BANGKO SENTRAL NG PILIPINAS
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Foreign Exchange Interventions, Capital Outflows, and Financial Vulnerabilities in Selected Asian Emerging Economies

Hazel C. Parcon-Santos

Series No. 2018-02

November 2018

Center for Monetary and Financial Policy
Monetary Policy Sub-Sector

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Abstract

This study examines the different motives of central bank FX market intervention. Particular attention is given to the financial stability motive by considering periods of capital outflows and residents' cross-border exposures. The following questions are raised: Do central banks explicitly account for cross-border exposures or linkages of domestic residents in their conduct of FX market intervention? Do these exposures increase the central bank's propensity to intervene during capital outflow episodes? Analysis is conducted by estimating a central bank FX intervention reaction function using a panel of six Asian emerging market economies with floating or managed float exchange rate regimes for the period 2005-2016. This paper contributes to the literature by including measures of cross-border exposures and capital outflows in an empirical estimation of a central bank's FX intervention reaction function, which have not been explicitly considered by past studies. Results reveal that apart from the traditional motives of FX market intervention (i.e., lean against the wind, reserves accumulation, and to support export competitiveness), financial stability considerations appear to influence the propensity of central banks to intervene in the FX market. In particular, in countries with higher cross-border exposures, the propensity of central banks to intervene during capital outflow episodes increases. There is likewise some evidence that central banks may have a higher propensity to intervene, whether there is a capital outflow episode or none, when residents have higher cross-border exposures.

JEL classification: E58, F31, F65
Keywords: foreign exchange intervention, exchange rates, capital flows, cross-border exposures
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Foreign Exchange Interventions, Capital Outflows, and Financial Vulnerabilities in Selected Asian Emerging Economies

Hazel C. Parcon-Santos[1]

1. The Context

There are several motives for central bank foreign exchange (FX) market intervention that are traditionally cited in the literature: to contain the volatility of the exchange rate or to temper short-term currency appreciation or depreciation pressures ("lean against the wind"); to reduce perceived exchange rate misalignment; to accumulate reserves; to support the competitiveness of the economy's export sector; and to address inflationary concerns (Chutasripanich and Yetman (2015), Malloy (2013)).

In recent years, a growing number of central banks have declared that financial stability considerations have become an increasingly important motive for FX interventions (Domanski, Kohlscheen and Moreno (2016)). This study examines this motive by giving specific attention to periods of capital outflows and residents' cross-border exposures. Why are these two elements important? First, since 2013, episodes of capital outflows in emerging market economies (EMEs) have been more frequent as the US Federal Reserve indicated normalization of its monetary policy (Figure 1). Correspondingly, EME currencies have been on a depreciating trend against the US dollar (Figure 2). These episodes may be an indication of future trends as advanced economies have begun to normalize their monetary policies. History is abound in evidence showing that risks may materialize during periods of capital outflows, especially if they are large, rapid and accompanied by large swings in the exchange rate.

Second, cross-border exposures of emerging market economies have been continuously increasing, possibly also increasing their external vulnerability. Since the early 2000s, many EME governments have undergone reforms and broken the tight link between the so-called "original sin"[2] and aggregate currency mismatch (Chui, Kuruc and Turner (2016)). Due to this success, sovereign credit spreads have declined. Accompanied by the low interest rate environment post-global financial crisis (GFC), this made it easier for both governments and the private sector to increase cross-border borrowings.

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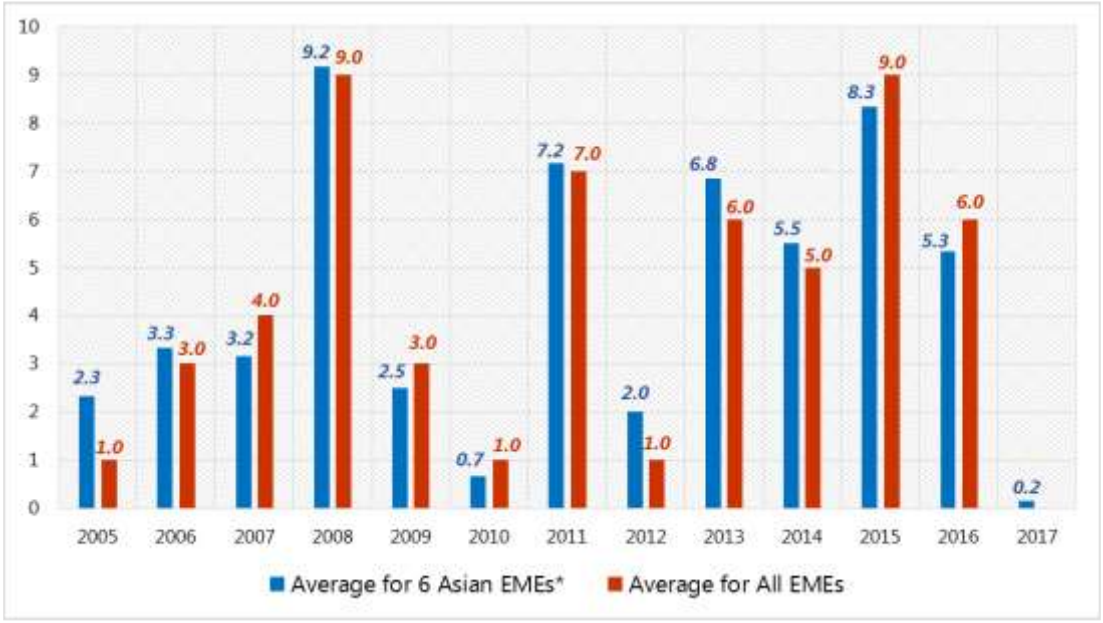
[1] Bank Officer V, Center for Monetary and Financial Policy, Bangko Sentral ng Pilipinas. This study was prepared in my capacity as Visiting Research Economist at the Bank for International Settlements (BIS), Hong Kong SAR, 1 April – 30 June 2018. I am grateful for guidance and comments from Eli Remolona (BIS), Ramon Moreno (formerly BIS), Madhusudan Mohanty (BIS), Emanuel Kohlscheen (BIS), Frank Packer (BIS), Peter Hoerdahl (BIS), Ilhyock Shim (BIS), James Yetman (BIS), Veronica Bayangos (BSP) and Cristeta Bagsic (BSP). I am equally thankful to Jose Maria Pastor (BIS), Jimmy Shek (BIS), Lilia Elloso (BSP), Irene Imson (BSP) and Won Hee Cho (DLSU) for excellent research assistance. The views expressed in this Working Paper are those of the author and do not necessarily represent those of the BSP or BSP policy. BSP Working Papers describe research in progress and are published to elicit comments and further debate.

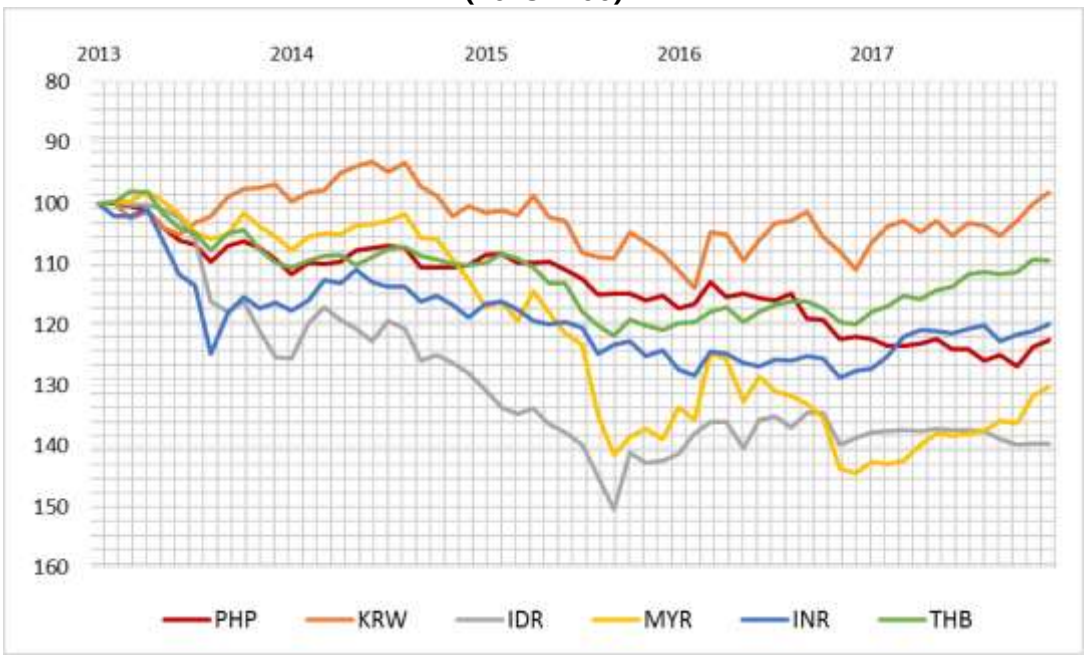
[2] Original sin is a phenomenon described in the literature where developing countries are unable to borrow abroad in their local currency and are therefore forced to borrow in foreign currency.

Figure 1
Capital Outflow Episodes in EMEs, 2005-2017
(average number of months with net outflows)



** India, Indonesia, Malaysia, Philippines, South Korea, Thailand*
Sources: Emerging Portfolio Fund Research (EPFR) Database; Author's calculations.

Figure 2
Selected Asian EMEs: Local Currency vs. US Dollar
(2013=100)



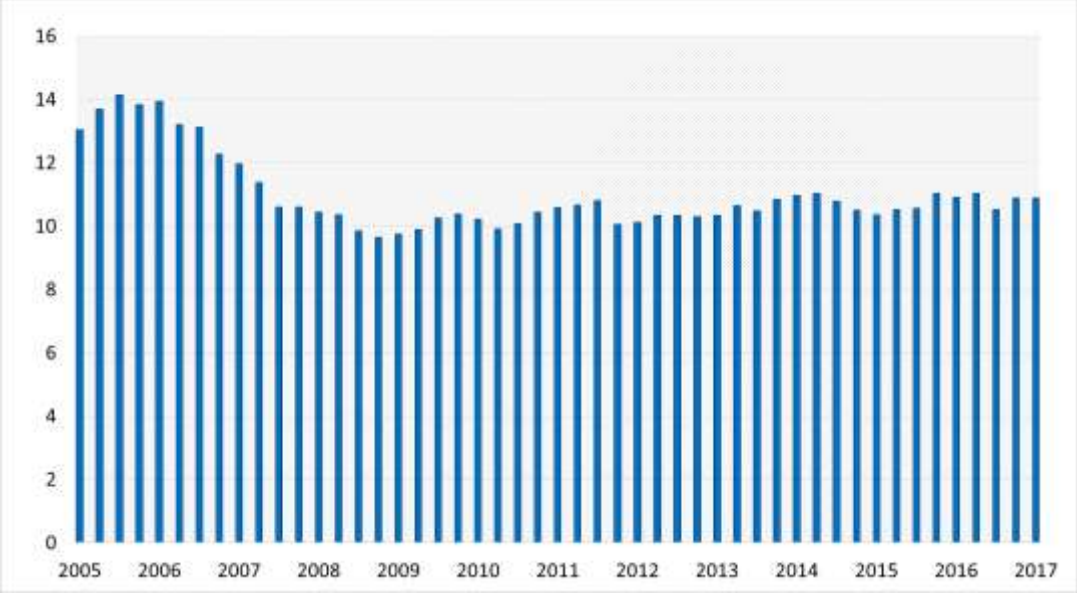
Note: End-of-period exchange rate
Source: BIS Statistics

However, foreign currency (FX) borrowing of the non-financial sector (NFS), specifically by non-financial corporates, has often been identified as a primary source of vulnerability of many EMEs (Chui, et al. (2016), IIF (2018a)). Chui et al. (2016) found that the remarkable growth in EME corporate borrowing has generally been accompanied by a large and broad-based decline in profitability. Thus, in the event of large capital outflows and depreciations, many EME corporates face increased currency mismatches with weaker balance sheets.

In Asian EMEs, the stronger economic growth in recent years have trimmed the average NFS FX debt relative to GDP (Figure 3a). Growth of NFS FX debt seem to be in a declining trend as well, but the stock still continues to grow (Figure 3b).

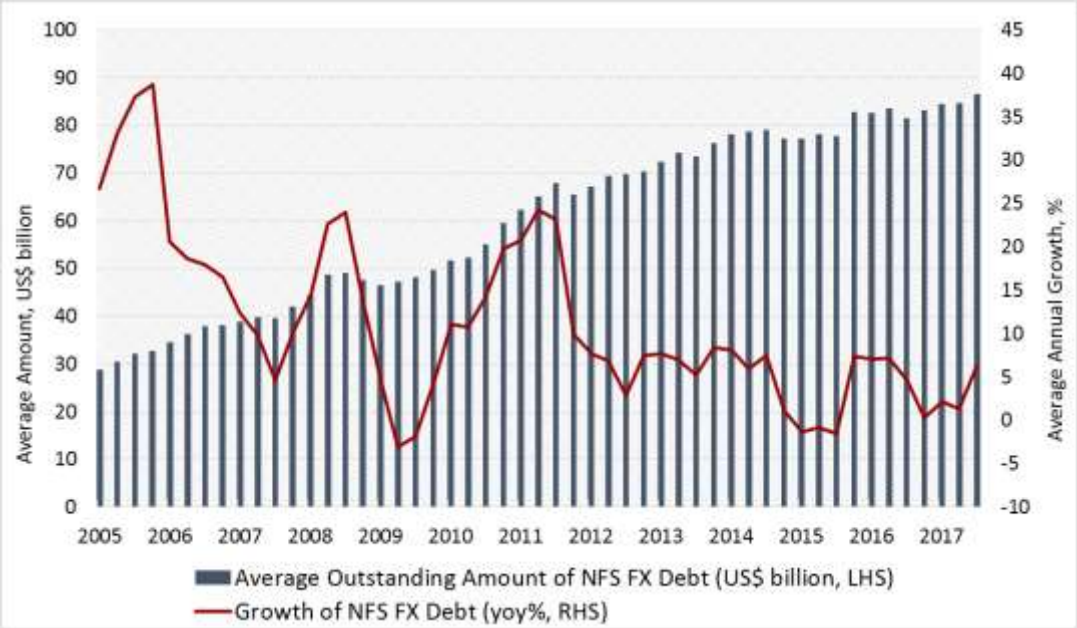
EME government cross-border exposures have also been on the rise (IIF (2018b)). In the early 2000s, many EME governments have been encouraged by international financial institutions to issue debt in their local currencies to avert currency mismatches that were prevalent in previous decades. As a product of EME macroeconomic reforms and sovereign debt rating upgrades, many EME governments have been able to issue local currency (LCY) bonds internationally. Correspondingly, fund managers have increased asset allocation to EMEs as part of their portfolio diversification strategy and search for yield (Sienaert (2012), Maddy-Weitzman (2012), Klingebiel (2014)). Thus, there is an increase in government-issued LCY bonds that are being held by foreign investors. This is apparent for Asian EMEs (Figure 4). In general, issuance of government international debt securities by Asian EMEs have been on a rising trend (Figure 5).

Figure 3a
Selected Asian EMEs: Average Non-Financial Sector FX Debt as percentage of GDP (quarter-end, %)



Notes: Selected Asian EMEs include India, Indonesia, Malaysia, Philippines, South Korea, and Thailand. Non-financial sector is the sum of non-financial corporates, households and non-profit institutions serving households, and general government. FX credit consists of two components: international debt securities and bank loans. Bank loans are loans by Locational Banking Statistics (LBS)-reporting banks to non-bank borrowers, including non-bank financial entities, comprise cross-border plus local loans.
Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd.; BIS Locational Banking Statistics; BIS calculations; CEIC Database, Authors' calculations.

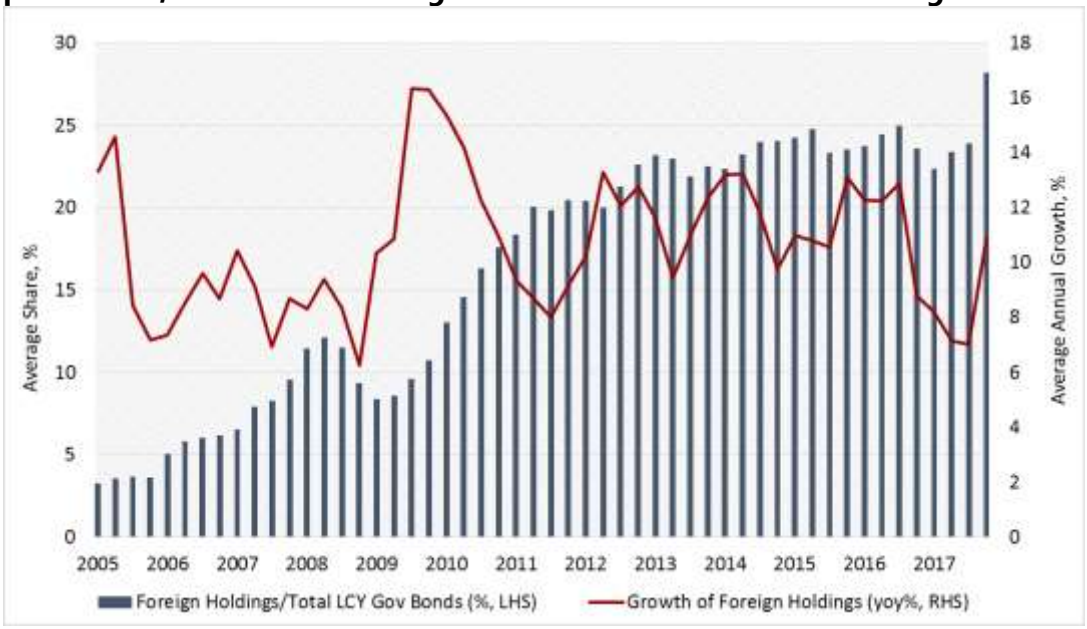
Figure 3b
Selected Asian EMEs: Average Outstanding Amount of Non-Financial Sector FX Debt (quarter-end, outstanding amounts in US$ billion and annual growth in %)



Notes: Selected Asian EMEs include India, Indonesia, Malaysia, Philippines, South Korea, and Thailand. Non-financial sector is the sum of non-financial corporates, households and non-profit institutions serving households, and general government. FX credit consists of two components: international debt securities and bank loans. Bank loans are loans by LBS-reporting banks to non-bank borrowers, including non-bank financial entities, comprise cross-border plus local loans.

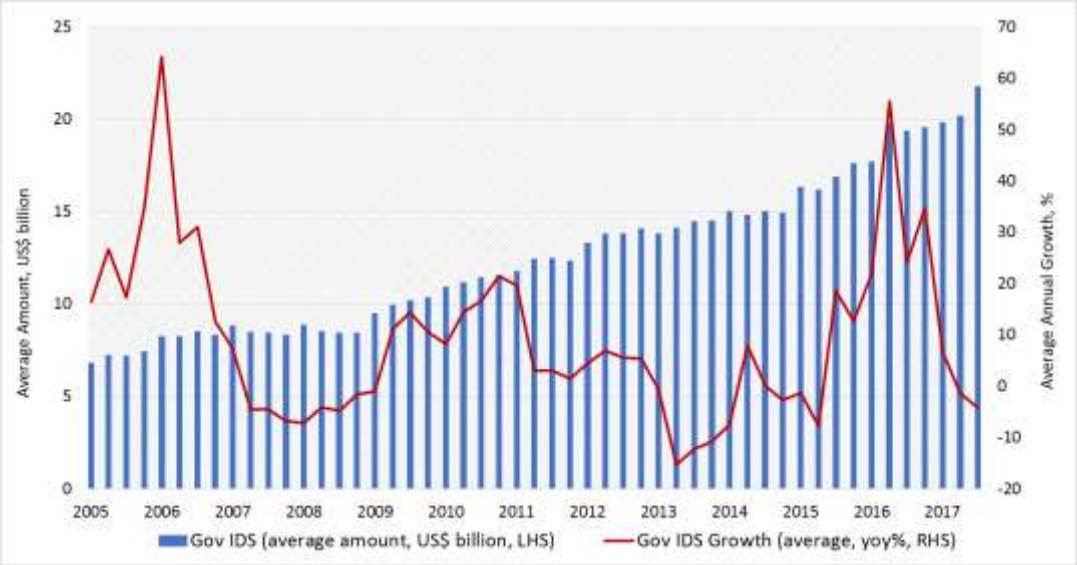
Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd.; BIS Locational Banking Statistics; BIS calculations; authors' calculations.

Figure 4
Selected Asian EMEs: Average Foreign Holdings of LCY Government Bonds (quarter-end, share of total LCY government bonds in % and annual growth in %)



Note: Selected Asian EMEs include Indonesia, Malaysia, South Korea and Thailand
Source: ADB Asia Bonds Online

Figure 5
Selected Asian EMEs: Government International Debt Securities
(quarter-end, outstanding amounts in US$ billion and annual growth in %)



Notes: Selected Asian EMEs include Indonesia, Malaysia, Philippines, South Korea and Thailand. International debt securities include all types of instruments and all maturities issued by the general government. Average annual growth was obtained by first calculating the annual growth for each country, then averaging across the 5 economies.
Sources: Dealogic, Euroclear, Thomson Reuters, Xtrakter Ltd., BIS calculations

From the point of view of the government issuing a LCY bond, it is not exposed to currency mismatches. However, from the perspective of foreign investors, EME debt remains a risky asset, especially in periods of stress or crisis (Turner (2011), Maddy-Weitzman (2012)). When the currency of the LCY bond-issuing country depreciates, the return on these bonds decrease from the point of view of foreign investors holding them. While foreign investors may have hedged their exposures, the cost of protection against exchange rate risk tends to rise in periods of market stress. Thus, foreign investors may be prompted to sell their LCY bond holdings. In some instances, even just the prospect or expectation of capital outflows or currency depreciation is enough to trigger a sell-off. In turn, this may raise local currency bond yields, increase borrowing costs, and may cause greater yield volatility in the bond-issuing country.

The foregoing trends demand greater monitoring and possibly more active policy actions for the central bank, including FX market interventions. Large capital outflows can trigger sharp currency depreciations that may leave insufficiently unhedged borrowers unable to service cross-border obligations. In a worst case scenario, defaults and crisis may ensue. Thus, FX interventions may be useful in order to prevent defaults of residents with cross-border exposures and thwart disorderly market conditions.

Given the foregoing, this study raises the following questions: Do central banks explicitly account for cross-border exposures or linkages of domestic residents in their conduct of FX market intervention? Do these exposures increase the central bank's propensity to intervene during capital outflow episodes?

Answers to these questions may be useful for policy. For instance, if findings reveal that higher cross-border exposure of residents increases a central bank's propensity to intervene in the FX market, especially during capital ouflow episodes (when there is greater pressure for the currency to depreciate), then this may imply that authorities are providing implicit guarantee to these exposures. This is a double-edged sword – while authorities may want to preserve financial stability, FX interventions influenced by domestic residents' cross-border exposures may also fuel greater risk exposure (moral hazard problem). Thus, a central bank must be wary in giving the impression that it is guaranteeing those exposures. Findings could likewise spark a debate among or within central banks on whether FX interventions should be rules-based and transparent. Rules-based FX intervention can be used to signal that intervention will be limited to some identified circumstances, hence, there is no explicit intention to provide insurance to cross-border exposures. However, the central bank may face credibility issues, especially when large depreciations take place.

This paper contributes to the literature on FX market interventions by including measures of cross-border exposures and capital outflows in an empirical estimation of a central bank's FX intervention reaction function, which have not been explicitly considered by past studies.

The rest of the paper is structured as follows: Section 2 presents the literature on FX market interventions, Section 3 discusses the data and empirical strategy used to answer the research questions, Section 4 presents the estimation results, Section 5 provides robustness checks and Section 6 concludes and provides policy implications.

2. Review of Related Literature

The literature on central bank FX market intervention commonly cites the following motives for intervention: to "lean against the wind"; to reduce perceived exchange rate misalignment; to accumulate reserves; to support the competitiveness of the economy's export sector; and to address inflationary concerns (Adler and Tovar (2011), Cavallino (2015), Malloy (2013), Daude and Levy-Yeyati (2014), and Chutasripanich and Yetman (2015)).

Lean against the wind. Central banks may conduct FX interventions to stem excessive volatility of the exchange rate or to contain the speed of currency appreciation or depreciation, but not to target a particular level of the exchange rate. This motive is often cited by central banks that have adopted either a floating or managed float exchange rate regime. A common rationale for this motive is to prevent disorderly markets.

There has been considerable empirical evidence showing that central banks "lean against the wind." For instance, Kim and Sheen (2004) found that the Bank of Japan (BoJ) interventions for the period 1991-2002 were motivated by short-term trend correction and high volatility in the exchange rate (as well as to support the monetary policy objective). Similarly, Ozlu and Prokhorov (2008) found that the deviation of the spot exchange rate from its 22-day moving average is a significant determinant of intervention by the Central Bank of

Turkey.[3] Nonetheless, others find that for some countries, concerns on real exchange rate misalignments provide more incentive to intervene than short-term exchange rate movements (Adler and Tovar (2011)).[4]

Reduce perceived exchange rate misalignments. This motive assumes that central banks know the equilibrium level of the exchange rate, which is inherently hard to determine (Chutasripanich and Yetman (2015)). Some measure the misalignment as a deviation of the real exchange rate from an estimated real exchange rate (for instance, Adler and Tovar (2011) used the history of assessments by the IMF's Consultative Group on Exchange Rates); while others simply use the deviation of the real exchange rate from a long-run average or trend (Eckhold (2005), Malloy (2013)).

Accumulate reserves. Central banks may intervene in the FX market during times of appreciation to accumulate foreign reserves that can provide a cushion of liquidity and can dissuade potential speculative attacks on the national currency. This was a prevalent motive after the Asian Financial Crisis and has once again gained prominence after the GFC (Mohanty and Berger, 2013). Studies generally find that EMEs with already high levels of foreign exchange reserves (relative to traditional reserve adequacy determinants) tend to continue to accumulate reserves (Adler and Tovar (2011), Malloy (2013)).

Another motive for reserve accumulation posited by some researchers is the desire to keep up with neighboring or peer countries – the so-called "keeping up with the Jones' effect" (Qian, Cheung, and Remolona (2018)). A central bank may decide to continue accumulating more reserves beyond what is implied by their reserve adequacy ratios because other central banks are doing so. A country with higher stock of reserves relative to neighbors may also give a signal that it is relatively more stable because its central bank is likely to be more successful in warding off speculative attacks (Hashimoto (2008)). Others have also pointed out the positive impact of higher reserves on sovereign debt ratings (Afonso, Gomes and Rother (2007)).

Support export competitiveness. FX interventions can be conducted to prevent too much appreciation of or to undervalue the local currency in order to support an economy's export sector – the so-called mercantilist motive. Levy-Yeyati , Sturzenegger and Gluzmann (2007) have referred to this as "fear of appreciation." Countries that depend more on the export sector or those that want to boost the competitiveness of the export sector or protect domestic industries may have more incentive to pressure their central banks to conduct FX interventions based on this motive (Levy-Yeyati et al. (2007), Rajan (2012), Malloy (2013), Wang, Li, Li, and Liu (2015)). While some central banks may be compelled to intervene based on this motive, it may not be openly declared since this can be considered a beggar-thy-neighbor policy.

Moderate inflationary pressures. FX intervention can be used to help achieve domestic monetary policy objectives, especially by inflation targeters. A central bank may decide to intervene in the foreign exchange market in support of its inflation objective, particularly if

[3] Other studies include Kim and Sheen (2002) for the case of Australia, and Frenkel et al. (2004) for Japan, and Aslanidi (2007) for Georgia.

[4] For instance, Peru, Guatemala, and Colombia, at least for the period 2007-2010.

changes in its principal monetary policy instrument appears to be insufficient to achieve its goal (Banlialper, Comert and Ocal (2017), Libman (2017), and Ghosh, Ostry and Qureshi (2017)).

The relevance of aforementioned motives are usually verified by estimating a central bank FX intervention reaction function. Studies suggest that motives are not mutually exclusive, which is true in practice. A central bank may intervene for several reasons at a time. For example, a central bank may purchase FX for precautionary purposes during periods of appreciation to add to its stock of reserves, smooth excessive exchange rate fluctuations, and temper currency appreciation to support export competitiveness.

Address financial stability concerns. This motive may be associated with the third generation models of currency crises popularized in the context of the Asian crisis, which led to the definition of "fear of floating" (Calvo and Reinhart, 2002). The basic idea is that central banks, which declared themselves as free or managed floaters, intervene to avoid sudden or large depreciations to either mitigate inflation pass-through or, in financially dollarized economies, balance sheet effects on currency-imbalanced firms and banks (Burnside, Eichenbaum and Rebello (2007)). In the early 2000s, this gained prominence and a number of studies confirm its existence (Calvo and Reinhart (2002), Honig (2005), Esaka (2006), Rizvi, Naqvi, Mirza, and Bordes (2017)). Studies on this motive typically do not consider the other motives in the analysis. Moreover, FX market interventions are usually gauged by looking at some measure of variability of the exchange rate, instead of actual FX market interventions or estimates of it.

In recent years, a growing number of central banks have declared that financial stability considerations have become an increasingly important motive for FX interventions, particularly to address large and rapidly shifting capital flows and widening currency mismatches (Domanski et al. (2016)). These concerns appear valid in light of increasing episodes or instances of capital outflows and rising cross-border exposures of EMEs.

Basu et al. (2016) built a theoretical framework focused on the optimality of FX interventions specifically during capital outflows episodes and which specifically identifies the factors that should be considered in judgments and trade-offs that central banks need to make. In particular, the monetary authority needs to determine: (i) the level of available reserves, (ii) the persistence of the shock, and (iii) the composition of the FX market participants. However, a limitation of their model is that the monetary authority is assumed to conduct FX intervention to minimize the deviations from a target exchange rate or pre-shock exchange rate even during periods of capital outflows. This may not be a central bank's primary motive during such episodes. During capital outflow episodes, financial stability considerations may become the primary motive of FX intervention and may diminish other motives, especially if large currency depreciation ensues.

FX intervention, especially during periods of capital outflows, may be useful in order to prevent bankruptcies by residents who cannot access or find it too costly to buy foreign currency with their depreciated domestic currency to service foreign currency obligations. If there are significant currency mismatches in the economy and if foreign currency liabilities are not fully backed by foreign currency assets or earnings, a currency depreciation can adversely affect the financial position of firms and households that borrow in foreign currency. A

sufficiently large depreciation could weaken balance sheets or even trigger a financial crisis under extreme conditions.

While capital outflows and cross-border exposures are discussed in recent research on FX market intervention (e.g., Mohanty and Berger (2013), Domanski et al. (2016), and Basu et al. (2016)), no attempt has been done, to the best of my knowledge, to explicitly consider these factors in an empirical estimation of a central bank's FX intervention function in conjunction with other FX intervention motives.

3. Empirical Strategy

To answer the questions raised in this study, a central bank reaction function is estimated as a function of FX intervention motives and other factors that may have an impact on central bank FX intervention.

$$FXI = f(ervol, erpres, ermis, accu, comp, inf, fc) \quad (1)$$

$$FXI = f(ervol, erpres, ermis, accu, comp, inf, fc, ko, cb) \quad (2)$$

where FXI is an indicator of FX intervention conducted by a central bank, *ervol* is a variable accounting for exchange rate volatility; *erpres* is a measure of short-term exchange rate pressures, *ermis* is a variable representing exchange rate misalignment; *accu* is a variable capturing the accumulation motive, *comp* is a proxy variable for the mercantilist motive, *inf* represents inflation, *fc* is a variable capturing broad macroeconomic or financial conditions, *ko* is an indicator for periods with capital outflows, and *cb* is a variable capturing residents' cross-border exposures.

Equation (1) assumes that central banks do not explicitly consider the cross-border exposure of residents and capital outflow episodes when FX intervention is conducted. Equation (2) adds variables that capture these factors (*ko* and *cb*). The equation that is empirically estimated takes the following form

$$FXI_{it} = \alpha + \beta ervol_{it} + \gamma erpres_{it} + \delta ermisal_{it-1} + \theta accu_{it-1} + \mu comp_{it-1} + \pi inf_{it-1} + \rho ko_{it} + \tau cb_{it-3} + \omega(ko_{it} * cb_{it-3}) + \sigma fc_{it} + \varphi_i + \varepsilon_{it} \quad (3)$$

where *i* refers to country, *t* refers to time period, ϕ represents country fixed effects, and ε is the error term. The primary coefficients of interest are ρ, τ, and ω.

Equation (3) is estimated using a panel of countries for the period 2005M01-2016M06.[5] Panel data takes advantage of cross-country differences that may provide additional information why one central bank is intervening differently from another. Asian EMEs with declared floating or managed-float exchange rate regime are included in the estimation, namely, India, Indonesia, Malaysia, Philippines, South Korea, and Thailand. Central banks of these countries do not actively manage or maintain the exchange rate at any specific level or

[5] Estimation using monthly frequency is more preferred than quarterly frequency to capture more central bank interventions. Quarterly data may mask or smoothen interventions, which may preclude useful inferences.

range (Appendix 1).[6] Moreover, central banks of these countries regularly communicate to the public that the exchange rate is market determined and that FX intervention is only conducted to address excessive exchange rate volatility or prevent market disorder.

A key variable to estimate a central bank reaction function is the choice of FX intervention measure of the central bank. Among the 6 countries in the sample, only India publicly discloses monthly FX intervention (FX sale/purchase) data.[7] For the other countries, the estimated FX intervention data used in Domanski et al. (2016) was used.[8] FX intervention was estimated using the stocks of FX reserves adjusted for valuation effects. The valuation adjustment considers changes in the exchange rates of official reserve currencies, and the average FX reserve composition for EMEs (based on the IMF Currency Composition of Official Foreign Exchange Reserves (COFER) database). It is assumed that each currency is remunerated at their respective Libor rate. The monthly changes in the adjusted FX reserves were then used as an estimate for central bank FX intervention. An increase (decrease) in monthly reserves implies that the central bank is buying (selling) FX.

Since one of the primary interests of this study is the response of central banks during capital outflow episodes, a dummy variable for months with net capital outflows was constructed for each country.[9] However, central banks may not necessarily respond to all capital outflow episodes. Thus, another dummy variable was constructed for periods with excessive net capital outflows, defined as periods where net capital outflows were more than 1 standard deviation of all net capital outflows.

Among the countries in the sample and for the period under study, Thailand had the most number of months with net capital outflows, followed by India and Indonesia (Figure 6). India had the most number of months with excessive net capital outflows, followed by South Korea and Malaysia. The Philippines had the least number of months with net capital outflows and excessive net capital outflows.

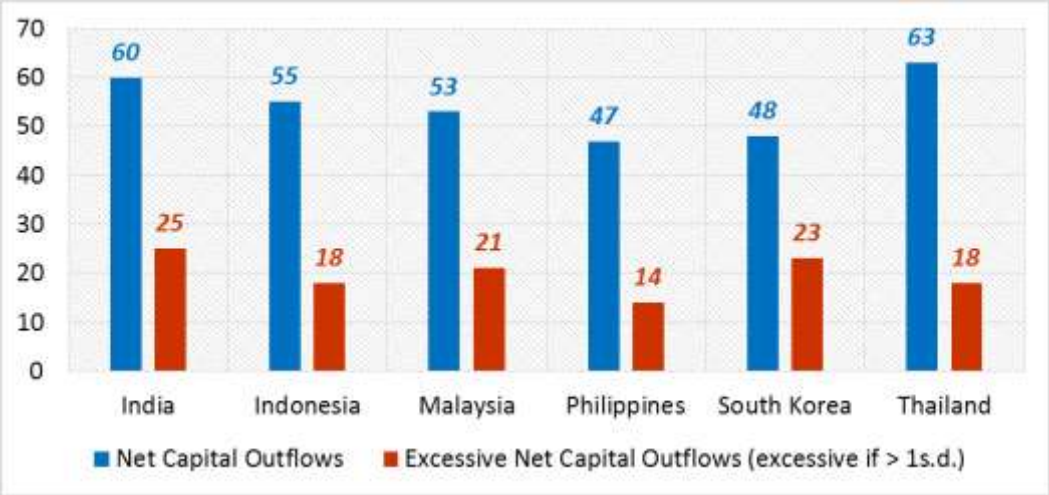
[6] Appendix 1 describes the exchange rate policy of each of these 6 countries. For comparison, exchange rate policies of China, Hong Kong and Singapore are included in the list, but were excluded in the estimation. It can be noted that while China has a managed float exchange rate regime, it is highly managed as the exchange rate is only allowed to fluctuate within a trading band set by the People's Bank of China. Similarly, Singapore's exchange rate is allowed to fluctuate within an undisclosed policy band, while Hong Kong's exchange rate is determined by a currency board.

[7] Economic ministers in South Korea declared that starting in March 2018, the government will be revealing the net amount of its market interference twice a year, a frequency which will be raised to once per quarter starting in 2020. (Hyun-jung, B. (2018). "Seoul will phase in FX market intervention disclosure plan: minister," The Korea Herald, 17 May).

[8] I am grateful to Emanuel Kohlscheen, Ramon Moreno, and Dietrich Domanski for generously sharing their estimated FX intervention data.

[9] Data on monthly net capital flows was obtained from EPFR Global Research Database. Three countries in the sample, namely, India, Indonesia, and Malaysia do not publicly release monthly Balance of Payments (BOP) data, which precludes its use in determining months with net capital flows.

Figure 6
Selected Asian EMEs: Frequency of Net Capital Outflow Episodes (2005M01-2016M06)



Sources: EPFR Global Research Database; Author's calculations.

Apart from dummy variables for months with net capital outflows, actual capital flows of residents and non-residents were included to check whether central banks are sensitive to the magnitude of capital flows and the source of capital flow movements. For this purpose, investments that are short-term in nature, namely, portfolio investments and other investments (as defined in the Balance of Payments (BOP) Statistics) were aggregated for both residents and non-residents, and both were scaled to GDP.[10] For ease of interpretation, non-resident net capital flows were multiplied by -1, so that non-resident net capital outflows would be reflected with a positive sign, similar for resident net capital outflows.[11] Thus, all variables for net capital flows, when positive, would indicate net outflows. Hence, if ρ, the coefficient of the capital flow variable is negative, then it can be said that central banks, on average, sell FX during periods with net capital outflows.

Meanwhile, to examine whether central banks explicitly consider the cross-border exposure of their residents when they intervene in the FX market, the following variables were included:[12]

1) annual growth of NFS FX debt,
2) annual change in NFS FX debt-to-GDP ratio,
3) annual growth of international debt securities issued by the government (IDSG),
4) annual change in IDSG-to-total government debt,
5) annual growth of foreign holdings of local currency government-issued bonds (LCYGB), and
6) annual change in foreign holdings of LCYGB-to-total LCYGB.

[10] For India, Indonesia and Malaysia, monthly flows were interpolated using quarterly BOP data.
[11] In BOP accounting, an investment made by a resident abroad is considered as an acquisition of asset, thus, resident net capital outflows are reflected in the BOP with a positive sign. Meanwhile, an investment of a non-resident in the domestic economy is considered as an incurrence of liability, thus non-resident capital outflows are recorded in the BOP with a negative sign to reflect reduction in liability.
[12] Indicators for cross-border exposure are available on a quarterly frequency. Monthly values were interpolated from quarterly data.

Thus, when τ, the coefficient of the cross-border exposure variable, is negative, then it can be assumed that central banks, on average, tend to sell FX as residents' cross-border exposure increases, regardless of whether there is a capital outflow episode or none.

It is likewise possible that a central bank's decision during capital outflow episodes is conditioned by the cross-border exposure of its residents. To account for this possibility, the capital outflow dummy is interacted with the different indicators of cross-border exposure. Thus, if ω, the coefficient of the interaction term is positive, then this implies that central banks in EMEs with higher cross-border exposure tend to intervene (sell FX) more during periods with capital outflows, most likely to moderate depreciation pressures that may put a strain on the balance sheets of residents and the government.

The other independent variables represent the other motives of FX intervention.[13]

Lean against the wind. To capture the "lean against the wind" motive, the 30-day historical volatility of the local currency vis-à-vis the US dollar and the monthly change in the (log) exchange rate were included in estimation of equation (3). A significant coefficient for both variables would indicate that central banks, in general, intervene to limit exchange rate volatility and appreciation or depreciation pressures.

Reduce deviation from medium-term trend or average. The deviation of the current month's real effective exchange rate (REER) from its 60-month moving average is included to possibly capture medium-term exchange rate pressures. A negative coefficient for this variable would imply that central banks are attempting to bring the current REER closer to its medium-term average.

Accumulation. To capture the possibility that central banks are intervening (purchasing FX) to accumulate foreign reserves for precautionary purposes, the annual change in the ratio of a country's gross international reserves relative to short-term external debt is included. Moreover, the ratio of a country's GIR-to-GDP relative to the average EME's GIR-to-GDP is included to possibly capture the so-called "keeping up with the Jones' effect."[14] If the coefficients of both variables are positive, this implies that a central bank has a tendency to continue accumulating FX reserves, even if the economy's GIR relative to its short-term external debt and to peer's GIR have increased over the past year.

Competitiveness motive. The ratio of exports-to-GDP is included to capture the possibility that central banks are intervening to support the export sector. Specifically, FX purchase by a central bank may give an indication that it is preventing too much appreciation of or is undervaluing its local currency.

Moderate inflationary pressures. The monthly year-on-year inflation rate is included to capture the possibility that a central bank intervenes (sell FX) to curb the depreciation of the

[13] Appendix 2 provides details for each of the explanatory variables, including description and sources.

[14] Two groups of peer EMEs were considered: (1) the 6 Asian EMEs covered by this study; and (2) group (1) plus Argentina, Brazil, Bulgaria, Chile, Colombia, Hungary, Mexico, Poland, Romania, Russia, South Africa, Turkey, and Ukraine.

local currency, which could add to inflationary concerns. A negative coefficient for this variable would imply that a central bank has a greater propensity to intervene in the FX market (sell FX), when inflation rate increases.

To control for broad economic or financial conditions that may influence the central bank to intervene in the market, the monthly change in the financial conditions index for Asia (excluding Japan)[15] was included in the estimation of equation (3).[16] A positive value of this index indicates accommodative financial conditions, while a negative value indicates tighter financial conditions relative to pre-crisis norms. Thus, if the coefficient of this variable is positive, then this implies that a central bank, in general, is able to purchase more FX when financial conditions are accommodative.

To address possible simultaneity bias, most of the explanatory variables were lagged one period. However, for the variables representing exchange rate and capital flow movements as well as financial conditions, which are fast-moving variables, the values for the current month were used. Using the lagged *ervol*, for instance, eliminates the simultaneity bias, however, it is more likely that a central bank will intervene in the foreign exchange market in response to exchange rate volatility in the current month rather than exchange rate volatility in the previous month. Nonetheless, the use of General Method of Moments (GMM) is expected to reduce or eliminate endogeneity issues in the model. Meanwhile, variables representing cross-border exposures of residents were lagged 3 months or 1 quarter since in practice the availability of these indicators typically come with more than 1 month lag. Hence, any decision by a central bank to intervene in the FX market as a response to cross-border exposure will be based on data in the previous quarter.

4. Estimation Results

Table 1, column 1 shows the benchmark results.

First, on average, Asian EME central banks appear to lean against the wind, that is, FX intervention is done to moderate exchange rate volatility and address short-term pressures on the exchange rate. This confirms the publicly declared exchange rate policy of the central banks in the sample. A 1 unit increase in measured volatility of the exchange rate increases FX sale by 0.09 percent, while a 1 percent depreciation (appreciation) of the local currency against the US dollar increases FX sale (purchase) by 0.24 percent (Column 1).

Second, Asian EME central banks appear not to respond to deviations of the REER from its 60-month or 5-year trend.

Third, even when a country's reserves are considered adequate, central banks, on average, still continues to purchase FX or accumulate reserves, such that a 1 percentage point increase in the GIR-to-ST external debt ratio increases FX purchases by 0.005 percent.

[15] The index is calculated by Bloomberg.

[16] Other variables were considered to capture broad economic and financial conditions. The VIX captures the general risk sentiment in the market, but was statistically insignificant in the estimations. The CDS spread captures the riskiness of a country from the perspective of lenders. However, CDS spread data for India only began in 2013.

Table 1
Determinants of FX Market Intervention

Dependent Variable: Δlog(adjusted FX reserves)					
	(1)	(2)	(3)	(4)	(5)
ER 30-day volatility	-0.090 **	-0.088 **	-0.089 **	-0.063 *	-0.063 *
	(-2.048)	*(-1.926)*	*(-2.017)*	*(-1.633)*	*(-1.684)*
Monthly Δlog(ER)	-0.241 **	-0.229 **	-0.230 **	-0.220 **	-0.218 **
	(-5.014)	*(-4.951)*	*(-4.759)*	*(-4.811)*	*(-4.595)*
REER deviation from 5-yr moving average (-1)	-0.030	-0.038	-0.032	-0.031	-0.029
	(-0.671)	*(-0.853)*	*(-0.740)*	*(-0.724)*	*(-0.690)*
Annual Δ(GIR/ST external debt) (-1)	0.005 **	0.005 **	0.005 **	0.004 **	0.004 **
	(2.585)	*(2.528)*	*(2.644)*	*(2.138)*	*(2.224)*
Annual Δ[(GIR/GDP) / EME (GIR/GDP) average] (-1)	-0.003	-0.003	-0.003	0.002	0.002
	(-0.384)	*(-0.478)*	*(-0.476)*	*(0.252)*	*(0.229)*
Exports/GDP (-1)	0.045 **	0.041 **	0.042 **	0.043 **	0.043 **
	(2.138)	*(1.990)*	*(2.008)*	*(2.197)*	*(2.173)*
Annual Δlog(CPI)(-1)	-0.108 *	-0.087	-0.101	-0.052	-0.058
	(-1.628)	*(-1.339)*	*(-1.562)*	*(-0.885)*	*(-0.981)*
Monthly Δfinancial conditions index for Asia	0.008 **	0.006 **	0.006 **	0.006 **	0.005 **
	(3.517)	*(2.908)*	*(2.573)*	*(2.581)*	*(2.208)*
Dummy_net KO		-0.005 **		-0.003	
		(-2.221)		*(-1.274)*	
Dummy_excessive net KO			-0.008 **		-0.006 **
			(-2.564)		*(-2.029)*
Resident investment/GDP				0.006	0.006
				(0.246)	*(0.265)*
Non-resident investment/GDP				-0.074 **	-0.075 **
				(-3.982)	*(-4.080)*
Constant	0.000	0.002	0.002	-0.004	-0.004
	(-0.026)	*(-0.343)*	*(0.217)*	*(-0.477)*	*(-0.476)*
Adjusted R-squared	0.218	0.222	0.224	0.257	0.261

*Note: All estimations cover the period 2005M01-2016M06 and include 6 countries. Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

Fourth, no evidence is found that FX interventions are motivated by Asian EME central banks comparing their FX reserves with their peers.

Fifth, in EMEs where the export sector is larger, there is evidence that central banks have a greater tendency to purchase FX at a faster rate, possibly to temper the appreciation of the local currency and support the competitiveness of the export sector. A 1 percentage point increase in exports-to-GDP ratio increases the rate of FX purchases by about 0.04 percent.

Sixth, there is no evidence that FX intervention is affected by inflationary pressures. This may imply that the primary monetary policy instrument of Asian EME central banks has, on average, been effective in addressing inflationary pressures, at least in the period covered by this study.

Finally, better financial conditions in Asian economies are associated with faster rate of FX purchases.

Columns (2) and (3) add dummy variables for capital outflow episodes. Both dummy variables are negative and statistically significant, implying that in periods with net capital outflows, the rate of FX sale increases. The rate increases slightly during periods with excessive net capital outflows.

Columns (4) and (5) add the actual net capital flows of residents and non-residents. Results suggest that the rate of FX intervention appears to be influenced more by capital flows of non-residents (liability flows) than residents (asset flows). In fact, the coefficient of resident flows are statistically insignificant. This may be because non-resident short-term capital flows are larger in volume and are more volatile relative to resident short-term capital flows.[17] For every percentage point increase in non-resident outflow relative to GDP, an Asian EME central bank, on average, increases the rate of FX sale by about 0.07 percent.

Noteworthy is that the dummy for net capital outflows (column 4) loses statistical significance, but the dummy for excessive net capital outflows retains its statistical significance. This suggests that central banks do not necessarily respond to all net capital outflow episodes. Likewise, there was a reduction in the coefficients of *ervol* and *erpres* when actual capital flows were included as explanatory variables. These imply that exchange rate volatility and exchange rate pressures partly emanate from capital flows.

Table 2 adds indicators of cross-border exposure of the non-financial sector. Panel A uses the dummy variable for all periods with net capital outflows, while Panel B uses the dummy variable for periods with excessive net capital outflows.

The shaded area displays the coefficients of the cross-border exposure indicators and the interaction terms for the net capital outflow dummy and cross-border exposure indicators. In Panel A, it can be seen that none of the NFS cross-border indicators are statistically significant. However, when interacted with the capital outflow dummy, the coefficients become statistically significant. The negative coefficient of the interaction term implies that the propensity of central banks in EMEs to intervene during periods of capital outflows increases when cross-border exposures of the non-financial sector are higher. In particular, a 1 percent increase in NFS FX debt over the past year increases the rate of FX sale by the central bank by about 0.04 percent when there is a capital outflow episode. Meanwhile, a 1 percentage point increase in NFS-to-GDP ratio over the past year increases the rate of FX sale by the central bank by about 0.29 percent when there is a capital outflow episode.

[17] In the sample of EMEs in this study, average short-term resident investment is 1.48 percent of GDP, while non-resident investment is 2.32 percent of GDP. In addition, volatility (measured as average of the coefficient of variation of capital flows for each country) of resident investment/GDP and non-resident investment/GDP stands at 2.79 and 3.39, respectively.

Table 2
FX Market Intervention and Cross-Border Exposure of the Non-Financial Sector

Dependent Variable: Δlog(adjusted FX reserves)	A. Cross-border exposure interacted with net KO dummy		B. Cross-border exposure interacted with *excessive* net KO *(excessive = st.dev.>1)*	
	(1)	(2)	(1)	(2)
ER 30-day volatility	-0.056	-0.059 *	-0.054	-0.059 *
	(-1.480)	*(-1.697)*	*(-1.576)*	*(-1.807)*
Monthly Δlog(ER)	-0.224 **	-0.217 **	-0.219 **	-0.214 **
	(-4.858)	*(-4.703)*	*(-4.505)*	*(-4.444)*
REER deviation from 5-yr moving average (-1)	-0.032	-0.045	-0.020	-0.035
	(-0.723)	*(-1.105)*	*(-0.474)*	*(-0.906)*
Annual Δ(GIR/ST external debt) (-1)	0.003 *	0.003 **	0.004 **	0.004 **
	(1.851)	*(2.029)*	*(1.978)*	*(2.204)*
Annual Δ[(GIR/GDP) / EME (GIR/GDP) average] (-1)	0.002	0.002	0.002	0.002
	(0.283)	*(0.281)*	*(0.315)*	*(0.358)*
Exports/GDP (-1)	0.045 **	0.035 *	0.043 **	0.032 **
	(2.357)	*(1.858)*	*(2.203)*	*(1.660)*
Annual Δlog(CPI)(-1)	-0.035	-0.051	-0.038	-0.045
	(-0.566)	*(-0.844)*	*(-0.622)*	*(-0.750)*
Monthly Δfinancial conditions index for Asia	0.005 **	0.005 **	0.005 **	0.005 **
	(2.449)	*(2.483)*	*(2.170)*	*(2.151)*
Resident investment/GDP	0.006	0.008	0.005	0.006
	(0.268)	*(0.321)*	*(0.222)*	*(0.239)*
Non-resident investment/GDP	-0.075 **	-0.077 **	-0.075 **	-0.077 **
	(-4.056)	*(-4.165)*	*(-4.083)*	*(-4.193)*
Dummy_net KO	0.000	-0.004 *	-0.003	-0.007 **
	(-0.148)	*(-1.806)*	*(-0.716)*	*(-2.092)*
Annual growth NFS FX debt (-3)	0.003		-0.006	
	(0.233)		*(-0.661)*	
Annual growth NFS FX debt (-3) * Dummy_net KO	-0.034 **		-0.045	
	(-1.915)		*(-1.410)*	
Annual Δ(NFS FX debt/GDP) (-3)		-0.096		-0.195 **
		(-1.099)		*(-2.629)*
Annual Δ(NFS FX debt/GDP) (-3) * Dummy_net KO		-0.290 **		-0.239
		(-2.198)		*(-1.121)*
Constant	-0.006	-0.002	-0.005	-0.001
	(-0.736)	*(-0.188)*	*(-0.590)*	*(-0.142)*
Adjusted R-squared	0.263	0.274	0.266	0.271

*Note: All estimations cover the period 2005M01-2016M06 and include 6 countries. Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

The interaction terms, however, lose significance when the dummy variable used was for excessive net capital outflows (Panel B, columns 1 and 2). A possible explanation is that central banks, on average, do not wait for excessive capital outflow episodes to occur when they intervene. In panel B, what is noteworthy is that the rate of central bank FX sale is higher in EMEs with higher annual changes in NFS FX debt relative to GDP, regardless of whether there is an outflow episode or none (Panel B, column 2). Results for the other explanatory variables are similar to those in Table 1.

Table 3 adds variables that capture the government's cross-border exposure.[18] The shaded area displays the coefficients of the cross-border exposure indicators and the interaction terms for the net capital outflow dummy and cross-border exposure indicators.

Table 3
FX Market Intervention and Cross-Border Exposure of the Government

Dependent Variable: Δlog(adjusted FX reserves)	A. Cross-border exposure interacted with net KO dummy				B. Cross-border exposure interacted with *excessive* net KO dummy *(excessive = st.dev.>1)*			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ER 30-day volatility	-0.061	-0.063	-0.063	-0.060	-0.062	-0.061	-0.064	-0.062
	(-1.351)	*(-1.562)*	*(-1.490)*	*(-1.432)*	*(-1.383)*	*(-1.585)*	*(-1.514)*	*(-1.463)*
Monthly Δlog(ER)	-0.213 **	-0.215 **	-0.210 **	-0.218 **	-0.217 **	-0.222 **	-0.213 **	-0.219 **
	(-4.102)	*(-4.266)*	*(-4.166)*	*(-4.348)*	*(-4.135)*	*(-4.221)*	*(-4.121)*	*(-4.284)*
REER deviation from 5-yr moving average (-1)	-0.043	-0.053	-0.044	-0.048	-0.035	-0.043	-0.039	-0.042
	(-0.851)	*(-1.058)*	*(-0.851)*	*(-0.995)*	*(-0.707)*	*(-0.869)*	*(-0.766)*	*(-0.890)*
Annual Δ(GIR/ST external debt) (-1)	0.005 **	0.003	0.004 **	0.003	0.005 **	0.004 *	0.004 **	0.003
	(2.295)	*(1.520)*	*(2.118)*	*(1.497)*	*(2.405)*	*(1.632)*	*(2.223)*	*(1.559)*
Annual Δ[(GIR/GDP) / EME (GIR/GDP) average] (-1)	0.008	0.001	-0.001	0.005	0.008	0.002	0.000	0.005
	(0.888)	*(0.125)*	*(-0.107)*	*(0.684)*	*(0.894)*	*(0.205)*	*(-0.045)*	*(0.720)*
Exports/GDP (-1)	0.046	0.046 **	0.044 **	0.045 **	0.048	0.046 **	0.045 **	0.045 **
	(1.524)	*(1.961)*	*(2.117)*	*(2.210)*	*(1.588)*	*((1.976)*	*(2.157)*	*(2.224)*
Annual Δlog(CPI)(-1)	0.021	-0.068	-0.033	-0.075	0.015	-0.080	-0.037	-0.077
	(0.273)	*(-0.863)*	*(-0.460)*	*(-1.024)*	*(0.198)*	*(-1.026)*	*(-0.516)*	*(-1.057)*
Monthly Δfinancial conditions index for Asia	0.006 **	0.008 **	0.008 **	0.008 **	0.006 **	0.008 **	0.007 **	0.007 **
	(2.574)	*(3.675)*	*(3.605)*	*(3.597)*	*(2.459)*	*(3.456)*	*(3.281)*	*(3.379)*
Resident investment/GDP	0.031	0.033	0.005	0.011	0.030	0.030	0.006	0.011
	(0.951)	*(1.015)*	*(0.182)*	*(0.445)*	*(0.927)*	*(0.936)*	*(0.252)*	*(0.435)*
Non-resident investment/GDP	-0.075 **	-0.067 **	-0.070 **	-0.072 **	-0.078 **	-0.073 **	-0.072 **	-0.073 **
	(-2.648)	*(-3.465)*	*(-3.699)*	*(-3.754)*	*(-2.778)*	*(-3.806)*	*(-3.845)*	*(-3.846)*
Dummy_net KO	-0.003	-0.002	-0.004	-0.003	-0.003	-0.002	-0.005 *	-0.004
	(-0.955)	*(-0.714)*	*(-1.455)*	*(-1.304)*	*(-0.733)*	*(-0.415)*	*(-1.616)*	*(-1.205)*
Annual growth in foreign holdings of LCYGB (-3)	-0.001				-0.002			
	(-0.186)				*(-0.599)*			
Annual growth in foreign holdings of LCYGB (-3) * Dummy_net KO	-0.003				-0.001			
	(-0.594)				*(-0.137)*			
Annual Δ(Foreign holdings of LCYGB/Total LCYGB (-3)		0.101 *				0.067		
		(1.798)				*(1.286)*		
Annual Δ(Foreign holdings of LCYGB/Total LCYGB) (-3) * Dummy_net KO		-0.157 *				-0.147		
		(-1.697)				*(-1.033)*		
Annual growth IDSG (-3)			0.009				0.006	
			(1.240)				*(0.974)*	
Annual growth IDSG (-3) * Dummy net KO			-0.008				-0.007	
			(-0.984)				*(-0.642)*	
Annual Δ(IDSG/Total govt credit) (-3)				-0.213 *				-0.250 **
				(-1.710)				*(-2.320)*
Annual Δ(IDSG/Total govt credit) (-3) * Dummy_net KO				-0.151				-0.156
				(-0.813)				*(-0.464)*
Constant	-0.008	-0.009	-0.007	-0.006	-0.010	-0.009	-0.007	-0.006
	(-0.681)	*(-0.790)*	*(-0.692)*	*(-0.615)*	*(-0.804)*	*(-0.877)*	*(-0.797)*	*(-0.697)*
Adjusted R-squared	0.247	0.288	0.271	0.279	0.246	0.284	0.270	0.278

*Note: All estimations cover the period 2005M01-2016M06 and include 5 countries (Indonesia, Malaysia, Philippines, South Korea, Thailand). Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

In Panel A, column 2, it can be seen that the coefficient of the interaction term between the annual change in the fraction of LCYGB held by foreigners and the capital outflow dummy

[18] India is excluded from these set of regressions because it does not have publicly available data on LCYGB held by foreigners and have very short time series data on IDSG. (Note that India has restrictions for foreigners to hold government-issued bonds.)

is negative and statistically significant. This implies that the propensity of central banks in EMEs to intervene during periods of capital outflows increases when the cross-border exposure of the government is higher and even if the exposure is in local currency. In particular, a 1 percentage point increase in the share of LCYGB held by foreigners relative to total LCYGB over the past year increases the rate of FX sale by the central bank by about 0.16 percent when there is a capital outflow episode. Nonetheless, by itself, the coefficient of the fraction of LCYGB held by foreigners is positive and statistically significant. This may imply that during non-outflow periods, central banks typically purchase FX as the fraction increases, possibly to have precautionary reserves.

In addition, there is evidence that the propensity of a central bank to intervene (sell FX) regardless of whether there is capital outflow episode or none increases when IDSG increases relative to total government credit as seen in Panels A and B, column 4. This gives an indication that a central bank, on average, may want to prevent too much depreciation of the local currency as the international debt securities issued by its government increases.

5. Robustness Checks

A number of robustness checks was conducted to verify the results.

First, the number of lags for indicators of cross-border exposure was increased from 3 to 6 months (Table 4). Results are consistent with earlier estimations. This implies that central banks are influenced by the growth or changes in cross-border exposure not just in the past quarter, but the trend over several quarters.

Table 4
Robustness Check: Increasing the Lag of Cross-Border Exposure

Dependent Variable: Δ log(adjusted FX reserves)	A. Cross-border exposure interacted with net KO dummy	B. Cross-border exposure interacted with *excessive* net KO dummy (excessive = st.dev.>1)
Annual growth NFS FX debt (-6)	0.000	-0.001
	(-0.038)	*(-0.106)*
Annual growth NFS FX debt (-6) * Dummy_net KO	-0.029*	-0.044
	(-1.800)	*(-1.312)*
Annual Δ(NFS FX debt/GDP) (-1)	-0.058	-0.187**
	(-1.141)	*(-2.100)*
Annual Δ(NFS FX debt/GDP) (-1) * Dummy_net KO	-0.330**	-0.148
	(-2.374)	*(-0.733)*
Annual Δ(Foreign holdings of LCYGB/Total LCYGB (-6)	0.089	0.055
	(1.452)	*(1.007)*
Annual Δ(Foreign holdings of LCYGB/Total LCYGB) (-6) * Dummy_net KO	-0.176*	-0.217
	(-1.841)	*(-1.475)*
Annual Δ(IDSG/Total govt credit) (-6)	-0.084	-0.146
	(-0.705)	*(-1.287)*
Annual Δ(IDSG/Total govt credit) (-6) * Dummy_net KO	-0.325*	-0.328
	(-1.631)	*(-0.264)*

*Note: All estimations cover the period 2005M01-2016M06. All explanatory variables used in previous estimations are included but not shown in the table. Estimations using indicators for NFS cross-border exposure include 6 countries include India, Indonesia, Malaysia, Philippines, South Korea, and Thailand. Estimations using indicators for government cross-border exposure excludes India. Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

While the coefficient for the annual change in IDSG-to-total government credit became statistically insignificant, the coefficient of the interaction term between the annual change in IDSG-to-total government credit and capital outflow dummy became statistically significant, suggesting that higher cross-border exposure of the government increases the propensity of the central bank to intervene during capital outflow episodes, still consistent with previous findings.

Second, an index for macroprudential measures (MPM)[19] and its interaction with the capital outflow dummy were included in the estimations to account for the possibility that MPM mitigate the need for FX intervention during capital outflow episodes (Tables 5a and 5b). Results show that tighter MPM is associated with FX purchases by a central bank.[20] However, the interaction term between the monthly change in the index for MPM and KO dummy is insignificant, suggesting that additional or tighter MPM do not mitigate the use of FX intervention during capital outflow episodes. This implies that FX interventions and macroprudential measures, by themselves, are not sufficient in eliminating fluctuations or risks. This is consistent with the literature on the complementarity of policies or instruments (Ghosh et al. (2017)). Moreover, earlier results still hold, that higher cross-border exposure of residents increases a central bank's propensity to intervene during capital outflow episodes.

Finally, the policy rate or the change in the policy rate and its interaction with the capital outflow dummy were likewise included as explanatory variables to account for the possible impact of monetary policy on the FX intervention behavior of the central bank. The coefficients are statistically insignificant (results not shown), suggesting that policy rate changes and FX market interventions are generally used by central banks for different policy objectives, at least for the period and countries covered in this study.

[19] The index was calculated based on tightening measures for both capital inflows and outflows implemented by the six Asian EMEs included in the study. These measures were compiled by the Center for Monetary and Financial Policy (CMFP)-BSP staff and was used by Bayangos (2017).

[20] This implies that central banks' FX purchase and MPM activation typically occur during the same period.

Table 5a
Robustness Check: Adding an Index for Macroprudential Measures

Dependent Variable: Δ log(adjusted FX reserves)	A. Cross-border exposure interacted with net KO dummy				B. Cross-border exposure interacted with *excessive* net KO dummy *(excessive = st.dev.>1)*			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ER 30-day volatility	-0.066 *	-0.067 *	-0.059 *	-0.063 *	-0.066 *	-0.066 *	-0.057 *	-0.062 **
	(-1.766)	*(-1.789)*	*(-1.629)*	*(-1.854)*	*(-1.822)*	*(-1.836)*	*(-1.743)*	*(-1.987)*
Monthly Δlog(ER)	-0.223 **	-0.222 **	-0.225 **	-0.218 **	-0.220 **	-0.220 **	-0.221 **	-0.216 **
	(-4.958)	*(-4.980)*	*(-5.007)*	*(-4.854)*	*(-4.736)*	*(-4.747)*	*(-4.656)*	*(-4.587)*
REER deviation from 5-yr moving average (-1)	-0.034	-0.036	-0.036	-0.049	-0.033	-0.034	-0.025	-0.040
	(-0.807)	*(-0.829)*	*(-0.815)*	*(-1.198)*	*(-0.775)*	*(-0.800)*	*(-0.599)*	*(-1.030)*
Annual Δ(GIR/ST external debt) (-1)	0.004 **	0.004 **	0.003 **	0.004 **	0.004 **	0.004 **	0.004 **	0.004 **
	(2.155)	*(2.168)*	*(1.881)*	*(2.064)*	*(2.239)*	*(2.242)*	*(1.996)*	*(2.229)*
Annual Δ[(GIR/GDP) / EME (GIR/GDP) average] (-1)	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002
	(0.239)	*(0.260)*	*(0.297)*	*(0.287)*	*(0.215)*	*(0.233)*	*(0.331)*	*(0.363)*
Exports/GDP (-1)	0.044 **	0.044 **	0.047 **	0.037 **	0.044 **	0.044 **	0.043 **	0.033 *
	(2.253)	*(2.277)*	*(2.423)*	*(1.939)*	*(2.228)*	*(2.221)*	*(2.248)*	*(1.722)*
Annual Δlog(CPI)(-1)	-0.065	-0.065	-0.047	-0.063	-0.070	-0.071	-0.051	-0.058
	(-1.083)	*(-1.088)*	*(-0.758)*	*(-1.032)*	*(-1.169)*	*(-1.181)*	*(-0.821)*	*(-0.959)*
Monthly Δfinancial conditions index for Asia	0.005 **	0.006 **	0.005 **	0.005 **	0.005 **	0.005 **	0.005 **	0.005 **
	(2.553)	*(2.600)*	*(2.475)*	*(2.513)*	*(2.200)*	*(2.195)*	*(2.158)*	*(2.162)*
Resident investment/GDP	0.003	0.004	0.004	0.006	0.004	0.004	0.003	0.003
	(0.157)	*(0.181)*	*(0.206)*	*(0.265)*	*(0.178)*	*(0.183)*	*(0.142)*	*(0.157)*
Non-resident investment/GDP	-0.074 **	-0.074 **	-0.074 **	-0.076 **	-0.075 **	-0.074 **	-0.074 **	-0.076 **
	(-3.968)	*(-3.958)*	*(-4.031)*	*(-4.140)*	*(-4.066)*	*(-4.051)*	*(-4.056)*	*(-4.165)*
Dummy_net KO	-0.003	-0.003	-0.001	-0.004 *	-0.006 **	-0.007 **	-0.003	-0.007 **
	(-1.216)	*(-1.280)*	*(-0.203)*	*(-1.793)*	*(-1.991)*	*(-2.030)*	*(-0.804)*	*(-2.154)*
Monthly Δindex for tighter MPM	0.003 *	0.004 *	0.003 *	0.003 *	0.003 *	0.003 **	0.003 *	0.003 *
	(1.883)	*(1.913)*	*(1.818)*	*(1.875)*	*(1.915)*	*(1.927)*	*(1.874)*	*(1.889)*
Monthly Δindex for tighter MPM*Dummy_net KO		0.001	0.001	0.001		0.002	0.003	0.003
		(0.834)	*(0.744)*	*(0.668)*		*(0.708)*	*(0.871)*	*(0.918)*
Annual growth NFS FX debt (-3)			0.002				-0.006	
			(0.149)				*(-0.696)*	
Annual growth NFS FX debt (-3) * Dummy_net KO			-0.032 *				-0.045	
			(-1.821)				*(-1.418)*	
Annual Δ(NFS FX debt/GDP) (-3)				-0.094				-0.190 **
				(-1.059)				*(-2.590)*
Annual Δ(NFS FX debt/GDP) (-3) * Dummy_net KO				-0.282 **				-0.242
				(-2.134)				*(-1.131)*
Constant	-0.004	-0.004	-0.007	-0.002	-0.004	-0.004	-0.005	-0.001
	(-0.514)	*(-0.531)*	*(-0.778)*	*(-0.243)*	*(-0.509)*	*(-0.494)*	*(-0.601)*	*(-0.160)*
Adjusted R-squared	0.263	0.262	0.267	0.278	0.265	0.265	0.292	0.275

*Note: All estimations cover the period 2005M01-2016M06 and include 6 countries. Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

Table 5b
Robustness Check: Adding an Index for Macroprudential Measures

Dependent Variable: Δlog(adjusted FX reserves)	A. Cross-border exposure interacted with net KO dummy		B. Cross-border exposure interacted with *excessive* net KO *(excessive = st.dev.>1)*	
	(1)	(2)	(1)	(2)
ER 30-day volatility	-0.067 *	-0.064	-0.062 *	-0.063
	(-1.762)	*(-1.570)*	*(-1.707)*	*(-1.556)*
Monthly Δlog(ER)	-0.208 **	-0.212 **	-0.217 **	-0.215 **
	(-4.199)	*(-4.283)*	*(-4.175)*	*(-4.248)*
REER deviation from 5-yr moving average (-1)	-0.062	-0.056	-0.053	-0.051
	(-1.272)	*(-1.172)*	*(-1.078)*	*(-1.089)*
Annual Δ(GIR/ST external debt) (-1)	0.003	0.003	0.004 **	0.003 *
	(1.558)	*(1.554)*	*(1.663)*	*(1.615)*
Annual Δ[(GIR/GDP) / EME (GIR/GDP) average] (-1)	0.001	0.005	0.002	0.005
	(0.170)	*(0.675)*	*(0.274)*	*(0.686)*
Exports/GDP (-1)	0.049 **	0.047 **	0.047 **	0.047 **
	(2.127)	*(2.352)*	*(2.088)*	*(2.308)*
Annual Δlog(CPI)(-1)	-0.083	-0.088	-0.096	-0.092
	(-1.099)	*(-1.228)*	*(-1.270)*	*(-1.280)*
Monthly Δfinancial conditions index for Asia	0.008 **	0.008 **	0.008 **	0.007 **
	(3.695)	*(3.632)*	*(3.440)*	*(3.373)*
Resident investment/GDP	0.029	0.009	0.026	0.008
	(1.100)	*(0.390)*	*(0.981)*	*(0.359)*
Non-resident investment/GDP	-0.067 **	-0.071 **	-0.073 **	-0.072 **
	(-3.472)	*(-3.734)*	*(-3.805)*	*(-3.822)*
Dummy_net KO	-0.002	-0.003	-0.002	-0.004
	(-0.728)	*(-1.266)*	*(-0.437)*	*(-1.269)*
Monthly Δindex for tighter MPM	0.005 **	0.005 **	0.005 **	0.005 **
	(2.292)	*(2.150)*	*(2.257)*	*(2.181)*
Monthly Δindex for tighter MPM*Dummy_net KO	0.003	0.002	0.010 **	0.007 *
	(1.164)	*(1.027)*	*(2.108)*	*(1.843)*
Annual Δ(Foreign holdings of LCYGB/Total LCYGB (-3)	0.096 *		0.059	
	(1.686)		*(1.153)*	
Annual Δ(Foreign holdings of LCYGB/Total LCYGB) (-3) * Dummy_net KO	-0.159 *		-0.170	
	(-1.775)		*(-1.244)*	
Annual Δ(IDSG/Total govt credit) (-3)		-0.214 *		-0.237 **
		(-1.735)		*(-2.279)*
Annual Δ(IDSG/Total govt credit) (-3) * Dummy_net KO		*-0.118*		*-0.134*
		(-0.664)		*(-0.392)*
Constant	-0.010	-0.007	-0.010	-0.007
	(-0.917)	*(-0.738)*	*(-0.957)*	*(-0.770)*
Adjusted R-squared	0.296	0.285	0.294	0.286

*Note: All estimations cover the period 2005M01-2016M06 and include 5 countries (Indonesia, Malaysia, Philippines, South Korea, Thailand). Dynamic panel GMM with country fixed effects is used in all estimations. An AR(1) correction term is included. Standard errors are robust. Value in ( ) is the t-statistic. ** and * indicate statistical significance at 5 percent and 10 percent level, respectively.*

6. Conclusion and Policy Implications

This study found empirical support for the financial stability motive of FX market intervention by examining the FX intervention behavior of central banks during periods with capital outflows and in response to residents' cross-border exposures. Results from estimating a central bank reaction function on a panel of Asian EMEs suggest that in countries with higher cross-border exposures, the propensity of the central bank to intervene during capital outflow episodes increases. Moreover, there is some evidence showing that central banks also have a higher propensity to sell FX, whether there is a capital outflow episode or none, when residents have higher cross-border exposures. These suggest that fear of floating still exists.

Results have important policy implications. First, central banks must be wary in giving the impression that it is guaranteeing the cross-border exposures of residents because such behavior may fuel greater cross-border exposures. Related to this, central banks may consider rules-based FX intervention to give a signal that interventions will be limited to some identified circumstances, hence, there is no explicit intention to provide insurance to cross-border exposures. Nonetheless, there is also a need for discretionary FX interventions, especially if large depreciations take place.

Second, findings justify the continuous monitoring and possible regulation of cross-border exposures of the non-financial sector. There may be scope to introduce regulations that would penalize unhedged open FX position and/or promote hedging with financial instruments. There may be benefits in identifying the banks that have extended loans to the NFS with substantial cross-border exposures and to introduce additional obligations, if necessary.

Finally, public debt managers may need to consider the fact that while local currency bonds minimize the currency mismatch problem that generally characterizes foreign currency bonds, this does not mean that there are no risks involved in allowing foreigners to participate in this market. To strengthen local currency bond markets and reduce foreign capital outflows during stressful periods, EME governments must target a broader base of domestic investors such as pension funds and other institutional investors. Furthermore, EMEs should continue to develop derivatives markets that will allow foreign investors to efficiently hedge their currency risk.

This study may be limited by the fact that central bank FX interventions were based on estimates and not on actual interventions, except for India. Future work may confirm the findings of this study as central banks become more willing to publicly reveal their actual intervention data, as in the case of South Korea.

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Appendix 1
Exchange Rate Policies of Asian Economies

Country	Exchange Rate Policy
India	India operates under a managed floating exchange rate regime. The Reserve Bank of India (RBI) intervenes in the forex market to contain the magnitude of exchange rate volatility of the rupee. Maintaining orderly market conditions has been the central theme of RBI's exchange rate policy. (Dua and Ranjan (2010)
Indonesia	Indonesia adheres to the free floating exchange rate system. Bank Indonesia operates an exchange rate policy designed to minimize excessive rate volatility, rather than to peg the exchange rate to a specific level. (https://www.bi.go.id/en/moneter/tujuan-kebijakan/Contents/Default.aspx)
Malaysia	Malaysia operates under a managed float system. The value of the exchange rate of the ringgit is determined by economic fundamentals. The ringgit exchange rate is greatly influenced by ringgit demand and supply in the foreign exchange market. Bank Negara Malaysia (BNM) does not actively manage or maintain the exchange rate at any specific level. Instead, it monitors the exchange rate against a currency basket to ensure that the exchange rate remains approximate to its fair value and intervenes only to minimize volatility. (http://www.bnm.gov.my/index.php?ch=en_press&pg=en_press&ac=904&lang=en)
Philippines	The Philippines' exchange rate policy supports a freely floating exchange rate system whereby the Bangko Sentral ng Pilipinas (BSP) leaves the determination of the exchange rate to market forces. Under a market-determined exchange rate framework, the BSP does not set the foreign exchange rate but instead allows the value of the peso to be determined by the supply of and demand for foreign exchange. Thus, the BSP's participation in the foreign exchange market is limited to tempering sharp fluctuations in the exchange rate. On such occasions of excessive movements, the BSP enters the market mainly to maintain order and stability. When warranted, the BSP also stands ready to provide some liquidity and ensure that legitimate demands for foreign currency are satisfied. (BSP (2018)
South Korea	South Korea has a free-floating exchange rate system. The exchange rate is decided by the interplay of supply and demand in the foreign exchange markets. However, the Bank of Korea implements smoothing operations to deal with abrupt swings I the exchange rate caused by temporary imbalances between supply and demand, or radical changes in market sentiment. (Rajan (2012)
Thailand	Exchange rate policy in Thailand functions under the managed-float exchange rate regime, which is also consistent with the inflation targeting regime. Under the managed-float and the inflation targeting framework, the value of the baht is determined by market forces, reflecting demand and supply for the baht in the foreign exchange market. Under the managed float, the Bank of Thailand does not target a fixed level for the exchange rate but is always prepared to intervene in the case of excess

Country	Exchange Rate Policy
	volatility. The Bank of Thailand aims to ensure that the value of the baht is allowed to fluctuate under the following conditions: (1) stands ready to intervene in the foreign exchange market, such that volatility of the exchange rate is at a level that the economy can tolerate; (2) maintains national competitiveness, as measured through the Nominal Effective Exchange Rate (NEER), which is composed of important trading partners; and (3) any intervention does not go against economic fundamentals which would otherwise lead to further imbalances. (https://www.bot.or.th/English/MonetaryPolicy/MonetPolicyKnowledge/Pages/ExchangeRate.aspx)
China	China has a managed floating exchange rate system to ensure the yuan currency stability. It takes stringent measures to manage currency through regulating trading activities and controlling daily changes of the yuan on the forex market. The yuan was pegged to the USD until the managed float was introduced in July 2005. In the succeeding years, the trading band was gradually increased from +/- 0.3% in the second half of 2005 to +/- 2% in March 2014. The most recent framework allows the PBOC to set the daily reference rate each morning. Currently, with a reference rate set by the PBOC, the yuan is authorized to trade each day within a +/- 2% band. (https://www.fxcm.com/insights/currency/asia-pacific-currencies/)
Hong Kong	Hong Kong has an exchange rate regime of a linked exchange rate system. It is a Currency Board system, which requires both the stock and the flow of the Monetary Base to be fully backed by foreign reserved. Any change in the size of the Monetary Base has to be fully matched by a corresponding change in the foreign reserves. The Monetary Base comprises of (1) Certificates of Indebtedness and Coins Issued; (2) The Aggregate Balance; and (3) Outstanding Exchange Fund Bills and Notes. (http://www.hkma.gov.hk/ eng/key-functions/monetary-stability/linked-exchange-rate-system.shtml)
Singapore	Since 1981, monetary policy in Singapore has been centered on the management of the exchange rate. (1) The Singapore dollar is managed against a basket of currencies of its major trading partners and competitors. (2) The Monetary Authority of Singapore operates a managed float regime for the Singapore dollar. The trade-weighted exchange rate is allowed to fluctuate within an undisclosed policy band, rather than kept to a fixed value. (3) The exchange rate policy band is periodically reviewed to ensure that it remains consistent with the underlying fundamentals of the economy. (4) The choice of the exchange rate as the intermediate target of monetary policy implies that MAS gives up control over domestic interest rates (and money supply) (MAS (2001)).

Appendix 2
Description and Sources of Variables Used in Estimations

Variable	Description	Source/s
FXI	Monthly change in stocks of FX reserves adjusted for valuation effects	Database used in Domanski, D., E. Kohlscheen, and R. Moreno (2016)
ervol	Exchange rate 30-day historical volatility	Bloomberg
erpres	Monthly change in log of nominal exchange rate, where the exchange rate is specified as end-of-month LCY/USD	BIS Statistics
ermis	Deviation of log real effective exchange rate from its 60-month moving average	BIS Statistics
accu	GIR-ST external debt	Central bank websites, CEIC
comp	Exports-to-GDP ratio	IMF International Financial Statistics
inf	Inflation rate (year-on-year)	CEIC, Bloomberg
fc	Finanical conditions index for Asia (excluding Japan); > 0 if accommodative	Bloomberg
ko	Dummy variable = 1 when monthly net capital flow < 0	EPFR Global Database
	Resident-to-GDP ratio	CEIC, central bank websites
	Non-resident-to-GDP ratio	CEIC, central bank websites
cb	Indicator of cross-border exposure	
	(1) annual growth of NFS FX debt	BIS Locational Banking Statistics
	(2) annual change in NFS FX debt-to-GDP ratio	BIS Locational Banking Statistics, CEIC
	(3) annual growth of international debt securities issued by the government (IDSG)	BIS International Debt Securities Statistics
	(4) annual change in IDSG-to-total government debt	BIS International Debt Securities and Total Credit Statistics
	(5) annual growth of foreign holdings of local currency government-issued bonds (LCYGB)	ADB Asia Bonds Online (for Indonesia, Malaysia, Korea and Thailand), Bangko Sentral ng Pilipinas (for the Philippines; where proxy variable is outstanding peso-denominated securities held by custodian banks for non-resident investors)
	(6) annual change in foreign holdings of LCYGB-to-total LCYGB	ADB Asia Bonds Online (for Indonesia, Malaysia, Korea and Thailand), Bangko Sentral ng Pilipinas (for the Philippines; where proxy variable is foreign share in government securities trades)

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