1.529		-4.447	**	6.416	***	2.070	**
	(1.089)		(1.688)		(2.190)		(0.891)	
r^*	0.147		0.360	***	-0.307		-0.081	
	(0.111)		(0.131)		(0.200)		(0.074)	
VIX	-1.290	***	0.880	**	-1.217	***	0.076	
	(0.391)		(0.359)		(0.355)		(0.137)	
RER	0.004	***	0.000		-0.002		-0.002	**
	(0.001)		(0.001)		(0.002)		(0.001)	
$kbr - effr$	0.121		-0.100		-0.419	**	-0.201	**
	(0.132)		(0.140)		(0.176)		(0.078)	
Equity return difference	-0.122		2.387	**	2.763	***	0.945	***
	(0.335)		(1.025)		(0.585)		(0.296)	
Flow (–1)	0.302	***	-0.092		0.236	**	0.167	**
	(0.083)		(0.204)		(0.092)		(0.078)	
R^2	0.294		0.551		0.703		0.593	

p< 0.1, p<0.05**, p<0.01***.* EF_t and BF_t are dependent variables. EF_t and BF_t are respectively equity gross inflow to Korea and bond gross inflow to Korea, both scaled by Korea's nominal GDP. r^* refers to US real interest rate. RER stands for real exchange rate, defined as USD/KRW. Thus, an increase in value of RER indicates depreciation of Korean Won against US dollars. $kbr - effr$, the interest rate differential is Bank of Korea monetary stabilization bond rate minus US effective federal funds rate. I define equity indices return difference as KOSPI 200 close price return − S&P 500 close price return. r^*, VIX, and RER are push factors, whereas interest rate differential and equity return difference are pull factors. White heteroskedasticity adjusted standard errors are shown in parenthesis below the coefficient estimates.

Table 6. Role of unconventional monetary policy in effect of VIX on cross-border flows

	(1)		(2)		(3)		(4)	
	EF_t		BF_t		EF_t		BF_t	
Observed time	Prior to crisis (Jan 2000- July 2009)				Post Crisis (Aug 2009- Dec 2019)			
Intercept	-2.100		1.637		7.133	***	2.276	**
	(1.452)		(1.302)		(2.127)		(0.898)	
r^*	0.309	**	0.264	**	-0.338		-0.049	
	(0.130)		(0.107)		(0.207)		(0.074)	
VIX	-0.909	**	0.271		-1.606	***	0.027	
	(0.346)		(0.376)		(0.583)		(0.185)	
UMP	1.498		-6.097	**	5.529		1.737	***
	(0.977)		(2.858)		(5.248)		(0.073)	
VIX×UMP	-0.588	*	2.375	**	-1.941	**	-0.510	
	(0.317)		(0.910)		(0.996)		(0.756)	
RER	0.003	**	-0.003	**	-0.002		-0.002	**
	(0.001)		(0.001)		(0.002)		(0.001)	
$kbr - effr$	0.324	**	0.400	***	-0.494	**	-0.252	***
	(0.158)		(0.142)		(0.190)		(0.087)	
Equity return difference	-0.775	*	0.478		3.088	***	0.949	***
	(0.427)		(0.508)		(0.655)		(0.293)	
Flow (–1)	0.175	*	0.263	***	0.252	***	0.142	*
	(0.094)		(0.074)		(0.093)		(0.082)	

p< 0.1, p<0.05**, p<0.01***.* EF_t and BF_t are dependent variables. EF_t and BF_t are respectively equity gross inflow to Korea and bond gross inflow to Korea, both scaled by Korea's nominal GDP. UMP (unconventional monetary policy) is proxied Taylor rule gap, which is defined as effective federal funds rate minus the rate that is derived from standard Taylor rule (1993). r^* refers to US real interest rate. RER stands for real exchange rate, defined as USD/KRW. Thus, an increase in value of RER indicates depreciation of Korean Won against US dollars. $kbr - effr$, the interest rate differential is Bank of Korea monetary stabilization bond rate minus US effective federal funds rate. I define equity indices return difference as KOSPI 200 close price return − S&P 500 close price return. r^*, VIX, and RER are push factors, whereas interest rate differential and equity return difference are pull factors. White heteroskedasticity adjusted standard errors are shown in parenthesis below the coefficient estimates.

Table A.1. Alternative measure of uncertainty

	(1) EF_t		(2) BF_t		(3) EF_t		(4) BF_t	
Observed time	Prior to crisis (Jan 2000- July 2009)				Post Crisis (Aug 2009- Dec 2019)			
Intercept	1.482		1.837		6.866	***	3.198	
	(1.238)		(1.328)		(2.243)		(1.963)	
r^*	0.015		0.218	**	-0.267		0.120	
	(0.110)		(0.097)		(0.214)		(0.182)	
EPU	-1.022	***	0.205	*	-1.185	**	0.021	
	(0.330)		(0.096)		(0.318)		(0.238)	
RER	0.003	***	-0.001		-0.005	**	-0.003	*
	(0.001)		(0.001)		(0.002)		(0.002)	
$kbr - effr$	0.037		0.285	**	-0.442	**	-0.243	*
	(0.130)		(0.137)		(0.176)		(0.164)	
Equity return difference	-0.631		0.408	*	2.097	***	2.243	***
	(0.331)		(0.409)		(0.597)		(0.727)	
Flow (–1)	0.275	***	0.280	***	0.240	***	0.037	
	(0.087)		(0.097)		(0.091)		(0.091)	

p< 0.1, p<0.05**, p<0.01***.* I use alternative measure of uncertainty, the index of Economic Policy Uncertainty (EPU) instead of VIX as robustness check. EPU, proposed by Baker et al. (2016) is based on newspaper coverage in the United States.

Table A.2. Alternative measure unconventional monetary policy

	(1)		(2)		(3)		(4)	
	EF_t		BF_t		EF_t		BF_t	
Observed time	Prior to crisis (Jan 2000- July 2009)				Post Crisis (Aug 2009- Dec 2019)			
Intercept	-2.355		-0.510		6.426	***	2.216	**
	(1.796)		(1.849)		(2.168)		(0.926)	
r^*	0.056		0.311	***	-1.360	*	-0.335	
	(0.233)		(0.097)		(0.774)		(0.397)	
VIX	-1.021	*	-0.071		-1.842	***	-0.039	
	(0.542)		(0.550)		(0.494)		(0.178)	
UMP	0.345		-1.004	*	-0.640	*	0.313	**
	(0.559)		(0.509)		(0.983)		(0.656)	
VIX×UMP	-0.066		0.257		0.599	**	-0.033	
	(0.157)		(0.162)		(0.306)		(0.169)	
RER	0.004	***	0.001		-0.001		-0.002	**
	(0.001)		(0.001)		(0.002)		(0.001)	
$kbr - effr$	0.172		-0.260	**	-0.325	*	-0.193	**
	(0.144)		(0.102)		(0.181)		(0.084)	
Equity return difference	-0.213		0.886		2.992	***	1.154	***
	(0.418)		(0.980)		(0.556)		(0.287)	

p< 0.1, p<0.05**, p<0.01****. I use alternative measure of unconventional monetary policy; the points decrease of one-year ahead futures rate.

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