Intervening against the Fed *

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Abstract

This paper develops a novel event-study methodology for identifying the effect of sterilized foreign exchange (FX) intervention. We use a US monetary policy shock purely identified by high-frequency method and compare the response of exchange rate and stock price to monetary shock in countries that intervene and do not intervene against the Fed. We find that, without intervention, an unexpected Fed funds rate hike depreciates local currencies and decreases the stock price of firms, especially those whose debt is disproportionately denominated in US dollars. However, if central banks counteract by selling the US dollar, the US monetary shock has a limited effect on the exchange rate and stock prices. This suggests that the FX intervention is successful in stabilizing both the exchange rate and stock markets.

Keywords: Foreign Exchange Intervention, Monetary Policy Spillovers, Exchange Rates, Dollar Debt

JEL Classification Codes: E44, F31, F32, F41

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1 Introduction

The Federal Reserve is an important driver of the “Global Financial Cycle" and changes in US monetary policy can have major spillovers to the global economy. When the Fed tightens monetary policy, the US dollar appreciates, and global stock prices as well as credit contract (Rey 2015, Miranda-Agrippino and Rey 2020). Although both academics and policymakers have signaled the first-order importance of this issue, there is limited consensus on how countries could protect themselves against these spillovers.

An increasingly popular policy tool both among policymakers and scholars is sterilized foreign exchange (FX) interventions, i.e. the purchases or sales of foreign currencies that do not involve directly changing the interest rate. Some academics and policymakers are in favor of intervening in the foreign exchange market. In fact, many central banks have accumulated FX reserves reaching record highs to keep the currency depreciated.[1] However, often the benefits of a depreciated currency for boosting exports remain elusive (Gopinath et al. 2020). Instead, an increase in US dollar debt of companies in emerging markets has raised concerns that depreciations are contractionary rather than expansionary, raising the question of whether the accumulated reserves in the US dollar can potentially be used to insulate themselves against an unwarranted tightening of US monetary policy.[2] Despite widespread use, from empirical perspectives, the effect of FX interventions on the exchange rate and the economy more broadly is far from well understood, both due to data availability and endogeneity issues.

This paper approaches the question using a novel dataset on daily FX interventions, as well as exchange rate and asset price returns. Our novel event study methodology exploits the US monetary shocks cleanly identified by high-frequency methods (Nakamura and Steinsson 2018a) combined with daily FX interventions data around FOMC announcements. This strategy allows us to compare the responses of exchange rates and stock prices to FOMC announcements in countries that do and do not counter-intervene against the US dollar and identify the effect of FX intervention more cleanly than was previously possible.

First, we present evidence that intervening against the Fed prevents exchange rate movements against the US dollar when US monetary policy surprisingly changes. When the Fed

[1] For example, the Swiss National Bank has sold franc to counter the over-valuation due to its safe-haven status and boost the export industries (Jordan 2017). Chinese foreign reserves increased from 733 billion US dollar in July 2005 to 3.99 trillion dollar in June 2014 (Das 2019).

[2] A notable example is that Brazil sold 110 billion US dollars in two years following Fed’s taper announcement in May 2013 (Chamon et al. 2017).

hikes rates unexpectedly and the country does not sell the US dollar to counteract the surprise, the domestic currency depreciates against the US dollar. However, when the domestic authority sells US dollars and buys the domestic currency, the domestic currency remains flat around the US monetary policy tightening. Second, we study daily stock returns around FOMC announcements. When the Fed hikes unexpectedly stock returns fall only if the domestic authorities do not intervene against the Fed. When the country counteracts the Fed's decision by buying (selling) domestic currency when the Fed tightens (loosens), stock returns are unresponsive.

The effect on the stock market cannot simply be measured by the aggregate stock market index response as it masks significant heterogeneity across firms. Instead, we take a more granular view and exploit variation in the degree of US dollar debt and trace the differential response in stock return across these firms. Firms with a large degree of US dollar debt see a decrease in their domestic net worth position in response to an appreciation of the US dollar, as the value of their liabilities in domestic currency increases. The availability of a rich corporate bond- or loan-level dataset of currency breakdowns allows us to investigate how firms with heterogeneous degrees of exchange rate exposure are affected by the FX intervention. Exploiting this heterogeneity across firms allows us to abstract from country-date specific factors that would drive the results. Instead, within a country, we can compare firms with and without a large amount of US dollar debt and trace their differences in stock returns. We find that firms that have a large degree of US dollar debt are significantly more negatively affected by US monetary policy tightening if the domestic country does not intervene against the Fed. However, when the domestic authority intervenes against the Fed, stock returns of firms with a larger degree of US dollar debt behave insignificantly differently than those of their counterparts. These results suggest that FX interventions can be successful in stabilizing both the exchange rate and stock returns, especially for those that are highly exposed to the global financial cycle. FX interventions can make countries more insulated from the global financial cycle.

We further refine our identification strategy by exploiting the debt maturity structure of firms around the FOMC announcements.[3] Firms that have a larger degree of US dollar debt may be inherently different from those that do not, potentially biasing our estimates. Therefore, we compare firms that have different degrees of US dollar debt maturing around the FOMC announcement. If the Fed tightens monetary policy unexpectedly and the US dollar appreciates,

[3]The debt maturity identification approach follows the approach by Almeida et al. (2011) and Duval et al. (2020) that study the effect of debt maturity during the global financial crisis on firms' outcomes. More recently, this approach has been applied in the context of the US dollar debt maturity structure around exchange rate movements by Casas et al. (2022).

the debt repayments of the firms increase in local currency. This increases the cost of rolling over debt and reduces the value of firms with dollar debt that matures shortly after the US tightening shock. In contrast, when the Fed loosens monetary policy, a depreciation of the US dollar reduces the debt repayments of firms and can have positive consequences. We show that when the domestic central bank intervenes against the Fed policy by buying local currency in response to a tightening shock, this disproportionately benefits the firms that have US dollar debt maturing just after the FOMC announcement relative to a scenario in which the central bank does not intervene against the Fed. Since the debt maturity structure is exogenous to exchange rate movements, the effect of debt repayment on stock price can potentially be interpreted causally.

Literature. Recent theories claim that interventions can affect the exchange rate and enhance welfare (Gabaix and Maggiori 2015, **?**, Cavallino 2019, Amador et al. 2020, Jeanne and Sandri 2020, Fanelli and Straub 2021), while empirical analyses have been limited due to endogeneity concern and data limitation. Previous empirical studies on the FX intervention, including Fatum and Hutchison (2010) and Fratzscher et al. (2020), used propensity score matching (PSM) developed by Rosenbaum and Rubin (1983). PSM calculates propensity scores from observed covariates and divides the sample into treatment and control groups using the samples with similar scores. Another work by Adler et al. (2019) uses monthly panel data to estimate the effects of FXI interventions. In contrast, our event study approach exploits daily FX data combing with US monetary surprises purely identified by a high-frequency approach (Gürkaynak et al. 2005, Gorodnichenko and Weber 2016, Nakamura and Steinsson 2018a;b, Jarociński and Karadi 2020, Bu et al. 2021). The advantage of high-frequency identification is that, by using changes in Fed funds futures in a narrow time window around FOMC announcements, it minimizes the possibility that monetary policy is affected by other macroeconomic conditions. Thus, using this high-frequency monetary shock as an unexpected shock to the exchange rate allows us to identify whether foreign exchange interventions are effective in leaning against exchange rate shocks. Moreover, although previous studies on FX intervention have focused on its effect on the exchange rate, there is limited studies on its effect on the stock market. Since the stock price reflects firms' future profitability, it is an important indicator to study the effect of FX interventions on broad economy, not just the exchange rate.

Both theoretical and empirical literature on exchange rate dynamics and international transmission of monetary policy mainly focuses on changes in policy interest rate, based on the

seminal work by Gali and Monacelli (2005). Especially, recent papers emphasize the special role of US dollar in both international trade and finance. For example, Corsetti et al. (2020), Egorov and Mukhin (2020), Gopinath et al. (2020) and Mukhin (2021) consider monetary policy when the US dollar plays a dominant role in trade. Akinci and Queralto (2019), Aoki et al. (2020), Gopinath and Stein (2021), and di Giovanni et al. (2022) study US monetary policy and corporate balance sheet risk when firms issue debt denominated in dollars. In the context of firm heterogeneity, Maggiori et al. (2020) and Salomao and Varela (2022) provide evidence that large firms issue foreign currency bond and take on currency mismatch on balance sheet, while small firms issue bonds in local currency. Amiti et al. (2014) construct a model with heterogeneous firms in exports and imports and Rodnyansky (2019) studies the effect of competitive devaluation in such an environment. Casas et al. (2022) study the role of US dollar borrowing for the transmission of exchange rate shocks to trade. de Ferra et al. (2020) and Guo et al. (2020) study an open economy New Keynesian model with households with heterogeneous degrees of trade and financial integration. Timmer (2018) studies the spillover of US monetary policy on corporate bond yields. However, monetary policy consists of many tools and we are not just interested in the responses of firms to interest rate changes. In contrast to most of extant studies, we study another widespread and important dimension of monetary policy, that is, sterilized FX intervention.

2 Data

2.1 Sources

We combine data from several sources. Our sample period is between 2000 and 2019, during which the data on US monetary shock and corporate balance sheet are available.

First, we collected data on sterilized FX interventions based on Fratzscher et al. (2020) and Adler et al. (2021). We use publicly available databases on central bank websites and the FRED database. If the data is not publicly disclosed, we individually contacted the central banks to be granted an access to the data. We then restricted the sample countries based on the following criteria. First, for the sake of high-frequency identification, we only used daily intervention data and excluded countries where only monthly or quarterly data is available. Second, since we study the interventions against US monetary shocks, our sample comprises countries that intervened against US dollar multiple times during the sample period. The

following 13 countries satisfy the above criteria: Argentina, Australia, Brazil, Chile, Colombia, Costa Rica, Georgia, Hong Kong, Japan, Mexico, Morocco, Peru, Switzerland, and Turkey. Our sample contains three advanced economies: Australia, Japan, and Switzerland, and the other 10 countries are emerging economies.

To address the endogeneity concern of monetary policy, we use the high-frequency change in Fed funds rate (FFR) identified by Nakamura and Steinsson (2018a).[4] They estimate the changes in Fed funds futures in a 30-minute window around the FOMC announcement. The advantage of high-frequency method is that, as they take a sufficiently narrow time window, it is unlikely that the monetary policy is affected by other macroeconomic variables. Since the futures rate is determined based on the expectation of future short-term interest rates, the changes in federal funds futures reflect the purely unexpected monetary policy shock.

We obtained daily data on the spot exchange rate, stock market index, and stock price from Thomson Reuters Datastream. Since Datastream reports the closing exchange rate at 4pm London time and FOMC announcement is made around 2pm Washington time, we moved the reported dates of exchange rates by one date forward so that the exchange rate on each date is reported after the FOMC announcement on the same date. Since the end-of-date stock price is released at different times in different time zones, we adjusted the dates of the stock price depending on whether the stock price is released before or after the FOMC announcement.

We use corporate balance sheet data on the Capital IQ platform provided by S&P Global Market Intelligence. Capital IQ satisfies the following three key requirements. The advantage of Capital IQ is that it provides information on the currency denomination of debt, which is not available in other databases, such as Worldscope, Compustat, and Orbis. Its Capital Structure database provides detailed information on each debt instrument held by each firm, including the principal amount due, the repayment currency, and maturity. For example, Agrometal S.A.I., a manufacturing firm in Argentina, has a total outstanding debt of 5.6 million dollars in December 31, 2015. Among them, 2.2 million dollars are repaid in US dollars and the remaining 3.4 million dollars are repaid in Argentine peso.[5] Hence, the share of dollar bond over total bond is 39 percent. Capital IQ provides annual data on corporate balance sheet after 2001. The sample is restricted to publicly listed firms as data on stock price is available.

We complemented the data using a variety of sources. Firm-level data on export and

[4]The original data was updated by Miguel Acosta and Joseph Saia. The data is currently available between 2000 and 2019.

[5]Capital IQ converts the principal due of peso bond to US dollar using the end-of-year spot exchange rate.

incorporation date is available on Worldscope. To measure the firms' reliance on intermediate imports in their production, we used sector-level data on import content of exports in OECD input-output tables, following Rodnyansky (2019).[6] The SIC industry code in Capital IQ is matched with ISIC Revision 4 industry code using a conversion table in the United Nations Statistics Division. Appendix A provides details on data cleaning procedure and selection criteria for our sample firms.

Finally, for country-level characteristics, we collected the data on monthly policy rate from the IMF Monetary and Financial Statistics, since not only exchange rate policy but also monetary policy can affect the exchange rate. We also used monthly data on exchange rate regimes provided by Ilzetzki et al. (2019), since the effect of monetary and exchange rate policies can be heterogeneous across countries with different exchange rate regimes. They classify the exchange rate regimes into five categories and larger category implies more flexible exchange rate regime. Category 1 is the de facto peg and category 5 is the freely floating regime. The exchange rate regimes are time-variant in some countries. We defined categories 1 and 2 as fixed regimes and categories 3, 4, or 5 as flexible regimes.[7]

2.2 Summary Statistics

Table 1 provides summary statistics for Fed funds rate shocks and changes in the exchange rate and stock price.[8] We trimmed top and bottom 5% of Fed funds rate shocks and winsorized top and bottom 5% of changes in exchange rate and firms' stock price in each country so that our result is not affected by outliers.

We study 136 FOMC announcement dates between 2000 and 2019. Row (1) shows the summary statistics for Fed funds rate shock estimated by Nakamura and Steinsson (2018a). The Fed funds rate shock is defined as the change in market expectations of the Fed funds rate over the remainder of the month in which FOMC meeting occurs. The shock is in terms of basis points and a positive value implies the increase in the Fed funds rate. As Nakamura

[6]Due to the data limitation, this paper focuses on the effect of FX intervention on firms with dollar debt rather than exporters and importers. First, almost all Worldscope firms, especially in emerging economies, are non-exporters. Second, it is difficult to obtain a firm-level data on invoicing currency of export and import for a number of countries.

[7]We used the coarse classification codes for exchange rate arrangement classification by Ilzetzki et al. (2019). Since the data on exchange rate regimes is only available until 2016 December, we extended the data until 2019 assuming that the regimes after 2017 January is the same as 2016 December. We omitted observations with category 6: a dual market in which parallel market data is missing.

[8]Table 3 shows the sample firms.

and Steinsson (2018a) discuss, the magnitude of Fed funds rate shocks estimated by the high-frequency method is small: the standard deviation is only 1.47 basis points. This prevents us from estimating the effect on variables in a distant future: for example, output several quarters away is likely to be influenced by other macroeconomic conditions. However, we can estimate the response of variables that move contemporaneously with the policy rate. As we use daily data on exchange rate, stock price, and FX intervention, we can minimize this "power problem" of monetary shocks.

Row (2) shows the summary statistics for the changes in exchange rate comparing before and after the FOMC announcement date. $e_{c,t}$ is the spot exchange rate at the end of date t in country c. The exchange rate is defined as the value of US dollar in terms of local currency so that higher $e_{c,t}$ implies the appreciation of US dollar or depreciation of local currency. We take the change in the logarithm of exchange rate from date $t-1$ to $t+1$. Similarly, row (3) shows the summary statistics for the change in stock price comparing before and after the FOMC announcement. $p_{i,t}$ is the stock price of firm i at the end of date t. The stock price is denominated in local currency. The standard deviation of exchange rate change is 0.72 percent and that of stock price return is 3.47 percent.

Table 2 shows the frequency (columns 1-3) and average amount (column 4-5) of interventions on and after the FOMC event dates in our sample countries. Among our 136 FOMC event dates, columns (1) and (2) report the number of buying and selling US dollar interventions, defined so that central banks buy or sell the US dollar at least once between dates t and $t+5$, where t is the FOMC announcement date[9]. We learn that many countries buy US dollar more frequently than sell it and that emerging economies intervene more frequently than advanced economies.

Column (3) reports the frequency of counteracting intervention, which is the main focus of our analysis. We define counteracting intervention as follows: if the Fed funds rate increases on date t, central banks sell the US dollar at least once and never buy the US dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Intuitively, since a higher Fed funds rate depreciates the local currency, central banks can offset the depreciation by selling the US dollar and buying the local currency. We will use this definition of counteracting FX intervention throughout the regression analyses in this paper.[10]

[9]We take a 5-day window around FOMC announcement because we will study the effect of interventions over time using local projection and difference-in-difference methods

[10]Appendix 4.3 defines the counteracting intervention in a different way: the central banks' average net purchase of US dollar between dates t and $t+5$ is negative when the Fed funds rate increases at date t, and vice versa when the Fed funds rate decreases. Our main results are robust to using this alternative definition.

Column (4) reports the average amount of FX intervention. We took the average amount of FX net purchase of between dates t and $t+5$ over all FOMC announcement dates t. The unit is millions of US dollars and positive and negative values imply buying and selling US dollars, respectively. Column (5) takes the ratio of net purchase of the US dollar by GDP to take into account the difference in country size.[11] The average net purchase of US dollar is 6.8 million dollars and 2.9×10^{-4} percent of total GDP. We see that countries buy US dollar by a larger amount than sell it and that emerging economies intervene by a larger amount than advanced economies, similarly to the frequency of intervention. Column (6) reports the sample period when the FX intervention data are available.

Table 3 describes the sample firms.[12] The table shows the total number of firms and the number of firms with dollar debt in each country. Our sample consists of 4,088 firms in total, out of which 261 firms (6%) have dollar debt and 431 firms (11%) are exporters.[13] The share of firms with dollar debt is relatively large in emerging economies, while most of the Japanese firms do not issue dollar debt as they borrow in Japanese yen. Among the firms with dollar debt, only four firms are exporters.[14] Hence, our result on firms with dollar debt is mainly driven by firms without corresponding exporting revenues: they are not naturally hedged against exchange rate depreciation.[15] The average share of dollar debt over total debt across all firms is 53% (66% except Japan), conditioning on firms issuing positive amount of dollar debt. Our results on FX intervention and stock market are robust even after controlling for export and import, as well as their interaction with Fed funds rate shocks.

[11]The annual data on GDP is retrieved from World Bank National Accounts Data. We took the average of GDP over the sample period in each country and divided the FX intervention by average GDP.

[12]We omitted the following countries from our sample firms. Turkey never conducted FX intervention in 5-day windows around FOMC announcement dates. In Switzerland, the daily FX intervention data is only available until 2001. In Costa Rica, Georgia, and Peru, there is very little data on corporate balance sheet.

[13]Table 3 defines firms with dollar debt as those which issued positive amount of dollar debt at least once during the sample period. Similarly, the exporters are defined as firms which report positive amount of export at least once during the sample period.

[14]Almost all exporters in our sample are Japanese firms which borrow in yen.

[15]Appendix 4.2 also controls for international sales and asset holdings, which affect firms' foreign currency revenue, and our main result does not change.

3 Result

3.1 Exchange Rate

We first study the effect of FX intervention on exchange rate. We test whether FX intervention can mitigate the depreciation of exchange rate caused by US monetary tightening. Our hypothesis is as follows. When the Fed funds rate increases, dollar appreciates and local currency depreciates as the demand for dollar increases. When central banks intervenes in the FX market by selling the US dollar, the demand for dollar decreases and thus the dollar does not depreciate.

We identify this mechanism using our novel event study approach. For identification purposes, we estimate the effect of Fed funds rate shocks on the exchange rate and compare the response in countries and dates with and without FX intervention. We divided the samples based on whether countries intervened counteractingly to Fed funds rate shock. As in column (3) of Section 2.2, counteracting intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US dollar at least once and never buy the US dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases.

Our baseline specification follows the local projection method by Jordà (2005). We estimate the following equation:

$$\log(e_{c,t+k}) - \log(e_{c,t-1}) = \alpha + \beta_k FFR_t + \delta_1 i_{c,m-1} + \gamma_c + \epsilon_{c,t}. \tag{1}$$

$e_{c,t+k}$ is the spot exchange rate between country c's local currency and the US dollar. An increase in e represents appreciation of US dollar or depreciation of local currency. t is the FOMC announcement date and $t+k$ is the date before or after the FOMC announcement ($-4 \leq k \leq 4$). The left-hand side captures the change in the log of exchange rate from the end of date $t-1$ to $t+k$. FFR_t is the Fed funds rate shock estimated by Nakamura and Steinsson (2018a). The Fed funds rate shock is defined as the unexpected change in Fed funds futures around the FOMC announcement. FFR_t is in terms of basis points and higher FFR_t represents the increase in interest rate. The coefficient β_k thus captures the percentage change in the level of exchange rate comparing before and after the Fed funds rate shock when the FFR increases by one basis point.

We also controlled the policy rate $i_{c,m-1}$ in country c in the previous month $m-1$ because

not only sterilized FX intervention but also changes in policy rates can affect the exchange rate. We lagged the policy rate by one month so that the exchange rate does not affect the policy rate. We included country fixed effect γ_c to control for the average change in the exchange rate around monetary policy announcements in countries. The standard errors are double clustered at the country and date levels.

Table 4 shows the result for $k = 1$. Columns (1) to (4) show the results for country-date observations where countries do not counter-intervene against Fed funds rate shocks, while columns (5) to (8) show the corresponding results when countries counter-intervene. Column (1) shows that, if the local monetary authority does not sell US dollar, when the Fed unexpectedly hikes interest rate the domestic currency depreciates in a statistical significant manner. However, column (5) shows that, when countries intervene, the exchange rate does not depreciate significantly. Columns (2) and (6) show that this result is robust even after controlling for the policy rate.

Column (3) shows that, without intervention, countries with relatively flexible exchange rate regimes face a large depreciation (0.5% in response to 10bp surprise hike) of exchange rates compared to the sample of all countries, as they are particularly vulnerable to exchange rate turbulence. However, column (7) shows that the exchange rate does not depreciate if these countries intervene. Finally, since most of our sample consists of emerging economies (except Australia and Japan), columns (4) and (8) restrict the sample to emerging economies and obtain a similar result. These results suggest that FX intervention is successful in stabilizing the exchange rates against unexpected US monetary tightening shocks.

Figure 2 shows the estimates of β_k in equation 1 over the time horizon $-4 \leq k \leq 4$. We used the sample of all countries and controlled for the policy rate, corresponding to column (2) of Table 4. Panels (a) and (b) use the country-date observations without and with counter-intervention, respectively. We see the persistent effect of both Fed funds rate shock and FX intervention. When the Fed hikes, if central banks do not counteract by selling US dollar, the domestic exchange rate depreciates against the dollar persistently. In contrast, if the central bank intervenes, the exchange rate does not depreciate after the tightening.

We then test whether the difference in responses of exchange rates in countries with and without FX intervention is statistically significant. We run the following regression:

$$\log(e_{c,t+1}) - \log(e_{c,t-1}) = \alpha + \beta_0 FFR_t + \beta_1 (FFR_t \times FXI_{c,t})$$

$$+ \delta_1 i_{c,m-1} + \gamma_c + \epsilon_{c,t}, \tag{2}$$

where $FXI_{c,t}$ is the dummy variable that takes one if a country c counter-intervenes and zero otherwise (see Section 2.2 for definition of counter-intervention). Coefficient β_0 measures the percentage change in the exchange rate when the Fed funds rate increases by one basis point in countries without counter-intervention. β_1 measures the percentage point difference in exchange rate changes when central banks counter-intervene against Fed hikes, compared to the scenario where central banks do not counter-intervene.

Table 5 shows the result. Column (1) shows that, without intervention, a 10bp increase in Fed funds rate leads to 0.34% increase in exchange rate. However, if countries intervene, the depreciation of the exchange rate is smaller by 0.77 percentage points compared to countries that do not intervene. This result is robust even after controlling for the policy rate (column 2), restricting our sample to countries with flexible exchange rate regimes (column 3) or emerging economies (column 4). This result suggests the large differences in exchange rate responses to US monetary shocks when countries intervene and do not intervene counteractingly in the FX market.

Finally, we implement a difference-in-difference estimation. We let the countries with FX intervention be treatment group and those without intervention control group and compare the response of exchange rates before versus after the FOMC announcements. We run the following regression:

$$\log(e_{c,t+k}) = \beta_k (FFR_t \times FXI_{c,t}) + \delta i_{c,m-1} + \gamma_{c,t} + \gamma_k + \epsilon_{c,t}. \tag{3}$$

t is the FOMC announcement date and k is the days before and after the announcement date ($-4 \leq k \leq 4$). $e_{c,t+k}$ is the spot exchange rate in country c on date $t + k$. The coefficient β_{t+k} measures the percentage point difference in the response of exchange rates to a one basis point increase in Fed funds rate in countries with counter-intervention, compared to those without counter-intervention. The country times event date fixed effect $\gamma_{c,t}$ captures the time-variant country-specific characteristics and the time fixed effect γ_k for k days before and after the event captures the trend of the exchange rate around the event. The standard errors are clustered at the country level to account for serial correlation between observations in the same country.

Figure 3 shows the average treatment effect of Fed funds rate shock on the exchange rate. We find that, when the Fed funds rate increases, the exchange rate depreciates less in countries

with counter-intervention compared to those without intervention. The effect of intervention is strong from the event date ($k = 0$) to the two periods after the event.

The overall result in this section suggests that, without FX intervention, US monetary tightening shock leads to depreciation in local currency. However, if central banks counteract against the Fed hikes by selling US dollar, the exchange rate does not depreciate. Our result suggests that FX intervention can successfully stabilize the exchange rate following unexpected US monetary shocks.

3.2 Stock Market

We next study the effect of FX intervention on the stock market. First, we study the effect on aggregate stock market index. Next, we take into account firm heterogeneity to study what drives the responses of stock market index. We use firm-level stock prices and study their responses across firms with different characteristics.

To study the effect on stock market index, we estimate the following equation:

$$\log(m_{c,t+k}) - \log(m_{c,t-1}) = \alpha + \beta_k FFR_t + \delta_1 i_{c,m-1} + \gamma_c + \epsilon_{c,t}. \tag{4}$$

$m_{c,t+k}$ is the stock market index between country c's local currency and the US dollar. The stock market index is denominated in the local currency. t is the FOMC announcement date and $t + k$ is the date before or after the FOMC announcement ($-4 \leq k \leq 4$). The left-hand side captures the change in the log of stock market index from the end of date $t - 1$ to $t + k$. The coefficient β_k thus captures the percentage change in the stock market index comparing before and after the Fed funds rate shock when the FFR increases by one basis point. Other notations are similar to Equation (1).

Table 6 shows the result for $k = 1$. Columns (1) to (4) show the results for country-date observations where countries do not counter-intervene against Fed funds rate shocks, while columns (5) to (8) show the corresponding results when countries counter-intervene. Column (1) shows that, if central banks do not counteract against the Fed by selling the US dollar, the Fed funds rate hike reduces the stock market index in a statistically significant manner. However, if countries intervene, the stock market index does not reduce significantly. This result is robust after controlling the policy rate (columns 2 and 6), restricting the sample to countries with flexible exchange rate regimes (columns 3 and 7) or emerging economies (columns 4 and 8).

Figure 4 plots the estimates of β_k over the time horizon $-4 \leq k \leq 4$. Panel (a) and (b) shows the results for countries without and with counter-intervention, respectively. As in column (2) of Table 6, we used the sample of all countries and controlled for the policy rate. When the Fed funds rate increases, if central banks do not counteract by selling the US dollar, the stock market index decreases persistently. However, if central banks counteract, we do not observe a significant decrease in the stock market index.

We then study what potentially drives these responses of stock market index. One of the important channels is driven by firms with debt denominated in US dollars as they are particularly vulnerable to exchange rate fluctuations. Empirical evidences suggest that non-US firms borrow in US dollars to finance their investment (Maggiori et al. 2020, Gopinath and Stein 2021, Salomao and Varela 2022, Casas et al. 2022). We hypothesize that firms with dollar debt benefit from FX intervention. If firms issue dollar debt but do not have the corresponding revenue in dollars, they face the currency mismatch on balance sheet. If countries do not counter-intervene against Fed hikes by selling the US dollars, the debt repayment in local currency increases and firms with dollar debt are harmed. However, if central banks counter-intervene, they can mitigate the appreciation of dollar benefiting firms with US dollar debt disproportionately more.

To test this channel, we estimate the following local projection equation:

$$\log(p_{i,t+k}) - \log(p_{i,t-1}) = \alpha + \beta_k FFR_t + \delta_1 Z_{i,y-1} + \delta_2 i_{c,m-1} + \gamma_i + \epsilon_{i,t}. \tag{5}$$

p is the stock price of firm i at the end of date t. The stock price is denominated in local currency. The dependent variable is the change in the logarithm of stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date and $t+k$ is the date before or after the FOMC announcement ($-4 \leq k \leq 4$). The coefficient β_k captures the percentage change in stock price when the Fed funds rate increases by one basis point. $Z_{i,y-1}$ is the set of annual control variables, including the export intensity (the ratio of export over total sales), import content of production, firm size (measured by total asset denominated in local currency), liquidity-to-asset ratio, and firm age. We control for exports and imports as they can affect firms' foreign currency revenue and cost, and also control for size, liquidity, and age since they can drive the heterogeneous response of firms to monetary shocks. We also include the interaction terms between the Fed funds rate shock and these controls to capture the heterogeneous response. We take the lagged controls (except for firm age) so that the Fed funds shock does not affect the stock prices via changes in

export, import, firm size, and liquidity.[16] $i_{c,m-1}$ is the policy rate in country c where the firm i belongs. We included a firm fixed effect γ_i to control for the average firm response around FOMC announcements. The standard error is double clustered at the firm and date levels. We estimate this equation separately for firms with and without dollar debt and countries with and without counteracting FX intervention (we follow the same definition of counter-intervention as Section 3.1).

Table 7 shows the result for $k = 1$. Columns (1) and (2) show the results for countries without counter-intervention and firms with and without dollar debt, respectively. We find that, if central banks do not counter-intervene against the Fed, a one basis point increase in Fed funds rate leads to larger decline in stock price (column 1) for firms with dollar debt than those without dollar debt (column 2). Columns (3) and (4) use the country-date observations with counter-intervention. If central banks counter-intervene against the Fed, stock price for firms with dollar debt does not decrease (column 3). On the other hand, the effect on firms without dollar debt is limited (column 4). These results are consistent with our hypothesis that FX intervention disproportionately benefits firms with dollar debt.

Figures 5 and 6 show the estimates of equation 5 for different time horizons over $-4 \leq k \leq 4$ in countries without and with counter-intervention, respectively. In both figures, panels (a) and (b) show the results for firms with and without dollar debt, respectively. We used sample firms in all countries and included the set of controls, corresponding to column (2) of Table 7.

Figure 5 shows that, if central banks do not counter-intervene against the Fed, an increase in Fed funds rate decreases the stock price of firms with dollar debt (panel a) but does not decrease that of firms without dollar debt (panel b). In contrast, Figure 6 shows that, if central banks counter-intervene against the Fed, there is little evidence that stock price decreases, regardless of whether firms have dollar debt (panel a) or do not have dollar debt (panel b). The FX intervention again benefits firms with dollar debt.

We then test the difference in responses of stock price to Fed funds rate shock for firms with and without dollar debt. We run the following regression:

$$\log(p_{i,t+1}) - \log(p_{i,t-1}) = \alpha + z\beta_0 dollardebt_{i,y-1} + \beta_1(FXI_{c,t} \times dollardebt_{i,y-1}) + \beta_2((1 - FXI_{c,t}) \times FFR_t \times dollardebt_{i,y-1})$$

[16] Jeenas (2019) shows that firms with fewer liquid assets reduce investment in response to contractionary monetary shocks. Cloyne et al. (2019) show that younger firms that pay no dividend are sensitive to monetary policy.

$$+ \beta_3 (FXI_{c,t} \times FFR_t \times dollardebt_{i,y-1})$$
$$+ \delta_1 Z_{i,y-1} + \delta_2 i_{c,m-1} + \gamma_i + \gamma_{c,t} + \epsilon_{i,t}. \quad (6)$$

where $dollardebt_{i,t-1}$ is the dummy variable that takes one if firm i has a positive amount of dollar debt in the previous year and zero otherwise (we will change this definition later) and $FXI_{c,t}$ is the dummy variable that takes one if a country c which firm i belongs to intervenes counteractingly and zero otherwise. We take a dollar debt in the previous year so that the Fed funds rate does not affect the issuance of dollar debt. Coefficient β_2 and β_3 measure the percentage point difference in stock price changes from date $t-1$ to $t+1$ between firms with and without dollar debt when the Fed funds rate increases by one basis point and when central banks do not counter-intervene (β_2) and counter-intervene (β_3) against the Fed, respectively. We included both the firm fixed effect γ_i to control for the firm-specific factor for stock price change and country times event date fixed effect $\gamma_{c,t}$ to control for the time-variant country-specific characteristics. Note that these fixed effects absorb both the FFR_t, the $FXI_{c,t}$, and their interaction. The standard error is clustered at the firm level.

Table 8 shows the result. Column (1) shows that, if central banks do not intervene, firms with dollar debt experience larger decline in stock price by 0.16 percentage point than those without dollar debt when the Fed funds rate increases by one percentage point. However, if central banks intervene, this difference reduces to 0.091 percentage point. Column (3) and (4) restrict the sample to emerging economies and countries with flexible exchange rate regimes. The differences in stock price decline for no intervention case are statistically significant except column (3) but those for intervention case are insignificant for all cases.

Columns (1)-(4) only considered extensive margin, that is, the differential response between firms that issue and do not issue dollar debt. In reality, the intensive margin of dollar debt is also important: conditional on issuing dollar debt, firms with larger degree of dollar debt should be affected more by US monetary tightening and FX intervention. To consider this possibility, column (5) defines $dollardebt_{i,t-1}$ as the percentage share of dollar debt over total debt instead of dollar debt dummy. We standardized the share of dollar debt so that the coefficient β_1 measures the difference in stock price changes to the one basis point hike in Fed funds rate when the share of dollar debt increases by one standard deviation. We find that, when firms' dollar debt is higher by one standard deviation, a one percentage point surprise hike in the Fed Funds Rate leads to larger decline in stock price by 0.037 percentage point. However, if

central bank intervenes, the Fed funds rate shock has little significant effect on the stock price of dollar borrowers. This suggests that firms with larger share of dollar debt over total debt are significantly more negatively affected by the Fed funds hike but they also benefits more from FX intervention.

Finally, we implement a difference-in-difference estimation. We let the firms with dollar debt be the treatment group and those without dollar debt be the control group and compare the trends of stock prices between before and after the FOMC announcement date. We estimate the following equation:

$$\log(p_{i,t+k}) = \beta_k(FFR_t \times FXI_{c,t}) + \delta i_{c,m-1} + \gamma_{c,t} + \gamma_k + \epsilon_{i,t}. \tag{7}$$

t is the FOMC announcement date and k is the days before and after the announcement date ($-4 \leq k \leq 4$). $p_{i,t+k}$ is the stock price of firm i on date $t+k$. The coefficient β_{t+k} measures the percentage point difference in the response of stock prices from date $t-1$ to $t+k$ to a one basis point increase in Fed funds rate comparing firms with and without dollar debt. The country times event date fixed effect $\gamma_{c,t}$ captures the time-variant country-specific factor for stock price and the time fixed effect γ_k for k days before and after the event captures the trend of stock price around the event. The standard errors are double clustered at the firm and date levels.

Figure 7 shows the average treatment effect of Fed funds rate on the stock price. Panel (a) shows that, without intervention, when the Fed funds rate increases by 1 basis point, the stock price of firms with dollar debt declines by around 0.6 percentage point at the trough compared to the firms without dollar debt. In contrast, panel (b) shows that, if central banks intervene, the stock price for firms with dollar debt does not decrease significantly compared to the firms without dollar debt. This result is consistent with our hypothesis that FX intervention is beneficial for firms with dollar debt because it mitigates the exchange rate depreciation caused by unexpected US monetary tightening.

4 Robustness Checks and Additional Exercises

4.1 Debt Maturity

Our main analysis on FX intervention and stock market focuses on currency denomination of debt: whether firms borrow in US dollars or not. Another important source of firm heterogeneity

is the maturity of debt. We hypothesize that FX intervention that counteracts against the Fed hikes especially benefits firms with outstanding debt that matures shortly after the US monetary tightening. Firms choose whether to roll over debt or stop borrowing when the debt comes to maturity. If the debt maturity is shortly after the US tightening, the borrowing cost increases and it is difficult for firms to roll over debt. The counter-intervention prevents this increase in funding cost and allows firms to continue borrowing. The debt maturity structure is important for identification purpose: since the debt maturity is exogenous to exchange rate shocks, the effect of debt repayment on stock price can be potentially interpreted causally.

To test this hypothesis, we divide the dollar debt into maturing and non-maturing dollar debt. We define maturing dollar debt as the one whose maturity comes before one quarter after the FOMC announcement date and non-maturing dollar debt the one whose maturity comes after one quarter after the announcement. We estimate the difference-in-difference equation 7 separately for firms with maturing and non-maturing dollar debt and in countries with and without counter-intervention.

Figure 8, panels (a) and (b) show the results without counter-intervention. In panel (a), the treatment group is the firms with maturing dollar debt and in panel (b), the treatment group is those with non-maturing dollar debt. The control group is the firms without dollar debt in both panels. We learn that, when the Fed funds increases, firms with maturing dollar debt experience a larger decline in stock price than those with non-maturing dollar debt. When the Fed funds rate increases by one basis point, the firms with maturing dollar debt experience 0.61 percentage point decline in stock price at the trough (date $t + 3$) relative to those without dollar debt. Firms with non-maturing dollar debt experience a 0.43 percentage point decline on the same date. Panels (c) and (d) show the corresponding results with counter-intervention. When the central banks intervene, Fed funds rate shock has little effect on stock price of firms with both maturing dollar debt (panel c) and non-maturing dollar debt (panel d) relative to the firms without dollar debt.

Overall, we find that the intervention that counteracts against the Fed benefits the firms with debt that matures shortly after the US monetary tightening: their stock price decreases by a large degree without intervention but does not decrease with intervention.

4.2 Controlling for International Sales and Asset Holdings

The baseline regressions of stock prices in Section 3.2 control for export and import because they affect firms' foreign currency revenue and cost. Other factors that could potentially affect firms' foreign currency revenue include international sales and international asset, as firms with international sales or asset may benefit from domestic currency depreciation. This section shows that our baseline result is robust even after controlling for these factors. The firm-level, annual data on international sales and asset are available on Worldscope. We reproduced Figures 5 and 6 after controlling for the international sales over total sales ratio, the international asset over total asset ratio, and their interaction with Fed funds rate shocks.

Figure 9 and 10 estimate Equation 5 with additional controls and show the results for countries without and with counter-intervention, respectively. The results are qualitatively similar to the one in Figures 5 and 6. In both figures, panels (a) and (b) show the results for firms with and without dollar debt, respectively. Figure 9 shows that, when the Fed hikes, if central banks do not counter-intervene against the Fed, stock price of firms with dollar debt decreases (panel a) but the stock price of firms without dollar debt does not decrease (panel b). In contrast, Figure 10 shows that, if central banks counter-intervene, Fed hikes do not have large effects on stock price, regardless of whether firms have dollar debt (panel a) or do not have dollar debt (panel b). Hence, firms with dollar debt disproportionately benefit from FX intervention.

4.3 Alternative Definition for FX Intervention

This section uses an alternative definition for FX intervention and test if the main results on exchange rate and stock price survive. Throughout the paper, our main focus is counteracting intervention: when the Fed funds rate increases, central banks can offset the exchange rate depreciation by selling US dollar and buying local currency. Section 3 defines counteracting intervention as follows: if the Fed funds rate increases, central banks sell the US dollar at least once and never buy the US dollar between dates t and $t+5$, where t is the FOMC announcement date, and vice versa when the Fed funds rate decreases. We use an alternative definition for counteracting intervention: the central banks' average net purchase of US dollar between dates t and $t+5$ is negative when the Fed funds rate increases at date t, and vice versa when the Fed funds rate decreases.

Our results on exchange rate and stock price using this alternative definition for counter-intervention are qualitatively similar to the results with benchmark definition in Section 3. Figure 11 estimates Equation (1) under the new definition. Panels (a) and (b) show the results without and with counter-intervention, respectively. When the Fed hikes, if central banks do not counter-intervene by selling US dollar, the domestic exchange rate depreciates against the dollar (panel a). In contrast, if central banks counter-intervene, the exchange rate does not depreciate (panel b). This implies that counter-intervention can mitigate exchange rate depreciation due to Fed's tightening. Next, Figures 12 and 13 estimates Equation (5) under the alternative definition and show the results for countries without and with counter-intervention, respectively. In both figures, panels (a) and (b) show the results for firms with and without dollar debt, respectively. Figure 12 shows that, when the Fed tightens, if central banks do not counteract by selling US dollar, stock price of firms with dollar debt decreases (panel a) but that of firms without dollar debt does not decrease (panel b). In contrast, Figure 13 shows that, if central banks counter-intervene, the effect of Fed hikes on stock price is weak, regardless of whether firms have (panel a) or do not have dollar debt (panel b). Hence, counter-intervention disproportionately benefits firms with dollar debt compared to those without dollar debt.

5 Conclusion

This paper develops a novel event-study methodology to identify the causal effect of FX intervention. We use a cleanly identified high-frequency US monetary shock and study the response comparing countries with and without intervention. We show that, if central banks do not counter-intervene against the Fed funds hikes by selling the US dollar, the domestic currency depreciates against the dollar and funds rate depreciates the exchange rate and reduces the stock price of firms with dollar debt. However, if central banks intervene, the exchange rate does not depreciate and the stock price does not decrease. Our results suggest that FX intervention is successful in stabilizing both the exchange rate and the stock market, especially for firms that are exposed to global financial cycle.

In future research, it would be interesting to study the macroeconomic implications of FX intervention. This would require a counterfactual exercise using a full-fledged general equilibrium framework. For example, Gabaix and Maggiori (2015) show that the intervention is effective when the international financial market is imperfect. Based on their framework,

we could introduce firms with dollar debt as well as export and import. Then, we would also be able to study issues including the interaction between monetary and exchange rate policies, the relationship between intervention and invoicing currency of exports and imports (producer currency, local currency, or dollar pricing), and cooperative and non-cooperative interventions.

Appendix

A Data Construction

This section provides the data definition and cleaning procedure. the firm-level data on fundamentals and balance sheet, the data definition and cleaning procedure follow the standard literature on monetary policy and corporate balance sheet risk, for example Ottonello and Winberry (2020). The cleaning procedure of Capital IQ data follows Kim et al. (2020).

A.1 Data Definition

- *Leverage:* the ratio of total debt over total asset.
- *Share of Dollar debt:* the ratio of total due amount of Dollar debt (the sum of due amounts of debt instruments whose repayment currency is U.S. Dollar) over the total due amount of debt denominated in all currencies.
- *Size:* the total asset which is denominated in local currency and deflated by consumer price index (CPI).
- *Liquidity:* the ratio of cash and short-term investments over total asset.
- *Age:* years after the incorporation date.
- *Export intensity:* the ratio of export over total sales.
- *Import content of production:* the imports content of exports, defined as the contribution of imports for the production of goods and services.

A.2 Data Cleaning Procedure

We only use data of publicly listed firms as the data on stock price is available. The sample only includes ultimate corporate parents which are headquartered in each country. Moreover, the sample excludes the following:

- Firm-year observations which do not report balance sheet information.
- Firm-year observations which do not report the currency composition of debt.

- Each control, including total asset, principal due, tangible asset, liquidity, and long-term investment, belongs to top or bottom 1% in each country.
- Leverage belongs to top 1% in each country.
- Financial firms (SIC industry code: 6000-6999).
- Government institution.
- Firm-year observations in which the sum of cash and cash equivalents and tangible assets is greater than the total asset.
- Firm-year observations in which the difference between the total asset and the sum of total liability and equity is greater than 10,000 U.S. Dollar.
- Firm-year observations in which the difference between the sum of principal dues of all individual debt instruments, which is available in the detailed financial statement, and the total principal due of debt, which is available in the main financial statement, is greater than 100,000 U.S. Dollar.
- Firm-year observations in which the sum of due amounts of Dollar debt in the detailed financial statement is greater than the total due amounts in the main financial statement.

References

Adler, G., Chang., K.S., Mano., R.C., Shao, Y., 2021. Foreign exchange intervention: A dataset of public data and proxies. IMF Working Paper No. 21/47.

Adler, G., Lisack, N., Mano, R.C., 2019. Unveiling the effects of foreign exchange intervention: A panel approach. Emerging Markets Review 40, 100620.

Akinci, O., Queralto, A., 2019. Exchange rate dynamics and monetary spillovers with imperfect financial markets. Mimeo.

Almeida, H., Campello, M., Laranjeira, B., Weisbenner, S., et al., 2011. Corporate debt maturity and the real effects of the 2007 credit crisis. Critical Finance Review 1, 3–58.

Amador, M., Bianchi., J., Bocola., L., Perri, F., 2020. Exchange rate policies at the zero lower bound. Review of Economic Studies 87, 1605–1645.

Amiti, M., Itskhoki, O., Konings, J., 2014. Importers, exporters, and exchange rate disconnect. American Economic Review 104 (7), 1942–1978.

Aoki, K., Benigno, G., Kiyotaki, N., 2020. Monetary and financial policies in emerging markets. Mimeo.

Bu, C., Rogers, J., Wu, W., 2021. A unified measure of fed monetary policy shocks. Journal of Monetary Economics 118, 331–349.

Casas, C., Meleshchuk, S., Timmer, Y., 2022. The dominant currency financing channel of external adjustment. International Finance Discussion Paper 1343.

Cavallino, P., 2019. Capital flows and foreign exchange intervention. American Economic Journal: Macroeconomics 11 (2), 127–70.

Chamon, M., Garcia, M., Souza, L., 2017. FX interventions in brazil: A synthetic control approach. Journal of International Economics 108, 157–168.

Cloyne, J., Ferreira, C., Froemel, M., Surico, P., 2019. Monetary policy, corporate finance and investment. NBER Working Paper No. 25366.

Corsetti, G., Dedola., L., Leduc, S., 2020. Global inflation and exchange rate stabilization under a dominant currency. CEPR Discussion Paper No. 14556.

Das, S., 2019. China's evolving exchange rate regime. IMF Working Paper No. 19/50.

Duval, R., Hong, G.H., Timmer, Y., 2020. Financial frictions and the great productivity slowdown. The Review of Financial Studies 33, 475–503.

Egorov, K., Mukhin, D., 2020. Optimal policy under dollar pricing. Mimeo.

Fanelli, S., Straub, L., 2021. A theory of foreign exchange interventions. Review of Economic Studies 88 (6), 2857–2885.

Fatum, R., Hutchison, M.M., 2010. Evaluating foreign exchange market intervention: Self-selection, counterfactuals and average treatment effects. Journal of International Money and Finance 29 (3), 570–584.

de Ferra, S., Mitman, K., Romei, F., 2020. Household heterogeneity and the transmission of foreign shocks. Journal of International Economics 124, 103303.

Fratzscher, M., Gloede, O., Menkhoff, L., Sarno, L., Stöhr, T., 2020. Foreign exchange intervention: A new database. DIW Berlin Discussion Paper 1915.

Gabaix, X., Maggiori, M., 2015. International liquidity and exchange rate dynamics. Quarterly Journal of Economics 130 (3), 1369–1420.

Gali, J., Monacelli, T., 2005. Monetary policy and exchange rate volatility in a small open economy. Review of Economic Studies 72 (3), 707–734.

di Giovanni, J., Kalemli-Özcan, S., Ulu, M.F., Baskaya, Y.S., 2022. International spillovers and local credit cycles. Review of Economic Studies 89, 733–773.

Gopinath, G., Boz, E., Casas, C., Díez, F.J., Gourinchas, P.O., Plagborg-Møller, M., 2020. Dominant currency paradigm. American Economic Review 110 (3), 677–719.

Gopinath, G., Stein, J.C., 2021. Banking, trade. and the making of a dominant currency. Quarterly Journal of Economics 136 (2), 783–830.

Gorodnichenko, Y., Weber, M., 2016. Are sticky prices costly? evidence from the stock market. American Economic Review 106 (1), 165–99.

Guo, X., Ottonello, P., Perez, D.J., 2020. Monetary policy and redistribution in open economies. NBER Working Paper No. 28213.

Gürkaynak, R., Sack, B., Swanson, E.T., 2005. Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. International Journal of Central Banking 1 (1), 55–93.

Ilzetzki, E., Reinhart, C.M., Rogoff, K.S., 2019. Exchange arrangements entering the twenty-first century: Which anchor will hold? Quarterly Journal of Economics 134 (2), 599–646.

Jarociński, M., Karadi, P., 2020. Deconstructing monetary policy surprises: The role of information shocks. American Economic Journal: Macroeconomics 12 (2), 1–43.

Jeanne, O., Sandri, D., 2020. Global financial cycle and liquidity management. NBER Working Paper No. 27901.

Jeenas, P., 2019. Firm balance sheet liquidity, monetary policy shocks, and investment dynamics. Mimeo.

Jordà, O., 2005. Estimation and inference of impulse responses by local projections. American Economic Review 95 (1), 161–182.

Jordan, T.J., 2017. High swiss current account surplus: Consequences for snb monetary policy? Speech at the University of Basel, Faculty of Business and Economics, Basel, Switzerland.

Kim, M., Mano, R.C., Mrkaic, M., 2020. Do FX interventions lead to higher FX debt? evidence from firm-level data. IMF Working Paper No. 20/197.

Maggiori, M., Neiman., B., Schreger, J., 2020. International currencies and capital allocation. Journal of Political Economy 128 (6), 2019–2066.

Miranda-Agrippino, S., Rey, H., 2020. U.S. monetary policy and the global financial cycle. Review of Economic Studies 87 (6), 2754–2776.

Mukhin, D., 2021. An equilibrium model of the international price system. American Economic Review 112 (2), 650–688.

Nakamura, E., Steinsson, J., 2018a. High-frequency identification of monetary non-neutrality: The information effect. Quarterly Journal of Economics 133 (3), 1283–1330.

Nakamura, E., Steinsson, J., 2018b. Identification in macroeconomics. Journal of Economic Perspectives 32 (3), 59–86.

Ottonello, P., Winberry, T., 2020. Financial heterogeneity and the investment channel of monetary policy. Econometrica 88 (6), 2473–2502.

Rey, H., 2015. Dilemma not trilemma: the global financial cycle and monetary policy independence. Technical Report. National Bureau of Economic Research.

Rodnyansky, A., 2019. (Un)competitive devaluation and firm dynamics. Mimeo.

Rosenbaum, P.R., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70 (1), 41–55.

Salomao, J., Varela, L., 2022. Exchange rate exposure and firm dynamics. Review of Economic Studies 89 (1), 481–514.

Timmer, Y., 2018. Emerging market corporate bond yields and monetary policy. Emerging Markets Review 36, 130–143.

Table 1: Summary Statistics: FFR shock, exchange rate, and stock price

	Mean	Med	S.D.	p5	p95	Obs
(1) FFR shock (basis point)	0.01	0	1.47	-2.58	3.58	136
(2) Exchange rate (% change, $\log(e_{c,t+1}) - \log(e_{c,t-1})$)	0.04	0	0.72	-1.37	1.29	876
(3) Stock price (% change, $\log(p_{i,t+1}) - \log(p_{i,t-1})$)	0.02	0	3.47	-5.60	5.70	124,589

Note: t is the FOMC announcement date. $e_{c,t+1}$ is the exchange rate in country c at date $t + 1$. Higher $e_{c,t+1}$ implies the appreciation of US Dollar or depreciation of local currency. $p_{i,t+1}$ is the stock price of firm i at date $t + 1$. The stock price is in terms of local currency. Observations are the number of FOMC announcement dates (row 1), country times FOMC announcement dates (row 2), and firm times FOMC announcement dates (row 3).

Table 2: Interventions around FOMC event dates

Country	Frequency			Ave. Net Purchese of USD		Periods
	Buy USD	Sell USD	Counter	Millions USD	% GDP ($\times 10^{-4}$)	
	(1)	(2)	(3)	(4)	(5)	(6)
Argentina	59	45	15	11	2.9	2003-2019
Australia	0	2	2	-0.7	-0.094	2000-2019
Brazil	11	1	8	19	1.2	2009-2019
Chile	6	0	4	0.01	0.0062	2008-2019
Colombia	34	2	18	5.6	2.3	2000-2019
Costa Rica	34	32	3	0.61	2.1	2006-2019
Georgia	9	12	15	0.21	2.3	2009-2019
Hong Kong	83	58	13	26	12	2000-2019
Japan	4	0	1	0.0094	0.0019	2000-2019
Mexico	0	24	7	-17	-1.6	2000-2011
Morocco	0	1	0	-6.7	-7.81	2018
Peru	72	51	26	6.6	4.7	2000-2019
Switzerland	0	0	0	-0.45	-0.094	2000-2001
Turkey	1	1	0	2.3	0.34	2002-2019
Total	313	229	112	6.8	2.9	2000-2019

Note: Columns (1) and (2) show the frequencies of buying and selling intervention. Buying intervention implies that central banks buy US Dollar at least once between date t and $t+5$, where t is the FOMC announcement date, and selling intervention is defined similarly. Column (3) shows the frequency of counter-intervention, defined so that the central bank sells US Dollar at least once and never buys US Dollar between the dates t and $t+5$ when the Fed funds rate increases at date t, and vice versa when the Fed funds rate decreases. Column (4) shows the average amount of net purchase of US Dollar between date t and $t+5$ over all FOMC announcement dates t. Column (5) shows the average ratio of net purchase of US Dollar over GDP. The positive and negative values imply buying and selling US Dollar, respectively. Column (6) shows the sample period when the data on FX intervention is available.

Table 3: Sample Firms

Country	Total	Dollar Debt	Country	Total	Dollar Debt
Argentina	34	25	Hong Kong	480	42
Australia	1190	126	Japan	2216	4
Brazil	68	21	Mexico	48	33
Chile	3	1	Morocco	28	0
Colombia	22	9	Total	4088	261

Note: The table shows the number of all firms and firms with Dollar debt in each country. For firms with Dollar debt, the table shows the number of firms which issued Dollar debt at least once during the sample period.

Table 4: Exchange Rate

	Change in exchange rate $(\log(e_{c,t+1}) - \log(e_{c,t-1}))$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FFR shock	0.0341**	0.0349**	0.0460*	0.0350**	-0.0465	-0.0546	-0.0824	-0.0517
	(0.0156)	(0.0154)	(0.0220)	(0.0151)	(0.0274)	(0.0313)	(0.0566)	(0.0318)
Observations	763	763	513	586	111	111	59	109
R-squared	0.0198	0.0230	0.0298	0.0218	0.104	0.111	0.133	0.109
Intervention	No	No	No	No	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Fixed Effects	Country	Country	Country	Country	Country	Country	Country	Country
Country	All	All	Flexible ER	Emerging	All	All	Flexible ER	Emerging

Note: The table reports the estimated β_1 coefficient from Equation (1). The dependent variable is the percentage change in spot exchange rate from date $t-1$ to $t+1$, where t is the FOMC announcement date. An increase in e implies the appreciation of US Dollar or depreciation of local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Columns (1) to (4) show the results when countries do not counter-intervene against the Fed funds rate shock and column (5) to (8) show the results when countries counter-intervene, respectively. Columns (3) and (7) report the results for countries with flexible exchange rate regimes. Columns (4) and (8) report the results for emerging market economies. We controlled for the policy rate. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The symbols *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 5: Exchange Rate: Differential Response

	Change in exchange rate $(\log(e_{c,t+1}) - \log(e_{c,t-1}))$			
	(1)	(2)	(3)	(4)
FFR shock	0.0344**	0.0369*	0.0487*	0.0296
	(0.0155)	(0.0196)	(0.0247)	(0.0204)
FFR shock × Intervention	-0.0777*	-0.0763*	-0.0994*	-0.0639*
	(0.0362)	(0.0351)	(0.0519)	(0.0344)
Observations	875	748	518	610
R-squared	0.0209	0.0234	0.0269	0.0200
Controls	No	Yes	Yes	Yes
Fixed Effects	Country	Country	Country	Country
Countries	All	All	Flexible ER	Emerging

Note: The table reports the estimated β_0 and β_1 coefficients from Equation (2). The dependent variable is the percentage change in spot exchange rate from date $t-1$ to $t+1$, where t is the FOMC announcement date. An increase in e implies the appreciation of US Dollar or depreciation of local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Columns (1) and (2) shows the results without and with controlling for the policy rate, respectively. Column (3) reports the result for countries with flexible exchange rate regimes. Column (4) reports the result for emerging market economies. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The symbols *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 6: Stock Market Index

	Change in stock market index ($\log(m_{c,t+1}) - \log(m_{c,t-1})$)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FFR shock	-0.140**	-0.141**	-0.168*	-0.176**	-0.108	-0.0758	-0.252	-0.0820
	(0.0570)	(0.0584)	(0.0760)	(0.0670)	(0.144)	(0.170)	(0.232)	(0.180)
Observations	646	646	488	469	81	81	47	79
R-squared	0.0296	0.0320	0.0420	0.0394	0.0299	0.0339	0.126	0.0325
Intervention	No	No	No	No	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Fixed Effects	Country	Country	Country	Country	Country	Country	Country	Country
Country	All	All	Flexible ER	Emerging	All	All	Flexible ER	Emerging

Note: The table reports the estimated β_1 coefficient from Equation (4). The dependent variable is the percentage change in stock market index from date $t-1$ to $t+1$, where t is the FOMC announcement date. The stock market index is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Columns (1) to (4) show the results when countries do not counter-intervene against the Fed funds rate shock and column (5) to (8) show the results when countries counter-intervene, respectively. Columns (3) and (7) report the results for countries with flexible exchange rate regimes. Columns (4) and (8) report the results for emerging market economies. We controlled for the policy rate. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The symbols *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 7: Stock Price

	Change in stock price $(\log(p_{i,t+1}) - \log(p_{i,t-1}))$			
	(1)	(2)	(3)	(4)
FFR shock	-0.535***	-0.111**	0.636*	0.0357
	(0.115)	(0.0518)	(0.330)	(0.222)
Observations	3058	87227	262	1420
R-squared	0.0805	0.0352	0.443	0.366
Dollar Debt	Yes	No	Yes	No
Intervention	No	No	Yes	Yes
Fixed Effects	Firm	Firm	Firm	Firm
Clusters	Firm, Date	Firm, Date	Firm, Date	Firm, Date

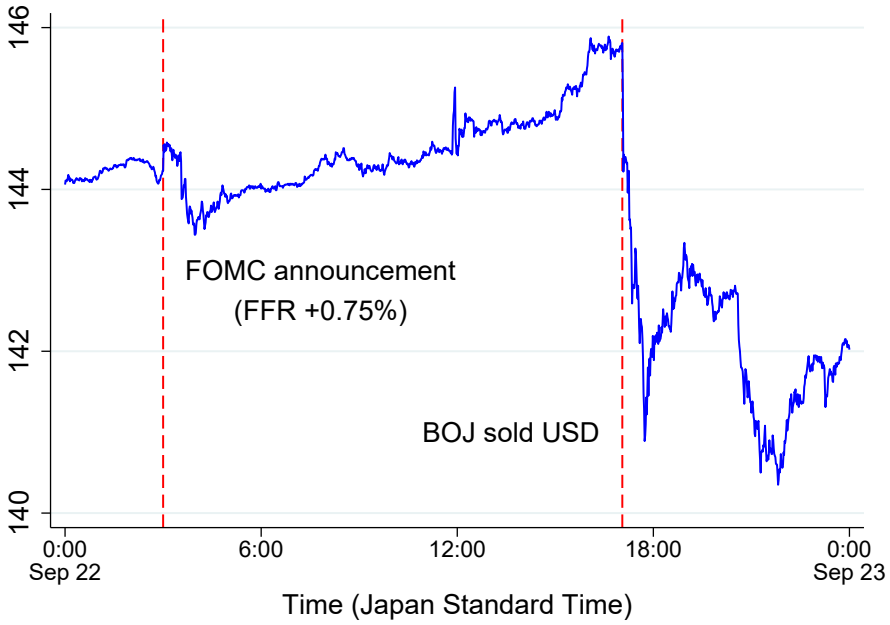
Note: The table reports the estimated β_1 coefficient from Equation (5). The dependent variable is the percentage change in stock price from date $t-1$ to $t+1$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Column (1) reports the result for firms with Dollar debt and countries without FX intervention. Column (2) reports the result for firms without Dollar debt and countries without FX intervention. Column (3) reports the result for firms with Dollar debt and countries with FX intervention. Column (4) reports the result for firms without Dollar debt and countries without FX intervention. We controlled for the export intensity, firm size (total asset), liquidity-to-asset ratio, firm age (firm-level), import content of production (sector-level), their interaction with Fed funds rate shocks, and policy rate (country-level). Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The symbols *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 8: Stock Price: Differential Response

	Change in stock price ($\log(p_{i,t+1}) - \log(p_{i,t-1})$)				
	(1)	(2)	(3)	(4)	(5)
No Intervention × FFR shock × USD Debt	-0.168***	-0.162***	-0.0233	-0.199***	-0.0377***
	(0.0470)	(0.0488)	(0.0467)	(0.0603)	(0.0116)
Intervention × FFR shock × USD Debt	-0.0911	-0.0441	-0.0528	-0.0408	0.0239
	(0.0985)	(0.112)	(0.113)	(0.116)	(0.0317)
Observations	124538	92225	9789	86283	92225
R-squared	0.0865	0.0848	0.171	0.0822	0.0849
Fixed Effects	Firm, Country × Date				
Clusters	Firm, Date	Firm, Date	Firm, Date	Firm, Date	Firm, Date
Controls	No	Yes	Yes	Yes	Yes
Countries	All	All	Emerging	Flexible ER	All
Dollar Debt Definition	Dummy	Dummy	Dummy	Dummy	Share

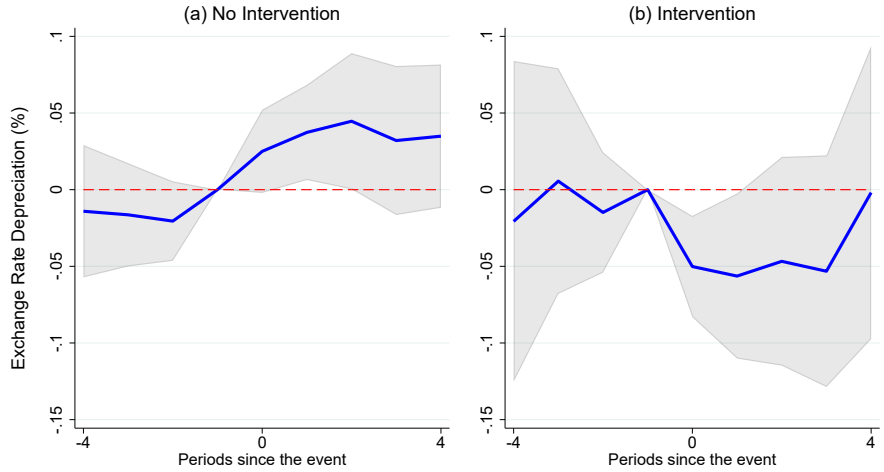
Note: The table reports the estimated β_2 and β_3 coefficients from Equation (6). The dependent variable is the percentage change in stock price from date $t-1$ to $t+1$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Columns (1) to (4) use the dummy variable that takes one if firms have Dollar debt and zero otherwise. Columns (1) and (2) show the results without and with including the controls, respectively. Column (3) reports the result for countries with flexible exchange rate regimes. Column (4) reports the result for emerging market economies. Column (5) uses the standardized share of Dollar debt over total debt. We controlled for the export intensity, firm size (total asset), liquidity-to-asset ratio, firm age (firm-level), import content of production (sector-level), their interaction with Fed funds rate shocks, and policy rate (country-level). Standard errors are in parentheses. Standard errors are clustered at the firm level. The symbols *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Figure 1: Spot Exchange Rate: US Dollar to Japanese Yen



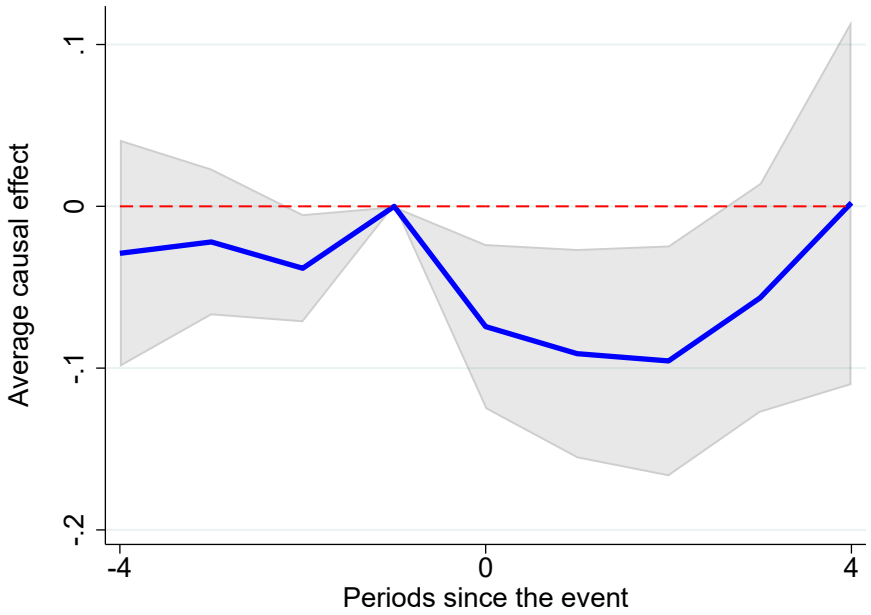
Note: The figure reports the minute-by-minute US Dollar to Japanese yen spot exchange rate on September 22, 2022. The exchange rate is defined as the value of one US Dollar in terms of yen and higher value implies the appreciation of Dollar or depreciation of Japanese yen. Source: Datastream.

Figure 2: Exchange Rate: Local Projection



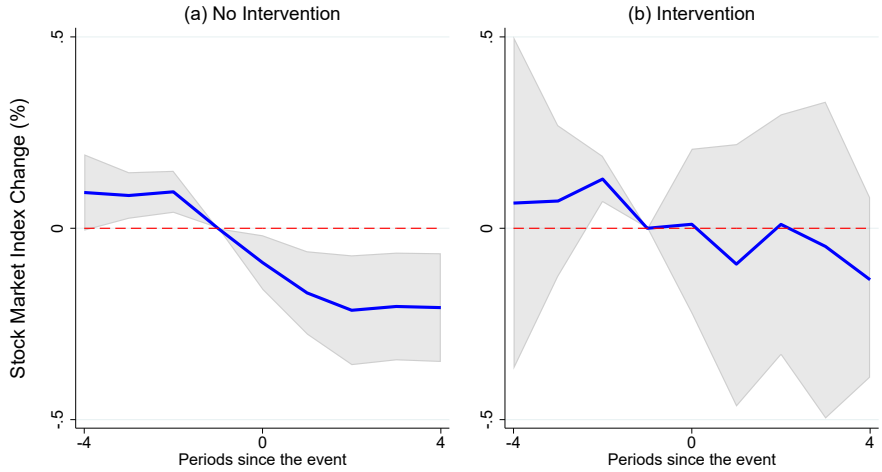
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (1). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in spot exchange rate from date $t-1$ to $t+k$, where t is the FOMC announcement date. An increase in e implies the appreciation of US Dollar or depreciation of local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Panel (a) shows the result when countries did not counter-intervene against the Fed funds rate shock and panel (b) shows the result when countries counter-intervene, respectively. We controlled for the policy rate. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The confidence interval is 90%.

Figure 3: Exchange Rate: Difference-in-Difference



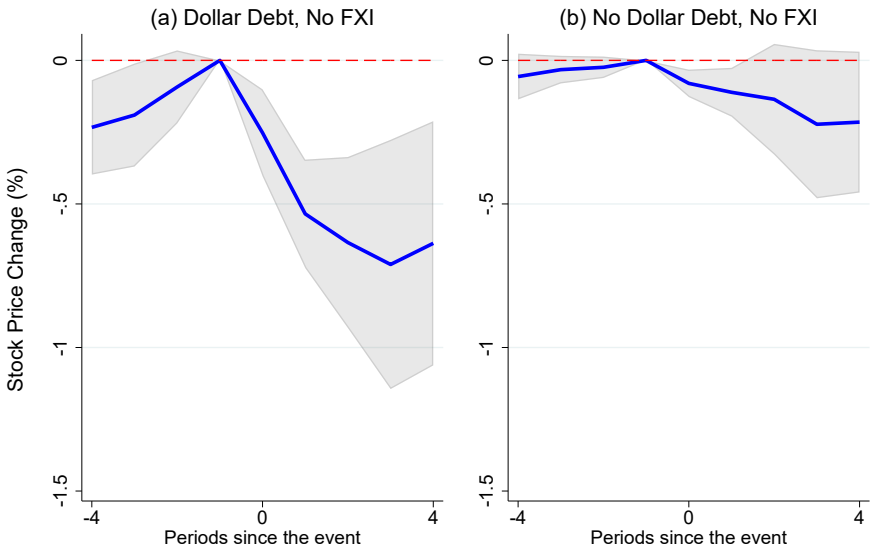
Note: The figure reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (3). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the logarithm of spot exchange rate on date $t + k$, where t is the FOMC announcement date. An increase in e implies the appreciation of US Dollar or depreciation of local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. We controlled for the policy rate. Standard errors are clustered at the country level. The confidence interval is 90%.

Figure 4: Stock Market Index: Local Projection



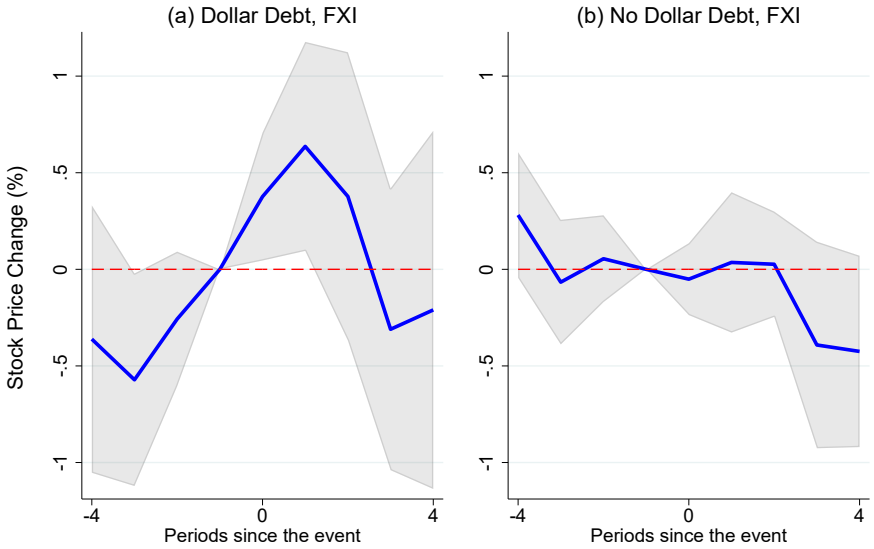
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (4). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock market index from date $t-1$ to $t+k$, where t is the FOMC announcement date. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Panel (a) shows the result when countries did not counter-intervene against the Fed funds rate shock and panel (b) shows the result when countries counter-intervene, respectively. We controlled for the policy rate. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The confidence interval is 90%.

Figure 5: Stock Price: Local Projection (No Intervention)



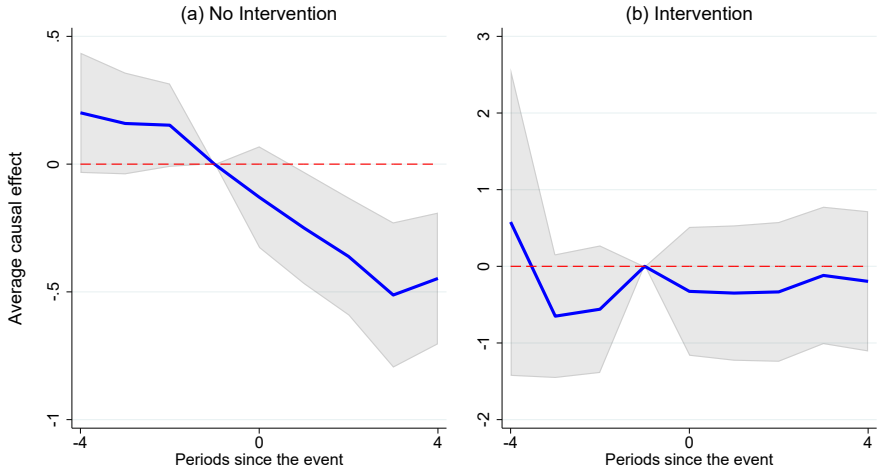
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counteracting intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries without counter-intervention and (b) firms without Dollar debt in countries without counter-intervention. We controlled for the export intensity, firm size (total asset), liquidity-to-asset ratio, firm age (firm-level), import content of production (sector-level), their interaction with Fed funds rate shocks, and policy rate (country-level). Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 6: Stock Price: Local Projection (Intervention)



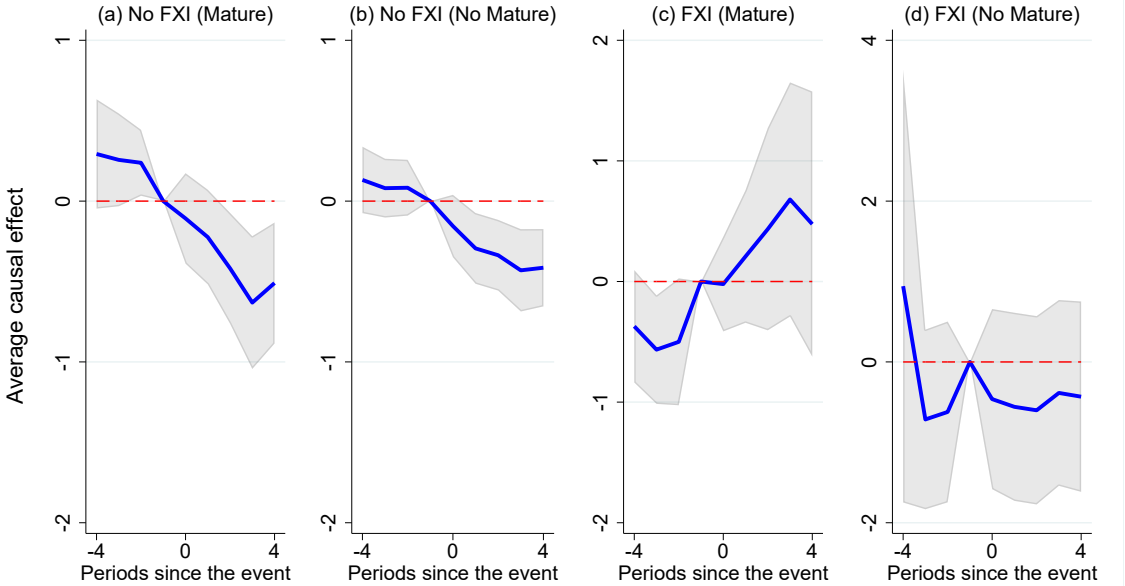
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counteracting intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries with counter-intervention, and (b) firms without Dollar debt in countries without counter-intervention. We controlled for the export intensity, import content of production, firm size (total asset), liquidity-to-asset ratio, firm age, their interaction with Fed funds rate shocks, and policy rate. Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 7: Stock Price: Difference-in-Difference



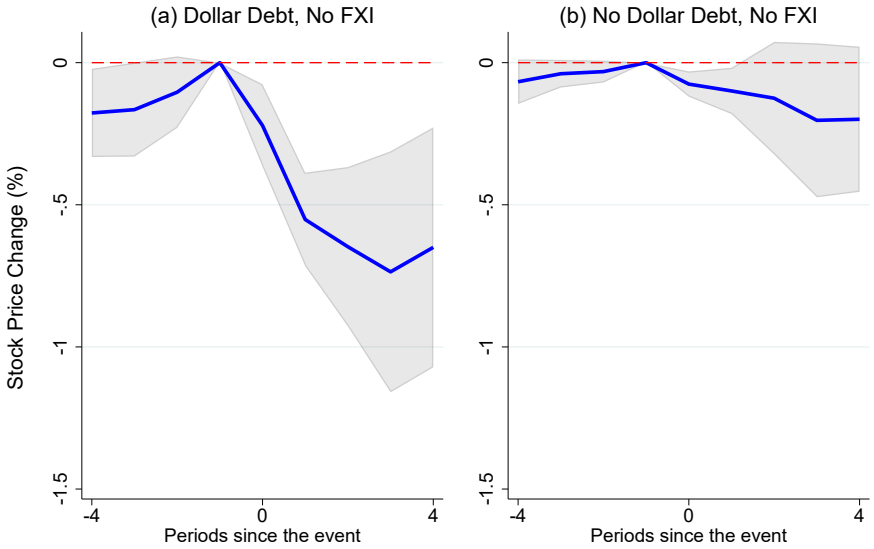
Note: The figure reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (7). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the logarithm of stock price on date $t + k$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t + 5$, and vice versa when the Fed funds rate decreases. We controlled for the policy rate. Panel (a) shows the result when countries did not counter-intervene against the Fed funds rate shock and panel (b) shows the result when countries counter-intervene, respectively. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 8: Stock Price: Difference-in-Difference (Maturing Dollar debt)



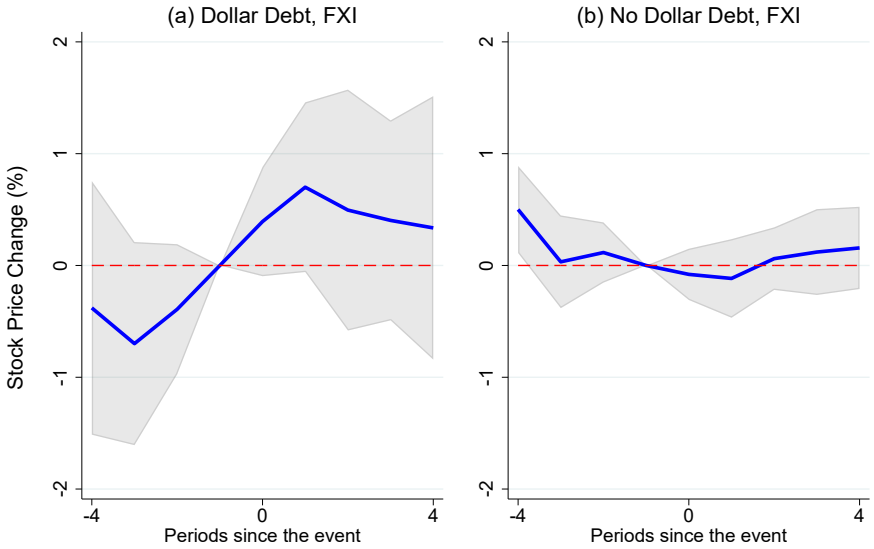
Note: The figure reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (7). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the logarithm of stock price on date $t + k$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t + 5$, and vice versa when the Fed funds rate decreases. Panels (a) and (b) show the results in countries without FX intervention and panels (c) and (d) show the results in countries with FX intervention. The treatment groups are the firms with maturing Dollar debt in panels (a) and (c) and those with non-maturing Dollar debt in panels (b) and (d) and the control groups are those without Dollar debt. We controlled for the policy rate. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 9: Stock Price: Controlling International Sales and Asset (No Intervention)



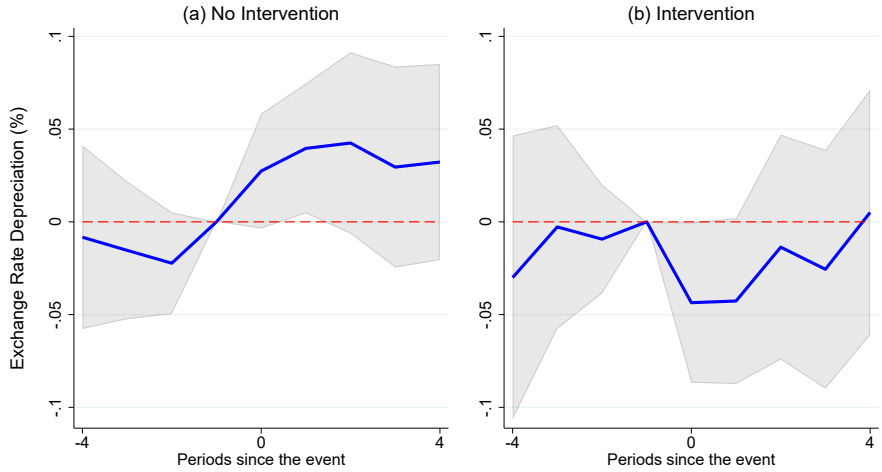
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries without counter-intervention and (b) firms without Dollar debt in countries without counter-intervention. We controlled for the export intensity, firm size (total asset), liquidity-to-asset ratio, firm age (firm-level), import content of production (sector-level), their interaction with Fed funds rate shocks, and policy rate (country-level). Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 10: Stock Price: Controlling International Sales and Asset (Intervention)



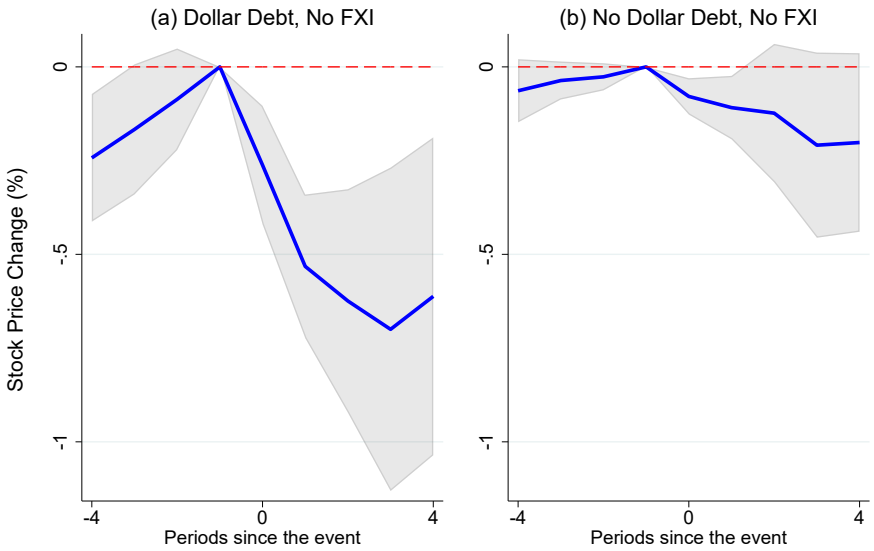
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The stock price is denominated in local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases on date t, central banks sell the US Dollar at least once and never buy the US Dollar between dates t and $t+5$, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries with counter-intervention, and (b) firms without Dollar debt in countries with counter-intervention. We controlled for the export intensity, import content of production, firm size (total asset), liquidity-to-asset ratio, firm age, international sales to total sales ratio, international asset over total asset ratio, their interaction with Fed funds rate shocks, and policy rate. Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 11: Exchange Rate: Local Projection (Alternative Definition for Counter-Intervention)



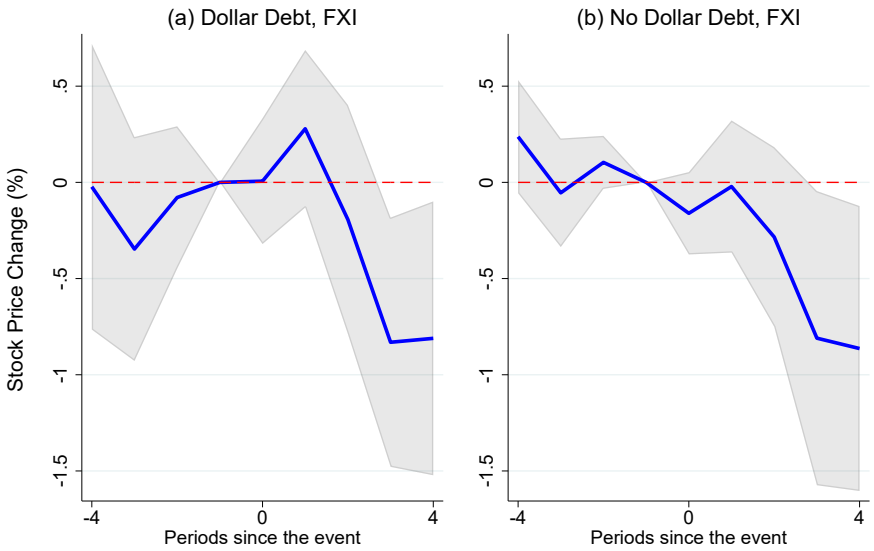
Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (1). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in spot exchange rate from date $t-1$ to $t+k$, where t is the FOMC announcement date. An increase in e implies the appreciation of US Dollar or depreciation of local currency. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counter-intervention is defined so that, if the Fed funds rate increases at date t, the central banks' average net purchase of US Dollar between dates t and $t+5$ is negative, and vice versa when the Fed funds rate decreases. Panel (a) shows the result when countries did not counter-intervene against the Fed funds rate shock and panel (b) shows the result when countries counter-intervene, respectively. We controlled for the policy rate. Standard errors are in parentheses. Standard errors are double clustered at the country and date levels. The confidence interval is 90%.

Figure 12: Stock Price: Local Projection: (Alternative Definition, No Intervention)



Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counteracting intervention is defined so that, if the Fed funds rate increases at date t, the central banks' average net sales of US Dollar between dates t and $t+5$ is positive, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries without counter-intervention and (b) firms without Dollar debt in countries without counter-intervention. We controlled for the export intensity, firm size (total asset), liquidity-to-asset ratio, firm age (firm-level), import content of production (sector-level), their interaction with Fed funds rate shocks, and policy rate (country-level). Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.

Figure 13: Stock Price: Local Projection (Alternative Definition, Intervention)



Note: The table reports the estimated β_k $(-4 \leq k \leq 4)$ coefficients from Equation (5). The coefficient β_{-1} is set zero as benchmark. The dependent variable is the percentage change in stock price from date $t-1$ to $t+k$, where t is the FOMC announcement date. The Fed funds rate shock is the unexpected change in Fed funds futures estimated by Nakamura and Steinsson (2018a). The shock is in basis points and positive shock implies the increase in Fed funds rate. Counteracting intervention is defined so that, if the Fed funds rate increases at date t, the central banks' net sales of US Dollar between dates t and $t+5$ is positive, and vice versa when the Fed funds rate decreases. Each panel shows the result for (a) firms with Dollar debt in countries with counter-intervention and (b) firms without Dollar debt in countries with counter-intervention. We controlled for the export intensity, import content of production, firm size (total asset), liquidity-to-asset ratio, firm age, their interaction with Fed funds rate shocks, and policy rate. Standard errors are in parentheses. Standard errors are double clustered at the firm and date levels. The confidence interval is 90%.