Dividend Flows and the Foreign Exchange Rate*

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Abstract

A simple dividend-based currency strategy, which shorts a currency on the date its country's recent aggregate dividend payment by listed companies is large, exhibits a significant Sharpe ratio and alpha not explained by standard FX factors. To understand this anomaly, I empirically identify the significant price impact of predetermined dividend payments on exchange rates around payment dates. I propose the dividend repatriation channel where benchmark investors (ETFs & mutual funds) predictably repatriate a certain proportion of dividends received in local currency due to the cash dividend treatment in the equity index methodology. I build a model in which heterogeneous financial intermediaries with limited risk-bearing capacity accommodate benchmark investors' currency demands stemming from dividend repatriation flows. In line with the model's implications, I find that the price impact of dividend flows on FX around the payment date is large when the intermediary capital ratio is low, the CIP deviation is large, and the FX implied volatility is high. I conclude by discussing the implications of my findings on currency market elasticity, capital regulations, and FX regimes.

Keywords: FX, dividend repatriation, benchmark investor, intermediary constraints
JEL Classifications: F3, G12, G14, G2

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1 Introduction

How do capital flows impact the foreign exchange rate (FX)? This is a central question in international finance. The answers to this question reflects how the currency market functions. More broadly, it also has important policy implications (Basu et al. 2020). Previous literature emphasizes capital flows' information content and how the information is incorporated into exchange rates (Evans and Lyons 2002, Lyons 2001). Recent developments highlights the key roles played by financial intermediaries with limited risk-bearing capacity in segmented capital markets (Camanho, Hau, and Rey 2022, Gabaix and Maggiori 2015, Itskhoki and Mukhin 2021)).

My paper provides new insights into this question via dividend flows. Dividend payments are predetermined in nature. At the company level, all dividend information is released on the dividend announcement date, including dividend amount and other dividend-related dates[1]. Aggregated up to the country/currency area level, dividend payments are informationless on the payment dates. In addition, dividend payments are recurring and frequent events, compared to other one-off events like changes in indices. These merits empower us to observe how predetermined flows can affect the foreign exchange rate and the time variation of its price impact. Though dividend flows have been used in the identification of the price impact of stock markets (Hartzmark and Solomon 2022, Schmickler 2022), they have not captured the attention of international economists yet. My paper fills this gap.

Specifically, I present new facts on how dividend flows impact the foreign exchange rate of G10 currencies. G10 currencies are ten of the most liquid and most traded currencies: Australian Australian dollar (AUD), Canada Canadian dollar (CAD), Euro (EUR),[2] Japan Japanese yen (JPY), New Zealand dollar (NZD), Norwegian krone (NOK), United Kingdom Pound (GBP), Swedish krona (SEK), Swiss franc (CHF), United States dollar (USD). [3] G10 is an ideal empirical setting for identifying the price impact of dividend flows on FX

[1]Other dividend-related dates include record date, ex-date, and payment date. The record date is the date on which registered shareholders in the company's book will be entitled to receive dividends. The ex-date is the date on and after which shareholders who buy the stock will not receive a dividend. The payment date is when the dividend payment actually happens. Depending on the banks and brokers, there may be a lag between the payment date and when the dividend credits to the investors' account.

[2]The euro area (aka. eurozone) consists of 19 countries that use the Euro: Belgium, Germany, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Greece, Slovenia, Cyprus, Malta, Slovakia, Estonia, Latvia and Lithuania. Starting January 1, 2023, Croatia became the 20th member of the eurozone.

[3]See the definition in Article I(2) in https://www.occ.gov/news-issuances/news-releases/2014/nr-occ-2014-157e.pdf. An alternative definition of G10 includes Danish krone (DKK). I do not include DKK as it is always pegged to EUR for my sample period.

for four reasons. First, G10 countries have large stock markets. Over the sample period from 2001 to 2022, the average stock market capitalization to GDP ratio ranges from 0.36 for New Zealand to 2.14 for Switzerland. Second, other countries' ownership of each G10 country's stock market is substantial. The sample average foreign ownership ranges from 17.6% in USA to 60% in Switzerland. Third, G10 currencies have less confounding central bank direct interventions in the FX market than emerging market currencies. Fourth, G10 currencies are the most liquid currencies. In the counter-factual world without central bank interventions, the price impact of dividend flows on G10 currencies should be smaller than other currencies. In this sense, my estimates in the paper can be interpreted as a lower bound for the price impact for other currencies.

As G10 currencies are the most researched and traded currencies by market participants, one might expect flows based on predetermined dividend payments should have negligible effects. However, this is not the case. As a stimulating and motivating fact, I present a simple dividend-based currency strategy, which goes short a currency if its country's recent aggregate dividend payment is large, and close the position the next day. As a concrete example, suppose the UK has a top 5% largest aggregate dividend payment in the past two days compared to its rolling one-year history, then the strategy will sell GBP against USD, and hold the position for one day. At the high level, the strategy aims to capture the local currency's depreciation pressure shortly after its dividend payment, as the response of the foreign exchange rate to the dividend flow may be delayed in a few days. This strategy can be implemented in real time as dividend payments are known beforehand. Surprisingly, such a simple strategy has a significant Sharpe ratio and alpha that are not explained by standard FX factors, including dollar, carry, momentum, and value factors. The results are robust under different parameters and reasonable transaction cost assumptions for institutional investors.

To understand this asset pricing puzzle, I proceed to empirically identify the price impact of dividends on the foreign exchange rate. My identification strategy exploits the fact that dividends are predetermined hence informationless on payment dates. Therefore, it should not contain contemporaneous information that affects the foreign exchange rate after its announcement, specifically around the payment date. Nevertheless, there may still be confounding factors correlated with dividends that we need to control for. Omitting such confounding variables will lead to potential biases. For example, dividend payment dates are influenced by traditions and customs, and may be concentrated in months with FX seasonality for non-dividend-related reasons. Moreover, when companies make dividend decisions, they may form their belief about the state of the economy in the future, using information up to announcement dates. If the underlying state of the economy is persistent in affecting FX changes, omitting firms' beliefs may bias the estimates.

The baseline identification strategy assumes the confoundings can be captured by explicitly specified controls and two-way fixed effects. In particular, any unspecified time-varying confoundings affect all currencies in the same way. The control variables include stock market returns and FX implied volatility. This is to control for alternative channels like investors' portfolio rebalancing as in Camanho, Hau, and Rey (2022). The time fixed effect controls for the month-end/quarter-end effect, FX seasonality, the underlying state of the economy, and the spillover effect of other country's dividend payments. I focus on the payment date on which the dividends are large, as their effects on foreign exchange rates should be the most prominent. Regressing the cumulative change of the exchange rate on the large dividend dummy reveals the following pattern: upon and after its large dividend payment, the local currency depreciates against USD. In two days after the dividend payment date, the cumulative currency depreciation against USD is around 4.70 basis points. Eight days after the dividend payment date, it further depreciates to 6.48 basis points, and then it shows signs of slight reversion afterward. In contrast, the price effect before the payment date is limited.

The confoundings may have more complicated structures. Different currencies may have heterogeneous exposures to the underlying confounding factors (e.g., commodity prices may affect different currencies differently.) To address the identification challenges, I develop an alternative identification strategy using the idea of synthetic control (Abadie (2021)) over multiple large dividend payment events. On a particular event date, the treated currency is the currency that has a large dividend payment, while the control group currencies are ones that do not have large dividend payments during the event window around the event date. I find a linear combination of control group currency called the synthetic control that best tracks the movement of the treated during the estimation window before the event window. The identification assumption is that if the treated currency did not have a large dividend event, its FX movement over the event window would be similar to the synthetic control. Therefore, by comparing the movement of the FX movement of the treated versus the synthetic control, we can identify the price impact of the dividend payment on the foreign exchange rates. In addition, the synthetic controls absorb the common confounding factors, leading to more precise estimates and more powerful tests. The results confirm that dividends move the foreign exchange rate shortly after the payment dates, while the anticipation effect is small and insignificant.

To explain why dividends move the foreign exchange rate, I propose the dividend repatriation channel. The dividend repatriation channel is defined as some global equity investors need to repatriate dividends out of the currencies shortly after receiving them. Benchmark investors like ETFs and mutual funds have particular incentives to do so, because of the construct of equity indices. Standard equity indices do not have cash components and assume reinvestment of dividends into the index itself pro rata. To minimize the tracking errors against the indices, benchmark investors will either repatriate the dividends back to the home country and use futures to establish effective exposures, or repatriate to other countries/currency areas and reinvestment directly into the underlying stocks. In either case, a proportion of the dividends are predictably repatriated outside the country that pays out the dividends. Using detailed daily positions (including cash and underlying stocks) data from First Trust Developed Markets ex-US AlphaDEX® Fund (FDT), I show that when it receives dividends in other currencies, it repatriates back to US dollars shortly afterward.

On the other side of the currency market are the financial intermediaries. They have limited risk-bearing capacity. Therefore, they need to be compensated to accommodate the currency demand from benchmark investors. Moreover, intermediaries have different sophistication in parsing the FX implications of dividend payments and, hence have different beliefs about future exchange rates. With the presence of unsophisticated intermediaries, dividend flows by benchmark investors will have a payment date effect, despite being public information before the payment dates.

I present a model of currency demand and supply that highlights the interaction between benchmark investors and heterogeneous intermediaries. The model implies the magnitude of the payment date effect of dividend flows depends on the size of dividend flows, the proportion of unsophisticated intermediaries, and the intermediaries' risk-bearing capacity. In line with the model's implications, I find that the price impact of dividend flows on FX around the payment date is large when the intermediary capital ratio is low, the CIP deviation is large, and the implied volatility is high. I find that the price impact of dividend flows is larger when the intermediaries' risk-bearing capacity is lower, e.g., when the intermediary capital ratio is lower, the CIP deviation is larger, and the FX implied volatility is larger.

I conclude by discussing the implications of my findings on currency market elasticity, capital regulations, and FX regimes. The back-of-envelop calculation shows 8.1 billion US dollar moves G10 vis-à-vis USD by 1%. At first glance, this falls in the ballpark of existing estimates in the literature and is consistent with the recent literature on the inelastic market hypothesis pioneered by Gabaix and Koijen (2021). However, the fact that dividend flows move the foreign exchange around the payment dates is more puzzling, as the model in Gabaix and Koijen (2021) predicts that most price effect should happen on the announcement date while the price effect on the payment date should be small if agents are forward-looking. My estimates also suggest one standard deviation (3.1%) decrease from the mean (7.38%) of the intermediary capital ratio is associated with the price impact almost doubling! Regarding FX regimes, I find preliminary evidence suggesting the price impact of dividends on FX is larger in the freely floating regime compared to other regimes.

1.1 Related Literature

My paper is related to three strands of literature. First, my paper is related to the literature on capital flows and its impact on the foreign exchange rate. Maggiori (2022) provides a comprehensive review of the literature. Theoretically, Evans and Lyons (2002) presents an exchange rate model highlighting the information content of order flows. Gabaix and Maggiori (2015) provides a theory of foreign exchange determination in which capital flows drive exchange rates by altering the balance sheets of intermediaries with limited risk-bearing capacity. Itskhoki and Mukhin (2021) shows the financial shocks (i.e., noise-trader demand shock) are the only plausible shocks to explain the exchange rate dynamics. Hau and Rey (2006), Camanho, Hau, and Rey (2022) develop an equilibrium model in which exchange rates, stock prices, and capital flows are jointly determined. They highlight the portfolio rebalancing channel of global equity investors. In contrast, my paper highlights that informationless dividend flows impact FX shortly around payment dates due to the dividend repatriation channel. Empirically, as capital flows are likely to be endogenous to exchange rates and financial conditions (e.g., Bergant, Mishra, and Rajan (2022)), most papers estimate the price impact of capital flows using one-off events and focus on the announcement date effect. Hau, Massa, and Peress (2010) uses the redefinition of the MSCI Global Equity Index in 2001 and 2002, a switch of index weights from market capitalization to freely floating. They find countries with a relatively increasing equity representation have a relative currency appreciation on the announcement date of the index change. Broner et al. (2021) uses the unexpected announcement of index inclusion into local-currency sovereign debt indexes of Citigroup WGBI and JP Morgan GBI-EM, and find that index-inclusion-induced inflow leads to an appreciation of the country's currency in the two days following the announcement. However, they find no effect during the implementation period between 2 and 6 months after the announcement date. In contrast, Raddatz, Schmukler, and Williams

(2017) find that large benchmark changes (such as upgrades and downgrades of countries) are associated with abnormal returns in asset prices and exchange rates around those events, both on the announcement and effective dates of these changes. Some other papers use more frequent events to estimate the price impact. Camanho, Hau, and Rey (2022) applies granular instrumental variable (GIV) approach to funds' rebalancing flows. Aldunate et al. (2022) uses Chilean pension funds flows induced by a Chilean financial advisor' market timing recommendations. In terms of the nature of flows, the closest paper to my paper is Pandolfi and Williams (2019), which uses mechanical rebalancings induced by J.P. Morgan Government Bond Index–Emerging Markets Global Diversified (GBI-EM Global Diversified) 10% index weight cap of any single country. This feature may not be widely recognized compared to the dividend payments, the latter of which are closely watched by market participants.[4] Besides the reduced form approach, Koijen and Yogo (2020) proposes a structural form approach based on demand system of global investors.

Second, my paper is related to recent developments investigating the relationship between flows and prices, mostly in the stock markets. Gabaix and Koijen (2021) develops a theory of inelastic demand under rigid institutional investors' mandate and uses granular instrumental variables (GIV) to estimate the price elasticity of demand of the aggregate stock market is small. In their paper, the most effect happens upon the news of the flow, not when the flows actually happens. Closely related to my paper is Hartzmark and Solomon (2022). They study the effect of predetermined dividend flow on the aggregate equity market. Despite the informationless nature, the dividend flows move the stock market due to the reinvestment channel. In contrast, I highlight the dividend flow moves the foreign exchange rate due to the dividend repatriation channel. Relatedly, Schmickler (2022) find dividends generate payment date price pressure for peer stocks' in the portfolio, but not on the announcement date. Dividend flows have yet to capture the attention of international economists. The literature related to dividend repatriation mostly focuses on corporate shareholders' repatriation of foreign subsidiaries' dividends, especially when there is a repatriation tax change or one-time tax holiday (De Simone, Piotroski, and Tomy 2019, Hanlon, Lester, and Verdi 2015). My paper's focus is different, which emphasizes the dividend repatriation channel by portfolio investors[5], especially benchmarked investors like ETFs and mutual funds.

Third, my paper is related to the literature on intermediary asset pricing, where financial intermediaries with limited risk-bearing capacity play a key role in FX determination. The-

[4] Analysts at banks regularly distribute the dividend information to their clients e.g., hedge funds.

[5] Corporate shareholders' ownership of foreign subsidiaries are counted as direct investment instead of portfolio investment, according to Balance of Payments.

oretically, He and Krishnamurthy (2013) proposes a model where the marginal investor is a financial intermediary. Empirically, He, Kelly, and Manela (2017) find that shocks to the equity capital ratio of financial intermediaries have significant explanatory power for cross-sectional variation in expected returns in many asset classes, including currencies. Reitz and Umlandt (2021) further refines the intermediary capital ratio for the currency markets using the balance sheet data of the top three foreign exchange dealers. Du, Tepper, and Verdelhan (2018) find out banks' balance sheet constraint has a causal effect on asset prices, as reflected in deviations from the covered interest rate parity condition (CIP). Interpreted more generally, financial intermediaries also include arbitrage capital like proprietary desks, macro hedge funds, active investment managers, etc. Their limited risk-bearing capacity leads to limits of arbitrage, pioneered by De Long et al. (1990), Shleifer and Vishny (1997), Gromb and Vayanos (2002).

2 Data

The dividend information is from Compustat Global and the Center for Research in Security Prices (CRSP).[6] For countries other than the USA, I use Compustat Global, while I use CRSP for dividend information in the USA. The dividend information includes dividend size, announcement date, ex-date, and payment dates. I focus on cash dividends and keep common/ordinary shares. I use their primary listing information for stocks with dual-listing or multiple currencies.

G10 currency market is a 24-hour market. In contrast, stock markets in each country have operating hours locally, and databases like Compustat Global and CRSP record date information in their respective time zones. The cutoff time in the standard sources of the foreign exchange rates may not necessarily aligned with the local stock market closing time. e.g., WM/Refinitiv FX Benchmark Rates have the cut-off time at London 4pm, while Bloomberg provides three pre-fixed cut-off times.[7] Misalignment of FX cut-off time and stock market closing time may lead to asynchronicity issues, especially in the daily frequency analysis.

To alleviate the concern of asynchronicity, I assembled a novel dataset of daily changes in foreign exchange rates of each currency, aligned with each country's local stock market

[6]Omitted dividends may not be recorded in either database. However, this does not affect the dividend-based currency strategy or the identification, as the decision to skip a dividend is announced before the payment date.

[7]BGN closes 5pm Friday EST (New York cut), BGNL closes at London 6pm (London cut) and BGNT closes at Tokyo 8pm (Tokyo cut). Both London and Tokyo cut close at 5pm EST on Friday. Some emerging market currencies have their cut-time limited to when the local market closes.

closing time. To do so, I use hourly spot exchange rate from WM/Refinitiv intraday fixing and snapshot the exchange rates at the closest hour of stock market closing time, as Table 4 shows. The WMR Intraday Spot Rate service was launched in 2001. It provides hourly spot rates from Monday 06:00 in Hong Kong/Singapore until Friday 22:00 in the UK.[8] The foreign exchange rates are quoted against US dollars using market conventions.[9] In my analysis and throughout the paper, I express all exchange rates in units of USD (or a basket of currencies) per local currency. Therefore, a negative change means local currency depreciates against USD. The sample period is from Jan 2001 to June 2023.

I construct three measures of FX change: against USD, against value-weighted G10 basket, and against equal-weighted G10 basket. In the value-weighted G10 basket for currency i, the weight of the currency pair j/i is proportional to the foreign country j's ownership of the stock market of i, proxied by data from Coordinated Portfolio Investment Survey (CPIS).

The ETF daily positions are from ETF Global, which covers ETFs listed in the US. Starting from April 2017, ETFG Data is primarily sourced directly from fund sponsors, custodians, distributors and administrators. [10] Its *Constituents* file contains actual holdings of the many ETFs at daily frequency, including cash, derivatives, and underlying. For longer time series of ETF and mutual fund quarterly holdings, I use Morningstar.

Information on cross-border flows and positions is from Balance of Payments and International Investment Position, downloaded from the International Monetary Fund (IMF). In addition to standard items related to trade and current account surplus, I focus on items related to portfolio investments[11] of different countries. It reports the dollar value of a country's ownership in other countries' assets (e.g., equity and debt securities), and the dollar value of a country's assets being owned by other countries. In the financial account, flows such as net acquisition of financial assets (i.e., the purchase of other countries' assets) and net incurrence of liabilities (i.e., assets being purchased by other countries) are reported. In the capital account, investment income from portfolio investment, including dividends and interest, is reported. The bilateral ownership information of portfolio investment comes from

[8] For more details, see https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/wm-refinitiv-methodology.pdf

[9] That is, in units of local currency per USD, except for EUR, GBP, AUD, NZD.

[10] https://wrds-www.wharton.upenn.edu/documents/1719/ETF_Global_Data_Package_-_U.S._Listed_-_2021_-_1.1.21.pdf

[11] Portfolio investment is defined as cross-border transactions and positions involving debt or equity securities, other than those included in direct investment or reserve assets. See Sixth Edition of the IMF's Balance of Payments and International Investment Position Manual (BPM6).

the Coordinated Portfolio Investment Survey (CPIS) by the IMF.

3 Stylized Facts about Dividends

In this section, I present stylized facts about dividends in G10 currency areas, showing that they are predetermined, substantial, and concentrated. In this paper, G10 countries/currency areas refer to major countries that use G10 currencies. They are: Australia (AUS), Canada (CAN), Switzerland (CHE), Euro area (EUR), United Kingdom (GBR), Japan (JPN), Norway (NOR), New Zealand (NZL), Sweden (SWE), United States (USA).

Dividends are predetermined. At the company level, there are four important dates related to dividends: the announcement date, the ex-dividend date, the record date, and the payment date. The announcement date is the date when a company announces its dividend information, including dividend amount and other dividend-related dates. The record date is the date on which registered shareholders in the company's book will be entitled to receive dividends. The ex-date is the date on and after which shareholders who buy the stock will not receive a dividend. Depending on the settlement cycle, the ex-date is typically one day before the record date. The payment date is the date when the dividend is actually paid to shareholders. I aggregate the companies' dividends to country/currency area level by payment date.

All dividend information is revealed on the dividend announcement date,[12] including dividend amount and other dividend-related dates, in all G10 countries/currency areas except Japan. For Japan, companies typically do not confirm the dividend amount before the ex-date, though the dividend guidance is usually available almost one year in advance. Therefore, on the actual payment date, the dividend is informationless. Table 2 shows the calendar days between the announcement date and the payment date for countries except Japan, and calendar days between the ex-date and the payment date for Japan. There is a big time gap - the average lead time is 58 days, with a median of 55 days. Such a time lag should be enough for the market to digest the information released on the announcement date.

Dividends are substantial. With aggregate dividend yields ranging from 2% to 5%, dividend payments are large in G10 countries. Importantly, due to large foreign ownership, dividends paid to foreign investors can be substantial.

[12]Even in rare circumstances where a company needs to skip a dividend payment, it will announce this decision on the announcement date.

In fact, data from the Balance of Payments can shed light on this. In my sample period from 2001 to 2022, Table 3 summarizes the dividends paid to foreign investors and the dividends received from foreign investments, and compares them with other flows on an annual basis, including portfolio investment flows and trade flows. Dividends to foreign investors (Column 1) is the *Debit* item of *Investment Income on Equity and Investment Fund Shares* in the Current Account, while dividends received from foreign investment (Column 2) is the *Credit* item. A country's purchase of foreign equity is shown in Column 3, *Net Acquisition of Financial Assets of Equity and Investment Fund Shares* under Portfolio Investment in the Financial Account. Foreign investors' purchase of one country's equity is recorded in Column 4, *Net Incurrence of Equity and Investment Fund Shares Liabilities*. Similarly, the portfolio investment of debt into foreign countries or by foreign countries are recorded in Columns 5 and Column 6, respectively. Column 7 shows the net export. We can see that the dividends paid to foreign investors and those received from foreign investments are comparable to portfolio investment and trade flows.

Dividends are concentrated. Dividend payments are not evenly distributed throughout the years. As Figure 1 shows, dividends can be intense in some days, weeks and months. e.g., the top 5% largest dividend payment dates contribute to a significant proportion of the total dividend payment in a year, ranging from 28% in the United States to more than 60% in Japan. Regarding months, dividend payments in the United States are concentrated in the last month of each quarter (March, June, September, December), while in Euro area, they are concentrated in May. In Japan, dividends are concentrated in June and December.

The reasons for the concentration of dividends are several. First, due to traditions and customs in a country, companies may follow a similar fiscal year calendar. For example, in Japan, most companies have fiscal year-end in March 31, following the government fiscal year calendar. Similarity in corporate fiscal calendar may lead to the concentration of dividend dates. Second, bigger companies pay larger dividends. With the company size being skewed, the dividends may be dominated by a few large companies. [13]

[13] For example, Taiwan Semiconductor Manufacturing Company Limited (TSMC) is the largest company primarily listed in the Taiwan Stock Exchange. As of 2022 year-end, its market capitalization is 379 billion New Taiwan dollars, 24% of the total stock market capitalization. Its quarterly dividend payments throughout 2022 sum up to 285 billion New Taiwan dollars, around 18% of the total dividend payment in the Taiwan stock market.

4 Dividend-Based Currency Strategy

In this section, I present a dividend-based currency strategy on G10 currencies. The strategy takes the following simple format: sell the currency if the country has large dividends in the past few days against USD and hold the position for one day. Despite its simplicity and only using dividend payment information that is publicly and ex-ante known, it has a significant Sharpe ratio and alpha not explained by standard FX factors, including carry, dollar, momentum, and value factors.

The log excess return of selling currency k against USD, and holding the position for one day is:

$$rx_{t+1}^{k} = f_t^k - s_{t+1}^k \approx -\Delta s_{t+1}^k + (i_t^{US} - i_t^k)$$

where s_t^k and f_t^k are log spot exchange rate and log 1-day forward exchange rate of currency k respectively, in terms of units of USD per local currency, i.e., currency k is the base currency. i_t^{US}, i_t^k is 1-day risk-free rate in the USA and country k, respectively. As my sample of WMR intraday hourly fixing does not contain 1-day forward exchange rate, I use $f_t^k \approx s_t^k + i_t^{US} - i_t^k$ to approximate it, where the risk-free rates are (annualized) 3-month risk-free rates divided by 365.

With transaction costs, the log excess return of selling currency k against USD, and holding the position for one day is:

$$rx_{t+1}^{k} = f_t^{k,b} - s_{t+1}^{k,a} \approx -\Delta s_{t+1}^k + (i_t^{US} - i_t^k) - TC$$

where the transaction cost (TC) is the bid-ask spread of spot exchange rates. The bid–ask spreads from WMR are based on indicative quotes. They are too large compared to actual effective spreads in FX markets (see, e.g., Lyons 2001). As G10 currencies are the most liquid currencies in FX markets, they have very tight bid-ask spreads for institutional investors, mostly a fraction of 1 basis point. Moreover, large intermediaries may collect the bid-ask spread when trading with clients or trading at close to the mid-price in interdealer markets. I present the dividend-based currency strategy not because I advocate this as a profitable strategy on its own for every investor, but because it reveals the fact that dividends move the foreign exchange rate. Therefore, I will use a constant 1 basis point as the transaction cost in the below discussion.

The dividend-based currency strategy takes the following form: for each country/currency area k and date t, if in the previous l days, the combined dividend payments in the country k rank in its top p-percentile in the rolling 1-year window, then we sell currency k against

USD, and hold the position for one day. If there are several currencies that satisfy this criterion, then each position is of \$1 size. The excess return on date t is calculated from summing across excess returns for each position.

Figure 3 shows the cumulative excess return of the currency dividend strategy in percentage points, where $l = 2, p = 5\%$, i.e., one sells a currency against USD if the combined dividend payments in the previous 2 days rank in the top 5% percentile in the rolling 1-year window of that country. Graphically, the strategy earns a decent return, both before the transaction cost (blue line) and after the transaction cost (orange line). It is also indicative that the performance of the dividend-based strategy is better after the Global Financial Crisis (GFC) than before.

Table 5 upper half shows the results are robust across different parameters of the lookback window l. The annualized returns and Sharpe ratio are statistically significant. Here, the standard errors of the Sharpe ratio are calculated using the formula in Lo (2002). Taking into account that $\approx 70\%$ days the strategy does not take any positions, the annualized return of this strategy is quite decent.

Table 5 lower half further demonstrates that the dividend-based currency strategy has alpha not explained by standard factors in the currency market. To show this, I run the following factor-spanning regression at the monthly frequency:

$$rx_t = \alpha + \beta_{DOL} DOL_t + \beta_{CAR} CAR_t + \beta_{MOM} MOM_t + \beta_{VAL} VAL_t + \epsilon_t \tag{1}$$

The rx_t are the log excess returns of dividend-based currency strategy aggregated to the monthly frequency. The dollar factor DOL_t is from Verdelhan (2018). The carry factor CAR_t is from Lustig, Roussanov, and Verdelhan (2011). The momentum factor MOM_t is from Menkhoff et al. (2012). The value factor VAL_t is from Asness, Moskowitz, and Pedersen (2013). As expected, the strategy has a significant loading on DOL_t, as when it sells a currency against USD.[14] The strategy's loadings on other factors are economically small and statistically insignificant. Importantly, the alpha is economically large and statistically significant. The monthly alpha is around 30bp. When annualized, the alpha accounts for almost all the annualized returns of the strategy.

[14]The dollar-neutral version of the dividend-based strategy is available upon request.

5 Identification

In this section, I empirically identify the price impact of dividends on exchange rates. I focus on the payment date on which the dividends are large, as their effects on foreign exchange rates should be the most prominent. The results are robust under various identification strategies.

My identification strategy exploits the fact that dividends are predetermined hence informationless on payment dates. Indeed, dividend decisions are made at the company level using information up to its announcement date. Therefore, it should not contain contemporaneous information that affects the foreign exchange rate after its announcement, specifically around the payment date.

Nevertheless, there may still be confounding factors correlated with dividends that we need to control for. Omitting such confounding variables will lead to potential biases. e.g., due to traditions and customs, dividend payments for some countries may be concentrated in certain months, as discussed in Section 3. If there is seasonality[15] in the foreign exchange rate due to non-dividend reasons, this can be confounding. In addition, dividend decisions may be correlated with the state of the economy, which is persistent. When companies make dividend decisions, they may use their beliefs about the state of the economy and their future earnings. e.g., if a company expects a crisis is coming hence would like to increase its cash buffer, it may reduce its dividend payments.

$$\ln E_{i,t+h} - \ln E_{i,t-1} = \alpha + \beta_h \mathbb{D}_{i,t} + F_{i,t}^{(h)} + \epsilon_{i,t}^{(h)} \tag{2}$$

Formally, to identify the cumulative FX effect of dividend payments at different horizons h, we need to control for the confounding factors $F_{i,t}^{(h)}$. I tackle this challenge under different identification assumptions and show robust results.

5.1 Baseline: Two-Way Fixed Effects with Controls

The baseline specification assumes the confoundings takes the following structure

$$F_{i,t}^{(h)} = Controls + \gamma_i^{(h)} + \xi_t^{(h)}$$

[15] e.g., Fei (2023) documents the dollar depreciates by 54 basis points on average in the last 10 trade days of the calendar year and appreciates by 47 basis points in the first 10 trade days of the next year. Tse (2018) documents all the G10 currency futures yield negative returns in January and returns in April are positive.

where $Controls$ are explicitly specified variables and the confounding variables that cannot be explicitly written out are absorbed by either currency fixed effect $\gamma_i^{(h)}$ or time fixed effect $\xi_t^{(h)}$. In particular, this specification assumes unspecified time-varying confoundings affect all currencies in the same way. Specifically, let $\mathbb{D}_{i,t}$ be the indicator for large dividends, i.e., $\mathbb{D}_{i,t}$ is equal to 1 if country/currency i has a top 5% largest dividend within the currency-year on the payment date t. The baseline regression is as follows:

$$\ln E_{i,t+h}^{US/LC} - \ln E_{i,t-1}^{US/LC} = \alpha_h + \beta_h \mathbb{D}_{i,t} + Controls + \gamma_i^{(h)} + \xi_t^{(h)} + \epsilon_{i,t}^{(h)}, \quad h = -10, ..., 0, ..., 10 \tag{3}$$

The left-hand side is the cumulative log change of the exchange rate of currency i against USD in basis points from date $t-1$ to $t+h$, with FX cut-off time aligned with the local stock market closing time. In the Appendix, I also use cumulative log change against value-weighted and equal-weighted G10 basket. $t=-1$ is one day before the payment date, which I normalize the cumulative change to be 0. The controls include local stock market returns and currencies' implied volatility. For the stock market returns, I use each country's primary stock index daily changes.[16] For the implied volatility, I use the 6-month at-the-money (ATM) implied volatility of each currency against USD.[17] This is to control for alternative channels like mean-variance investors' portfolio rebalancing as in Camanho, Hau, and Rey (2022). The US stock market return is absorbed by the time fixed effect (at the date level). The time fixed effect also controls for the month-end/quarter-end effect, FX seasonality (Fei 2023), and the underlying state of the economy. If the spillover effect of other country's large dividend payment on the same date is similar across currencies, then the time fixed effect also controls for it. The currency fixed effect controls for currency-specific trends throughout the sample. The standard error is clustered at the date level.

Table 6 compares the coefficients β_h estimated by the variants of Eq (3). Panel *OLS* shows the estimates without controls and fixed effects. Panel *OLS with Controls* shows the estimates controlling for stock market returns and FX implied volatility. Panel *Two-Way Fixed Effects with Controls* is the baseline regression results, which are plotted in Figure 4. They show a consistent pattern: upon and after its large dividend payment, the local currency depreciates against USD. Indeed, the cumulative currency depreciation against USD is 4.70 basis points two days after the dividend payment date. It further depreciates to 6.48 basis

[16] Specifically, S&P/ASX 200 Index (Australia), S&P/TSX Composite Index (Canada), Swiss Market Index (Switzerland), Euro Stoxx 50 (Euro area), FTSE 100 Index (United Kingdom), NIKKEI 225 (Japan), OBX STOCK Index (Norway), S&P/NZX 50 Index (New Zealand), OMX Stockholm 30 Index (Sweden), S&P 500 Index (United States).

[17] The results using other tenors of implied volatility are almost exactly the same.

points eight days after the dividend payment date, then it shows signs of slight reversion afterward. In Section 6, I argue such depreciation pressure is due to *dividend repatriation channel*, i.e., investors' predictable repatriation of dividends from the dividend currency to other currencies shortly after receiving the dividend payments. e.g., benchmark investors which track equity indices have particular incentives to do so, in order to minimize the tracking errors. Nevertheless, the response may be delayed as cash dividends may appear in an investor's account with a lag, as shown by the example in Section 6.2.

In contrast, the anticipation effect before the dividend event $t = 0$ is economically and statistically limited. The only statistically significant among the three specifications is $t = -1$ under Panel *Two-Way Fixed Effects with Controls*. As dividend payments are public information and ex-ante known, the anticipation effect may be due to some investors' pre-positioning by selling local currency in advance to take advantage of the benchmark investors' dividend repatriation. Alternatively, some investors may conduct the FX spot transaction 1 or 2 days before the dividend payment date, as the settlement date for FX spot transactions is T+2, i.e., two business days after the trade date.[18] When cash dividends in local currency appear on their cash account, they can directly use it to settle the FX spot transaction.

Figure 4 compares before and after the GFC. This figure compares the coefficients β_h estimated by Eq (3) in the subsample before and after the 2007–2008 Global Financial Crisis (GFC). I define the pre-GFC subsample as before December 2007, and the post-GFC subsample as after June 2009, inclusive.[19] As the point estimates indicate, the local currency depreciates more against USD after the country's large dividend payments in the post-GFC subsample.[20] For example, two days after a country's large dividend payment, its currency depreciates 7.4 basis points vis-à-vis USD in the post-GFC period on average, while before the financial crisis, it only depreciates 1.5 basis points. This difference in the price impact of dividends on FX between post-GFC vs pre-GFC period is consistent with the difference in the profitability of the dividend-based currency strategy as we see in Section 4. I discuss the two reasons for the increase in price impact in Section 6.4.

[18]For USDCAD spot transactions, the settlement date is T+1, one business day after the trade date.

[19]Per NBER business cycle dating, the peak of the financial crisis is December 2007, and the trough month is June 2009.

[20]The standard errors in the pre-GFC subperiod are too large to conclude the differences are statistically significant.

5.2 Alternative: Synthetic Controls

The baseline identification strategy assumes that unspecified time-varying confounding has the same effect on all currencies and hence can be absorbed by the time effect. However, different currencies may have different influencing factors over different periods of time, and the same underlying factors may affect different currencies differently. For example, the commodity price increase may benefit commodity-exporting countries' terms of trade and currencies.

To resolve this, I develop an alternative identification strategy using the idea of synthetic control (e.g., Abadie (2021)), which carefully chooses a linear combination of other currencies that aims to replicate the movements of the confoundings underlying the currency over a short period of time.

$$|F_{i,t} - \sum_j w_i F_{j,t}|$$

By taking the difference between the currency of interest and this linear combination, one can take out the unspecified confoundings in a flexible way. In addition, it also gives a more precise estimate, as taking the difference absorbs the noisy variation in the estimation.

Specifically, I define a dividend event as a currency-day pair (i_0, t_0) where the country i_0 has a top 5% largest dividend within the currency-year on the payment date t_0. Denote the event date by $t = 0$ and all days relative to it are in trading days. One concern of the discretization of dividend dummy $\mathbb{D}_{i,t}$ is that dividend payments immediately below the size threshold are classified as non-events, which may pollute the comparison of the treated and the controls. To address this concern, I incorporate a buffer in defining the control group units, i.e., the qualified controls are currencies that do not have the top 10% largest dividend payments within currency-year over the event window, from -10 days to +10 days. The results are robust to both choice of size threshold and buffers.

Among the control group currencies $\mathcal{C}$, I randomly select one p_0 as the placebo. Denote the remaining control group currencies as $\mathcal{C}'$. I find non-negative weights $\{w_i\}_{i\in\mathcal{C}'}$ that sum up to 1, and the linear combination of currencies best tracks the movement of treated currency i_0 over the estimation window [-70,-11]. In other words, the synthetic control weights are calculated from the following optimization problem:

$$\min_{\{w_i\}_{i\in\mathcal{C}'}} \sum_{t=-70}^{-11} |\Delta \ln E_{i_0,t}^{US/LC} - \sum_{i\in\mathcal{C}'} w_i \Delta \ln E_{i,t}^{US/LC}|^2 \tag{4}$$

s.t.

$$\sum_i w_i = 1, w_i \geqslant 0, \forall i \in \mathcal{C}'$$

where the foreign exchange rates are snapshots at the local stock market closing time of the treated currency i_0. With estimated weights, I compare the cumulative FX movement of the treated currency with the synthetic control over the event window [-10,10] for the dividend event (i_0, t_0), where I normalize the pre-event t=-1 to be 0. The treatment effect is as follows:

$$\Delta_h e_{i_0,t} - \sum_{i \in \mathcal{C}'} w_i \Delta_h e_{i,t}, \quad h = -10, ..., 0, ..., 10 \tag{5}$$

where $\Delta_h e_{i,t} = \ln E^{US/LC}_{i,t+h} - \ln E^{US/LC}_{i,t-1}$ is the h-day cumulative log change of the foreign exchange rate. The placebo effect for this event is calculated similarly, with the synthetic control weights optimized for the placebo itself using the same procedure as in Eq (4). The foreign exchange rates involved are cut at the local stock market closing time of the placebo currency p_0.

$$\Delta_h e_{p_0,t} - \sum_{i \in \mathcal{C}'} w_i^{(p_0)} \Delta_h e_{i,t}, \quad h = -10, ..., 0, ..., 10 \tag{6}$$

The average treatment effect (ATT) is the average of Eq (5) across all events. The standard errors are calculated from the placebo effect in Eq (6) across all events.

Figure 6 illustrates how this method works. Aug 5, 2022 is a dividend event date ($t = 0$) for the UK, as it has a large dividend payment of ≈1.9 billion GBP on this date, among which 1.1 billion is Vodafone's dividend.[21] Over the event window [-10,10] trading days, The qualified controls include AUD, CHF, EUR, JPY, NOK, NZD, SEK, as their countries do not top 10% dividend payments within currency-year over the trading days $t = -10$ to $t = +10$. As SEK is selected as the placebo randomly, the remaining control group $\mathcal{C}'$ includes AUD, CHF, EUR, JPY, NOK, NZD. Solving the optimization problem (4) gives the following best mimicking linear combination over the estimation window from $t = -70$ to $t = -11$: 15.7% AUD + 15.0% CHF + 30.6% EUR + 14.3% JPY + 9.0% NOK + 15.4% NZD. As Figure 6 shows, the synthetic control tracks the day-to-day movement of the treated currency well during the estimation window. The underlying identification assumption is that going forward into the event window, the synthetic control captures the unspecified confounding factors in a flexible way.

[21] For the financial year ending 31 March 2017 and beyond, Vodafone's dividends has been declared in euros and paid in euros, pounds sterling and US dollars. See https://investors.vodafone.com/individual-shareholders/dividends

Figure 7 Panel A shows the average treatment effect. It confirms the pattern in Section 5.1. Upon and after the country's large dividend payment dates, the local currency starts to depreciate against USD. The price effect of exchange rates before the dividend payment, i.e., the anticipation effect, is limited and statistically insignificant. In contrast, a placebo currency does not have large dividend payments during the event window. Therefore, there should be no depreciation pressure on its exchange rate. Figure 7 Panel B confirms this is indeed the case.

To ensure the results are not driven by the particular choice of linear combination of control group currencies, I also use standard difference-in-difference (DiD), which put equal weights on the control group currencies $\mathcal{C}$. The standard errors are two-way clustered at currency level and date level. Figure 8 shows a similar pattern as in the method of synthetic control, albeit with a less precise estimate.

One concern of using the synthetic control or DiD is the violation of Stable Unit Treatment Values Assumption (SUTVA) assumption. Repatriation of the treated currencies to the control group currencies may cause control group currencies to appreciate against US dollars. Moreover, different foreign exchange rates influence each other through general equilibrium forces. To address the spillover concern, I conduct regression analysis to ensure the spillover effect is small. Specifically, I run the following regression:

$$\ln E_{i,t+h}^{US/LC} - \ln E_{i,t-1}^{US/LC} = \alpha_h + \beta_h \mathbb{D}_{i,t} + \gamma_h \mathbb{D}_{-i,t} + Controls + \gamma_i^{(h)} + \epsilon_{i,t+h} \tag{7}$$

where the indicator $\mathbb{D}_{i,t} = 1$ iff country i has a large dividend payment on date t, while indicator $\mathbb{D}_{-i,t} = 1$ iff any other countries has a large dividend payment. As the date fixed effect will absorb $\mathbb{D}_{-i,t}$, I only include currency fixed effect in Eq (7). As before, the controls include stock market returns and FX implied volatility. Table A1 reports own-effect β_h and cross-effect γ_h. As we can see, β_h estimated is similar to Table 7. In the meantime, the cross-effect γ_h, i.e., other countries' dividend payment on country i's exchange rate against USD is insignificant.

As further robustness checks for identification, I also conduct the identification using panel regression controlling currency-by-year-month fixed effects, and interactive fixed effect model as in Bai (2009). See Appendix C for details. All results confirm that the foreign exchange rate depreciates shortly after the dividend payment dates, while the anticipation effect before the dividend payment date is limited.

6 Inspecting the Mechanism

In this section, I discuss the mechanism of why the foreign exchange rate depreciates after the predetermined dividend payments. I highlight the cash dividend treatment underlying most equity index methodology. To minimize the tracking errors against indices, benchmark investors like ETFs and mutual funds have incentives to repatriate a certain proportion of dividends out of the country that pays the dividends. To accommodate this currency demand stemming from dividend repatriation, financial intermediaries with limited risk-bearing capacity need to use their balance sheets and get compensated. Due to the time variation of their risk-bearing capacity, the price impact of dividend flows differs from time to time.

6.1 Treatment of Cash Dividends by Equity Indices

Equity index methodology pays particular attention to corporate actions. Related to my paper is its treatment of cash dividends. There are three kinds of returns associated with equity indices: price return, gross (total) return, and net (total) return. The price return is the change in the price index[22] level, which is the weighted average of the underlying price of constituents, without taking into account the regular cash dividends.[23] The gross return assumes the dividends are re-invested into the index itself. The net return further considers the dividend withholding tax for foreign investors, assuming the dividends are reinvested after the deduction of withholding tax. Importantly, equity indices do not have cash components. In the equity index calculation, the dividends are reinvested immediately on the ex-date.

The dividends are not only reinvested into the original stocks that pay the dividends. Instead, the dividends are reinvested to the entire portfolio pro rata.[24] [25] Formally, denote the total amount of dividends in index points divided by the index level by α. On ex-date, each share count is scaled up by a factor of $1/(1-\alpha)$. See FTSE (2023) Section 4, MSCI (2023) Section 2, and Appendix X.[26]

[22] Some index providers like FTSE Russell use the terminology *capital return* and *capital index*.

[23] A special cash dividend that is nonrecurring may affect the calculation of the price index.

[24] Note that the index weight of the stock paying the dividend changes before and after its dividend ex-date, as the ex-dividend price is lower than the cum-dividend price.

[25] For fund inflows/outflows, proportional investing assumption is common in the literature of mutual funds like Lou (2012) and Chen (2022). Following this literature, Schmickler (2022) also assumes dividend payments are reinvested pro rata. Here, I emphasize the underlying reason, i.e., the specific treatment of cash dividends by the equity index methodology.

[26] Weiner (2023) Chapter 3 provides an example showing how the dividend affects the shares count in index

For the global equity indices, the underlying stocks are not denominated in a single currency. The treatment of cash dividends in the index calculation implies dividends will be repatriated abroad. For example, suppose an index has 20% allocation in the UK and 80% outside the UK. On the ex-date of a dividend paid by a UK company in GBP, the index calculation assumes that ≈80% of the dividend will be reinvested to stocks outside the UK (hence in currencies other than GBP), converted by the spot exchange rates on the ex-date.

6.2 Dividend Repatriation by Benchmark Investors

Benchmark investors like ETFs and mutual funds have benchmark indices to track or beat. Most global equity benchmark investors' benchmark indices are net (total) return index. Passive ETFs and mutual funds aim to minimize the tracking errors against their benchmark indices. Even for the active funds, closet indexing is common (Cremers et al. 2016). As the equity index's pro rata dividend reinvestment implies dividend repatriation, benchmark investors may have particular incentives to do so.

Despite equity indices prescribing dividends to be reinvested on the ex-date,[27] investors do not receive dividends until the payment date. Between the ex-date and the payment date, dividends are accrued to investors' accounts.[28] Accrued dividends are not reinvested and are in local currency. Therefore, compared with equity index treatment, accrued dividends will lead to tracking errors due to cash drag and FX fluctuations between the ex-date and the payment date. If a fund manager chooses to reinvest dividends in exactly the same way as the underlying index methodology on the ex-date, he will need to borrow money, which incurs additional funding costs. Alternatively, he can wait until dividends are paid and then act. Depending on the institutional setup, the dividends may appear on the fund's available cash account on or shortly after the payment date.[29] Once the cash hits the account, the fund manager has incentives to act fast, as further delay may lead to further tracking errors. Regarding the exact implementation of reinvestment, the fund manager can either repatriate to other currencies and reinvest directly into the underlying stocks. Or, more commonly, he can repatriate the dividends back to the fund currency and use futures to establish effective

close file before the ex-date and index open file on the ex-date.

[27]Index methodologies prefer to assume all dividends are reinvested on the ex-date rather than incur the complications of allowing a time lag before reinvesting the declared dividends on the payment date. See FTSE (2023) Section 4.5.1.

[28]Dividend accrual is reflected in the fund NAV calculation and recorded under the receivables in the financial statement.

[29]Hartzmark and Solomon (2022) notices that cash may appear on investors' accounts even after the payment date due to institutional reasons.

exposures. Doing so is more cost-effective. In either case, a proportion of the dividends are predictably repatriated from the currency that pays the dividends and converted into other currencies.

I define the *dividend repatriation channel* as investors' predictable repatriation of dividends from the dividend currency to other currencies shortly after receiving the dividend payments. This channel differs from month-end or quarter-end rebalancing, as the timing is different, i.e., the dividend repatriation channel is in the near term. This also differs from the portfolio rebalancing due to risk-averse investors' portfolio optimization as in Camanho, Hau, and Rey (2022). In my paper, the dividend repatriation channel is due to benchmark investors' minimization of tracking errors against global equity indices. Such dividend repatriation is mechanical and hence informationless.

Figure 9 uses detailed daily positions from First Trust Developed Markets ex-US AlphaDEX® Fund (FDT) to illustrate the dividend repatriation channel. Launched in April 2011 and issued by First Trust, FDT is a passive global equity ETF tracking NASDAQ AlphaDEX Developed Markets Ex-US Index. As of December 2022, its asset under management (AUM) is 419 million USD. Despite not being large, it has relatively clean daily cash reporting in ETF Global and does not have frequent fund inflows/outflows (i.e., creation/redemption).[30] Hence, we can see clearly how the dividend repatriation channel works without confounding. Let's focus on the period from Nov 30, 2022 to Dec 9, 2022. During this period of time, there are no fund inflows or outflows, no change in underlying stock positions, and no distributions to the ETF investors. Based on FDT's portfolio holdings and the dividend payment information, the fund should receive dividend payments in JPY (grey bar) from its portfolio holdings of Japanese companies from Nov 30, 2022 (Wednesday) to Dec 2, 2022 (Friday), with the dividend payment on Dec 1, 2022 (Thursday) being the largest. In the meantime, dividends received in other currencies are negligible. The JPY dividends appeared on its JPY cash account (red line) on Dec 5, 2022 (Monday), after which the JPY cash position decreased while the USD cash position (black line) increased by a similar amount. Note that the USDJPY spot transaction follows T+2 settlement rule, i.e., the cash is delivered at time T+2 for a spot transaction done at time T. Therefore, the "sell JPY/buy USD" trade should be conducted on Dec 5, 2022 for the JPY cash position to decline on Dec 7, 2022. Such trade affects the foreign exchange rate on Dec 5, 2022 (Monday), which is two business days after the dividend payment on Dec 1, 2022 (Thursday).

[30] ETF creation/redemption can either be in-kind, in-cash, or mixed, i.e., it may contain cash components in the basket. See Koont et al. (2023).

6.3 Financial Intermediaries with Limited Risk-Bearing Capacity

Accommodating benchmark investors' currency demand are financial intermediaries. Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021) highlight financial intermediaries play a central role in FX determination. He, Kelly, and Manela (2017) and Reitz and Umlandt (2021) provides empirical evidence that financial intermediaries price FX. Importantly, financial intermediaries have limited risk-bearing capacity. Limited risk-bearing capacity may result from regulations (Du, Tepper, and Verdelhan 2018), risk management (Fang and Liu 2021), or margin constraints (Garleanu and Pedersen 2011). Sandulescu, Trojani, and Vedolin (2021) shows financial intermediaries' risk-bearing capacity explains the time variation of international SDFs. As the risk-bearing capacity is limited and the balance sheet is constrained, for financial intermediaries to accommodate the currency demand, they need to be compensated to take the other side of the market,

Financial intermediaries are heterogeneous. They have different sophistication and different beliefs. They heavily trade among themselves. According to the latest BIS Triennial Central Bank Survey (BIS 2022), 46% of global turnover of FX are among reporting dealers[31], and 22% are between reporting dealers with non-reporting banks[32]. If interpreting financial intermediaries more broadly to include arbitrage capital like hedge funds and proprietary desks, 7% of global FX turnover is between reporting dealers and hedge funds & proprietary trading firms.[33]

Unlike unexpected capital flows, in principle, dividend flows can be estimated ex-ante. This is because aggregate dividend payments are predetermined (Section 3) and a certain

[31] According to BIS (2022), reporting dealers are defined as financial institutions that participate as reporters in the Triennial Survey. These are mainly large commercial and investment banks and securities houses that (i) participate in the inter-dealer market and/or (ii) have an active business with large customers, such as large corporate firms, governments and non-reporting financial institutions; in other words, reporting dealers are institutions that actively buy and sell currency and OTC derivatives both for their own account and/or to meet customer demand.

[32] According to BIS (2022), non-reporting banks are smaller or regional commercial banks, publicly owned banks, securities firms or investment banks not directly participating as reporting dealers

[33] According to BIS (2022), hedge funds & proprietary trading firms are (i) Investment funds and various types of money managers, including commodity trading advisers (CTAs), which share (a combination of) the following characteristics: they often follow a relatively broad range of investment strategies that are not subject to borrowing and leverage restrictions, with many of them using high levels of leverage; they often have a different regulatory mandate than "institutional investors" and typically cater to sophisticated investors such as high-net-worth individuals or institutions; and they often hold long and short positions in various markets, asset classes and instruments, with frequent use of derivatives for speculative purposes. (ii) Proprietary trading firms that invest, hedge, or speculate for their own account. This category may include specialized high-frequency trading (HFT) firms that employ high-speed algorithmic trading strategies characterized by numerous frequent trades and very short holding periods.

proportion of dividends are predictably repatriated shortly after dividend payment dates by benchmark investors (Section 6.2). Nevertheless, financial intermediaries may differ in their sophistication in collecting and processing this information. Therefore, they may have different beliefs on the FX implications. The model in Section 6.4 shows that heterogeneous intermediaries with limited risk-bearing capacity that meet the dividend repatriation currency demand from benchmark investors are the underlying reason why predetermined dividend flows move the exchange rate shortly after the payment dates.

6.4 Model

In this section, I present a partial equilibrium model of FX market incorporating the key ingredients discussed above, highlighting the dividend repatriation channel.

The are two countries, the US and the UK. Denote the exchange rate E_t as units of USD per GBP, i.e., the strength of GBP. A negative change in E_t means GBP depreciates.

There are 3 period $t = 0, 1, 2$. At time 0, UK companies announce the dividend payment in GBP, with the ex-date and the payment date both at time $t = 1$.[34] Time $t = 2$ is the long-run equilibrium, where the exchange rate is expected to revert back to the steady state $\bar{E}$ on average, i.e.,

$$\mathbb{E}_1[E_2] = \bar{E}, \quad Var_1[E_2] = \sigma_E^2 \tag{8}$$

The model features a benchmark investor following the global equity index, a noise trader, and two types of financial intermediaries with limited risk-bearing capacity in the currency market.

The benchmark investor mechanically follows the equity index in order to minimize the tracking errors. The global equity index methodology prescribes the reinvestment of dividends into the entire portfolio pro rata, including both in UK and US. Upon the dividend payment from the UK in GBP at time $t = 1$, the benchmark investor repatriates a certain proportion out of the currency, i.e., dividend flow. To do so, the benchmark investor needs to sell f GBP and buy USD at time $t = 1$, where f is a constant known at time $t = 0$. The benchmark investor will not trade on $t = 0$ as the equity index composite does not change at this time.

The noise trader has a stochastic demand for currency at time $t = 1$, independent of everything. It buys η GBP and sells the equivalent amount in USD. Here, η can be either

[34] For simplicity, I combine the ex-date and the payment date together. In some countries like Switzerland, the ex-date and the payment date are only a few days apart.

positive or negative. If $\eta < 0$, it means the noise trader sells $|\eta|$ GBP and buys the equivalent amount of USD. For simplicity of notation, assume that the strength of the noise trader's currency demand is such that $Var_0[E_1] = \sigma_E^2$.[35]

The financial intermediaries are heterogeneous, with λ proportion being type A (aka. hedge funds), $1-\lambda$ proportion being type B (aka. dealers). Both types of intermediaries can trade at time 0 and 1. They are both mean-variance investors with risk aversion γ that maximize the following utility function to determine their demand for GBP at time t:[36]

$$\max_x \mathbb{E}_t^i[(E_{t+1} - E_t)x] - \frac{\gamma}{2} Var_t[(E_{t+1} - E_t)x] = \mathbb{E}_t^i[(E_{t+1} - E_t)]x - \frac{\gamma \sigma_E^2}{2} x^2$$

which gives the following demand curve for GBP for each intermediary:

$$q_t^i = \frac{1}{\gamma \sigma_E^2} \mathbb{E}_t^i[(E_{t+1} - E_t)]$$

The two types of intermediaries differ in their beliefs of expectations of the future exchange rate. Type A intermediaries have rational expectations, in the sense that their expectation of the future exchange rate is correct:

$$\mathbb{E}_t^A[E_{t+1}] = \mathbb{E}_t[E_{t+1}]$$

In particular, at $t = 0$ type A intermediaries are attentive to the dividend payments forthcoming at $t = 1$ and the associated dividend repatriation when they form their expectation of the exchange rate $\mathbb{E}_0[E_1]$. Aggregating λ measure of type A intermediaries, their demand curve for currency depends on the exchange rate today and tomorrow, as in Gabaix and Maggiori (2015), Maggiori (2022), Itskhoki and Mukhin (2021):

$$Q_t^A = \lambda q_t^A = \frac{\lambda}{\Gamma} \mathbb{E}_t(E_{t+1} - E_t) \tag{9}$$

where $\Gamma = \gamma \sigma_E^2$ represents the (inverse) risk-bearing capacity of the financial intermediary sector, with smaller Γ being the larger risk-bearing capacity. Type A intermediaries will demand more GBP if they expect GBP to appreciate against USD, which makes buying GBP and selling USD a profitable trade. On the other hand, if they expect GBP to depreciate in the future due to benchmark investor's selling at $t = 1$, they will sell GBP beforehand at

[35] As shown in the proof of Proposition 1, this requires $\Gamma \sigma_\eta = \sigma_E$.

[36] For simplicity, I assume gross interest rates in both countries are equal to 1. In this model, currencies are synonyms for bonds.

time $t = 0$.

In contrast, Type B intermediaries are less sophisticated. They do not think through the implications of dividend payments and dividend repatriation by the benchmark investor on the exchange rate at time $t = 1$. Type B intermediaries' expectation of the next period's exchange rate is always the long-run equilibrium exchange rate,

$$\mathbb{E}_t^B[E_{t+1}] = \bar{E}$$

Aggregating $1 - \lambda$ measure of Type B intermediaries, their currency demand depends on the deviation of the exchange rate at time t against the long-run equilibrium exchange rate, as in Camanho, Hau, and Rey (2022):

$$Q_t^B = (1 - \lambda) q_t^B = \frac{1 - \lambda}{\Gamma} (\bar{E} - E_t) \tag{10}$$

Given the long-run equilibrium exchange rate $\bar{E}$, type B intermediaries' demand only depends on the exchange rate today. If time $t = 0$'s exchange rate is lower than $\bar{E}$, type B intermediaries will buy GBP, even if the next period's exchange rate may be lower due to the benchmark investor's selling.

Proposition 1. *Dividend flow moves the foreign exchange rate E at the payment date, i.e., GBP depreciates on the UK dividend payment date. The price impact of the dividend flow on FX depends on the dividend flow size f, the proportion of intermediaries mix λ, and the intermediary sector's risk-bearing capacity Γ, i.e.,*

$$\mathbb{E}_0 \Delta E_1 = \mathbb{E}_0 E_1 - E_0 = -(1 - \lambda)\Gamma f \tag{11}$$

Figure 10 summarizes the model ingredients. At time $t = 0$, as the benchmark investor will not trade, the trade must happen between the two types of intermediaries. If E_0 were lower than $\mathbb{E}_0 E_1$, both types of intermediaries would buy GBP and the currency market would not be clear. Hence, for the currency market to clear, the exchange rate on the payment date should be lower than the date before. In this case, type A intermediaries sell GBP while type B intermediaries buy at date $t = 0$. If there are only type A intermediaries, i.e., $\lambda = 1$, the exchange rate E_0 will adjust to $\mathbb{E}_0[E_1]$ for there to be no trade. Therefore, to have a significant dividend payment date effect, we need some intermediaries to be type B, which do not fully understand the implications of dividend payments and dividend repatriation by the benchmark investor on the exchange rate at time $t = 1$. In fact, when $\lambda = 0$, it is equivalent to the model where the capital flow f is unexpected. In this case, the price impact of capital flow is the largest at $-\Gamma f$. The pattern identified in Section 5 that the anticipation effect is limited while the payment date effect is significant implies λ to be small. i.e., type A intermediaries should be few.[37]

From the lens of the model, There are two reasons for the increase in the price impact of dividend payments on the foreign exchange rate. On the one side, with the development of financial integration and passive investing, there is a substantial increase of foreign ownership by benchmark investors like ETFs and mutual funds, which makes the dividend repatriation channel stronger. That is to say, for the same amount of dividend payments in local currency, the dividend repatriation flows f out of this currency is larger. In fact, as Figure 11 shows, average across the other G10 countries, the market value US-domiciled ETFs' holdings as a percentage of the local stock market capitalization grows from 0.7% in 2011 to 3.2%, more than quadruple in 9 years. Meanwhile, US-domiciled mutual funds' grow from 1.93% in 2002 to 4.6% in 2011 to 6.6% in 2020. On the other side, after the 2007-2008 financial crisis, more stringent regulations on financial intermediaries have made their balance sheet constraints tighter. Financial intermediaries now need more compensation to bear the same amount of risk, i.e., Γ increase. Both forces contribute to the increase in the price impact of dividend payments as shown in Fig 5.

The model has further implications on the time variation of dividend flows' price impact on the foreign exchange rate. Taking the intermediaries mix λ as relatively stable, the price impact of dividend flows depends on on the time variation of (inverse) risk-bearing capacity parameter $\Gamma = \gamma\sigma_E^2$. The risk aversion γ can be interpreted as the balance sheet constraints of financial intermediaries, while σ_E^2 stands for the FX market volatility. When the balance sheet constraints are tight, or the market volatility is high, the risk-bearing capacity of intermediaries will be low. I use the intermediary capital ratio and the CIP deviation to proxy for the balance sheet constraints, as the intermediary capital ratio is the primitive while CIP deviation is the result. I use the currency implied volatility to proxy for the FX market volatility, as it is forward-looking. I summarize the implications of time variation of dividend impact on the foreign exchange rate in the following proposition:

Proposition 2. *The price impact of dividend flows on the foreign exchange rate is larger, if*

1. *the intermediary capital ratio is lower*

[37] As dividends payments on a particular date may be from several companies and are announced on dates, there is no single announcement date associated with a particular payment date. Nevertheless, using the same procedure as in Section 5 using dividends aggregated to announcement dates and set event date $t = 0$ to be announcement dates produces insignificant results.

2. *the CIP deviation is larger*

3. *the currency implied volatility is higher*

7 Time-Variation in the Price Impact of Dividend Flows

In this section, I empirically test three implications of the limited risk-bearing capacity of financial intermediaries. I find that the price impact of dividend flows is larger, when the intermediaries' risk-bearing capacity is lower, e.g., when the intermediary capital ratio is lower, the covered interest parity (CIP) deviation is larger, and the currency implied volatility is higher.

Consistent with the pattern established in Section 5.1, I focus on the two-day cumulative change after dividend payments in this section. The short-run effect is closer to the essence of dividend repatriation as highlighted in Section 6.2. Other horizons gives similar results, though the power of the test may decrease as the horizon increases. The main specification is similar to Eq (3), as follows:

$$\Delta_2 e_{i,t+2}^{US/LC} := \ln E_{i,t+2}^{US/LC} - \ln E_{i,t-1}^{US/LC} = \alpha + \beta DivOut_{i,t} + Controls + \gamma_i + \xi_t + \epsilon_{i,t+2} \quad (12)$$

The key variable $DivOut_{i,t}$ is country i's dividends paid out to foreign investors on date t normalized by the previous year-end local stock market capitalization. Both the numerator and denominator are in the local currency. Therefore, there is no foreign exchange rate involved in the construct of $DivOut_{i,t}$. Dividends paid out to foreign investors are calculated using total dividend payments from Compustat Global/CRSP, multiplied by the foreign ownership calculated in Appendix A. Scaling by the foreign ownership is to control for the increasing trend, as higher foreign ownership means potentially larger dividend repatriation flows f given the same amount if dividend payments. Normalization by the previous year-end local stock market capitalization makes $DivOut_{i,t}$ stationary, as both dividends and stock market capitalization have grown significantly over the past 20 years.

As Figure 2 shows, this calculation matches the dividends imputed from the Balance of Payments closely. For dividends paid out to foreign investors imputed from the Balance of Payments, I use the item *Dividends on Equity Excluding Investment Fund Shares* (BMIP-IPED). If the country does not report this item, I use the item *Investment Income on Equity and Investment Fund Shares* (BMIPIPE), scaled by the ratio ILPEEO/ILPE. Here, ILPEEO represents the country's liability of *Equity Securities Other Than Investment Fund Shares*, while ILPE represents the country's liability of *Equity and Investment Fund Shares*, both categories falling under the country's *Portfolio Investment*. Liability in this context means owned by other countries. Despite this adjustment, BOP imputed dividends may be slightly larger than Compustat/CRSP calculated dividends, as BOP includes both publicly listed equities and private ones. However, this concern may not be large. Oftentimes private equity involves control and hence is classified as direct investment by BOP instead of portfolio investment.

7.1 Intermediary Capital Ratio

The intermediary capital ratio can be used as a proxy for the balance sheet constraint of financial intermediaries. As in He, Kelly, and Manela (2017), I define intermediary capital ratio as the New York Fed's primary dealers' market equity divided by market equity plus their aggregate book debt. The New York Fed's primary dealers are New York Fed's trading counterparties in implementing monetary policy. The primary dealers are large financial institutions[38], many of which are active in the G10 currency market. Therefore, their capital ratio should be relevant for the G10 currency market. Reitz and Umlandt (2021) refines the intermediary capital ratio for the currency markets using the balance sheet data of the top three foreign exchange dealers. Their measure is highly correlated with He, Kelly, and Manela (2017), with the correlation being 0.90 from 1999 to 2017, when Reitz and Umlandt (2021) sample ends. The results in this section are qualitatively and quantitatively similar if using Reitz and Umlandt (2021)'s measure.

Table 7 Panel B confirms Proposition 2.1. Column 1 reiterates the findings in Section 5 using continuous variable $DivOut_{i,t}$ in Eq (12). The price impact coefficient implies 1% local stock market capitalization paid out to foreign investors as dividends will lead to the local currency depreciation against USD by 0.806% in two days time after the payment date. Column 2 and Column 3 are split sample regressions. Column 2 is over the subsample where the intermediary capital ratio is greater than the median. This is when the balance sheet constraint is looser. The estimated price impact coefficient is -0.192 and statistically insignificant. Column 3 is over the subsample where the intermediary capital ratio is smaller

[38] As of 2023, the primary dealers include ASL Capital Markets, Bank of Montreal, Bank of Nova Scotia, BNP Paribas Securities, Barclays Capital, BofA Securities, Cantor Fitzgerald & Co., Citigroup Global Markets, Daiwa Capital Markets America, Deutsche Bank Securities, Goldman Sachs & Co., HSBC Securities (USA), Jefferies, J.P. Morgan Securities, Mizuho Securities USA, Morgan Stanley & Co., NatWest Markets Securities, Nomura Securities International, RBC Capital Markets, Santander US Capital Markets, Societe Generale, TD Securities (USA), UBS Securities, Wells Fargo Securities

than the median. This is when the balance sheet constraint is tighter. The estimated price impact coefficient is -1.209 and statistically significant. Column 4 adds the interaction term between $DivOut_{i,t}$ and the subsample dummy variable in addition to first-order terms, with fully saturated fixed effects. It shows that the difference in price impact coefficient in Column 2 and Column 3 is economically large and statistically significant. i.e., when the capital ratio is lower, the price impact of dividend flows on the foreign exchange rate is larger.

7.2 Deviations from Covered Interest Rate Parity

Another proxy of the balance sheet constraints of financial intermediaries is the deviations from covered interest rate parity (CIP). Traditionally, CIP is a textbook example of no-arbitrage condition. It requires the US dollar interest rate in the cash market to be the same as the synthetic dollar interest rate, which borrows in foreign currency and use FX swap to transform into USD. Since the 2007-2008 Global Financial Crisis, the CIP deviation has been persistent. Duffie (2017), Du, Tepper, and Verdelhan (2018), Du and Schreger (2022) find this is the results from the post-GFC regulatory reforms in the banking sector, especially the non-risk-weighted capital requirements in the form of the leverage ratio or supplementary leverage ratio. Following the GFC, new regulations (e.g., the Basel III leverage ratio rule and the U.S. supplementary leverage ratio) were introduced that require banks to maintain a minimum capital ratio against all assets, regardless of their risk characteristics. This limits global banks' capacity to arbitrage. Therefore, CIP deviation can be used as a barometer for the intermediaries' balance sheet constraints.

Following the literature, I measure the CIP deviation using the cross-currency basis against USD, i.e.,

$$x_t^i = y_t^\$ - (y_t^i - \rho_t^i)$$

where $y_t^\$$ is the US dollar interest rate in the cash market, $(y_t^i - \rho_t^i)$ is the synthetic US dollar interest from the FX swap market. $\rho_t^i = (\log F_t^{i/\$} - \log S_t^{i/\$})^4$ is the annualized forward premium, where $\log S_t^{i/\$}$ is spot exchange rate and $F_t^{i/\$}$ is 3-month forward outright, both in terms of units of local currency per USD.

Table 7 Panel B confirms Proposition 2.2. Column 1 is the full sample results. Column 2 and Column 3 are split sample regressions. On the subsample where the absolute value of the CIP deviation is lower than the median within currency, the price impact coefficient is -0.302 and statistically insignificant. This is when the balance sheet constraints are more relaxed. On the subsample where the absolute value of the CIP deviation is higher than the median within currency, the price impact coefficient is -1.259 and statistically significant. This is when the balance sheet constraints are more stringent. Adding the interaction term between $DivOut_{i,t}$ and the subsample dummy variable in addition to first-order terms, Column 4 confirms the difference in price impact coefficient in Column 2 and Column 3 is not only economically large but also statistically significant. That is to say, when the balance sheet constraints are more stringent, the price impact of dividend flows on the foreign exchange rate is larger.

7.3 Currency Implied Volatility

In addition to the risk aversion coefficient γ, the FX volatility σ_E also affects the intermediary risk-bearing capacity Γ. In reality, this can stem from financial intermediaries' risk management practice in the form of value-at-risk (VaR) constraints (e.g., Fang and Liu (2021)). VaR constraints are widely used in the financial industry, including banks, hedge funds, etc. As higher volatility translates into tighter VaR constraints, the intermediaries' risk-bearing capacity is lower.

The FX volatility in the model in Section 6.4 is next-period volatility. Therefore, to proxy σ_E, I use the FX implied volatility which is forward-looking. I use 6-month tenor as it strikes a balance between short-term and long-term volatility. Using other tenors or realized volatility gives similar results.

Table 7 Panel C confirms Proposition 2.3. Column 1 is the full sample results, while Column 2 and Column 3 are the results for split sample regressions. When the implied volatility is lower than the median within currency, the price impact coefficient is -0.359 (Column 2). This is when the intermediary risk-bearing capacity is larger. When the implied volatility is lower than the median within currency, the price impact coefficient is -1.290 (Column 3). This is when the intermediary risk-bearing capacity is smaller. Adding the interaction term between $DivOut_{i,t}$ and the subsample dummy variable in addition to first-order terms, Column 4 confirms the difference in price impact coefficient in Column 2 and Column 3, -0.931, is economically large but also statistically significant. Therefore, at time when the currency implied volatility is higher, the price impact of dividend flows on the foreign exchange rate is larger.

8 Implications for International Finance

In this section, I discuss the implications of my paper. First, I provide a back-of-envelop calculation of the price multiplier in the FX market, compare it with other estimates in the literature, and link it to the inelastic market hypothesis developed by Gabaix and Koijen (2021). Second, I discuss how the price impact estimates are useful to shed light on intermediaries' capital requirements. Third, I present evidence that the price impact of dividend flows is larger in the free-floating FX regime than other regimes.

8.1 FX Elasticity

The price impact coefficient estimated using Eq (12) implies 1% of local stock market capitalization paid out to foreign investors in local currency as dividends will lead to the local currency depreciation against USD by 0.806% in two days time after the payment date (Table 7 Panel A Column 1). At the end of 2022, the average stock market capitalization in non-US G10 countries is 2,681 billion USD. Expressed in semi-multiplier,[39] this implies $33(= 1\%/0.806 \times 2681)$ billion USD-equivalent dividends paid to foreign investors are associated with 1% G10 currency movement against USD.

However, not all dividends paid out to foreign investors in the local currency are repatriated in the short run. To have a sense of the magnitude of actual dividend repatriation flows, we need to estimate the *dividend repatriation intensity*. In Section 6.2, I argue the short-run effect of dividend payments on the foreign exchange rate is most likely due to benchmark investors' dividend repatriation channel. Using Morningstar data (Figure 11), as of 2020 year-end, US-domiciled ETFs hold 3.2% of the local stock market capitalization, average across non-US G10 countries. In addition, US-domiciled mutual funds hold 6.6% of the local stock market capitalization. In total, US-domiciled benchmark investors hold 9.8% of local stock market capitalization. Using the data underlying Table A, the foreign ownership across non-US G10 countries is 40.3% as of 2020.

Therefore, $\approx 24.3\%(= 9.8\%/40.3\%)$ of the dividends paid to foreign investors are paid to the US-domiciled benchmark investors, who are likely to be repatriated out of the local currency.[40] With $\approx 24.3\%$ dividend repatriation intensity of foreign investors extrapolated

[39] Semi-multiplier is defined as $d\ln E/dQ$, where E is the foreign exchange rate against USD and the capital flow Q is expressed in USD-equivalent amount.

[40] This back-of-envelop estimate ignores non-US based ETFs and mutual funds, though they are much smaller than US-domiciled counterparts. In addition, US-domiciled benchmark investors may keep a certain proportion of dividends reinvested in the local stock markets.

to 2022,[41] 33 billion USD dividends paid to foreign investors is translated to 8 billion USD dividend repatriation flows out of the local currency. To conclude, on average, dividend flows of 0.30%(= 1%/0.806 × 24.3%) of local stock market capitalization move the G10 currency by 1%. In terms of semi-multiplier, \$8.1(= 1%/0.806 × 24.3% × 2681) move the G10 currency by 1% vis-à-vis USD.

Table 8 compares my estimates with the others in the literature. The existing papers often rely on ad-hoc normalization, including GDP, M2, market capitalization, etc. Therefore, I convert the numbers in these papers to the semi-multiplier, i.e., the dollar amount of flows that can move the exchange rate by 1%. Though estimates differ in types of flows and currencies, my estimates generally fall in the ballpark of the existing ones in terms of order of magnitude. For the developed market (DM) currencies, the closest estimate to mine is Camanho, Hau, and Rey (2022). Recently, Camanho, Hau, and Rey (2022) uses GIV on rebalancing flow for mutual funds domiciled in the US, the UK, Eurozone and Canada. They estimate that \$5.3bn to \$7.1bn equity flow is associated with 1% US dollar movement.[42] Their mutual fund rebalancing flow are unexpected flows, while the dividend flows I use are predetermined. Hau, Massa, and Peress (2010) uses MSCI Global Equity Index redefinition from market capitalization to freely floating in 2001 and 2002, and estimates that \$2.6bn equity flow moves the exchange rate by 1% against USD over 6-day window around the announcement date across 33 currencies (developed market currencies & emerging market currencies).[43] Their estimate is about the announcement date effect while my estimate is about the payment date effect. In Evans and Lyons (2002) estimate that a US\$1.9 billion FX orderflow moves Deutsche Mark exchange rate against USD by 1%.[44] The order flows contain contemporaneous information about exchange rates while dividends do not.

For the emerging market (EM) currencies, Pandolfi and Williams (2019) uses 10% cap rule in J.P. Morgan Government Bond Index–Emerging Markets Global Diversified (GBI-EM Global Diversified) that the benchmark weight of any single cannot exceed 10% of the index at the beginning of each month, inducing monthly rebalancings for a purely mechanical reasons. Their estimate implies \$1.4bn move the local currency against USD by 1% on average across 16 EM currencies.[45] Broner et al. (2021) uses the unexpected announcement

[41] Here, I extrapolate from 2020 to 2022 as my sample of US-domiciled ETFs/mutual funds from Morningstar ends in 2020Q4.

[42] p5262-5264.

[43] p1699 estimates that an (uninformative) capital flow of US\$1 billion therefore amounts to an average appreciation of 0.38% against USD.

[44] p178: \$1 billion of net dollar purchases increases the deutsche mark price by 0.54 percent.

[45] p393 Table 6 estimates that 1% inflow, relative to the market value of the sovereign bonds, leads to a

of index inclusion into local-currency sovereign debt indexes of Citigroup WGBI and JP Morgan GBI-EM, and estimates \$5bn inflow leads to 1% local currency appreciation against USD in the two days following the announcement.[46] However, they find no effect during the implementation period between 2 and 6 months after the announcement date. Recently, Aldunate et al. (2022) uses Chilean pension funds flows induced by a Chilean financial advisor' uninformed market timing recommendations. Their estimate implies US\$1.4 billion produces a depreciation of the Chilean peso against US dollar by 1%.

8.2 Capital Regulation

Regulations on global banks affect their risk-taking appetite. Even for arbitrage capital like hedge funds to size up their positions, they often need funding from banks, hence taking space in banks' balance sheets. Since the Global Financial Crisis (GFC), regulations on intermediaries' balance sheets have tightened considerably (Du, Hébert, and Huber (2023)). This is consistent with the pattern we see in Figure 5 that dividends have larger price impact on exchanges than pre-GFC.[47] As the CIP deviation can be used as a proxy for balance sheet constraints, this is also consistent with the pattern in Table 7 Panel B.

On the other hand, Table 7 Panel A shows that a higher intermediary capital ratio in terms of equity/asset ratio (He, Kelly, and Manela (2017)) helps alleviate the price impact of dividend flows on exchange rates. To quantify how the intermediary capital ratio affects the dividend price impact coefficient, I run the following regression with the term of capital ratio interacted with dividends paid out to foreign investors, in addition to first-order terms:

$$\Delta_2 e_{i,t+2}^{US/LC} = \alpha + (\beta_0 + \beta_1 CR_t) \times DivOut_{i,t} + Controls + \gamma_i + \xi_t + \epsilon_{i,t+2} \tag{13}$$

The parameters of interest are β_0, β_1. The results are reported in Table 7 Panel A Column 5. The sample average capital ratio $\overline{CR}$ is 7.38%, while 1 standard deviation $std(CR)$ is 3.1%. At $\overline{CR}$, the implied price impact coefficient is $\beta = -2.123 + 20.513 \times 7.38\% = -0.609$. At $\overline{CR} - std(CR)$, the implied price impact coefficient becomes $\beta = -2.123 + 20.513 \times (7.38\% - 3.18\%) = -1.26$. That is to say, one standard deviation decrease in intermediary capital ratio will double the price impact of flows!

close to 0.42% appreciation against the dollar in the exchange rate. I scale back this estimate by the market value of the sovereign bonds \$60.12bn in their Table 1, i.e., $(1\%/0.42\%) \times (60.12 \times 1\%) = 1.4$.

[46] p17 Fig. 11 estimates 1.1% inflow, relative to GDP, leads to a 1% appreciation in the local currency against USD. I scale back this estimate by the nominal GDP in USD of the event dates.

[47] The same pattern also holds if using $DivOut_{i,t}$ as RHS variable instead of $\mathbb{D}_{i,t}$.

8.3 FX Regimes

How capital flows affect exchange rates may depend on the FX regimes. If a currency is in a non-free-floating regime, central banks may need to conduct foreign exchange interventions to maintain the FX regimes. In this section, I present evidence on how the price impact of dividends on the foreign exchange rate differ in different FX regimes.

Ilzetzki, Reinhart, and Rogoff (2019) classifies currencies into 15 fine classifications from 1940 to 2019. Relevant to G10 currencies are the following regimes: pre-announced peg (2), de facto horizontal band $\leqslant 2\%$ (6), de facto crawling band $\leqslant 2\%$ (8), moving band $\leqslant 2\%$ (11), managed floating (12) and freely floating (13). I extend the last observation of classification to date. As Figure 12 shows, over the sample period since 2001, AUD, EUR, JPY, USD have always been in the freely floating regime, NOK has always been managed floating (anchoring to AUD), and NOK has always been de facto moving band $\pm 2\%$ against Euro. CAD switched from de facto moving band ($\pm 2\%$ band against US dollar) to freely floating in June 2002. GBP switched from de facto moving band ($\pm 2\%$ band against Euro) to freely floating in January 2009. SEK switched from de facto horizontal band ($\pm 2\%$ band against Euro) to de facto moving band ($\pm 2\%$ band against Euro) in September 2008. CHF switched to pegging to Euro during September 2011 to January 2015, while in other time, de facto moving band ($\pm 2\%$ band against Euro). In the sample, the number of observations in freely floating regime are similar to the number of observations in other regimes. Therefore, I estimate Eq(12) for non-freely-floating regimes vs freely floating regime.

Table 9 shows the Column 1 is the full sample results. Column 2 and Column 3 are split sample regressions. On the subsample of non-freely-floating regimes, the price impact coefficient is -0.353 and statistically insignificant. On the subsample of the freely-floating regime, the price impact coefficient is -1.689 and statistically significant. Adding the interaction term between $DivOut_{i,t}$ and the subsample dummy variable, Column 4 confirms the difference in price impact coefficient in Column 2 and Column 3 is not only economically large but also statistically significant. That is to say, the price impact of dividend flows on the exchange rate is larger in the freely floating regime than in other FX regimes.

9 Conclusion

In this paper, I show that dividends, despite being ex-ante known, move the foreign exchange rate around the payment dates. This pattern informs us about the interaction in the currency market. On the one hand, benchmark investors have incentives to repatriate dividends received in local currency. On the other hand, financial intermediaries may not fully "arbitrage" the dividends' price impact beforehand. The interaction between the benchmark investors and financial intermediaries leads to the significant dividend payment date effect.

In addition, as dividends are recurring and universal, they can be a valuable tool in international economists' toolbox. e.g., they may be used as instruments for other capital flows. In this paper, I use dividend flows to estimate their price impact on the foreign exchange rate at different times and under different FX regimes.

As the FX market is often claimed to be the largest and the deepest market in the world,[48] the price effect of dividend flows and other capital flows on exchange rates appears to be very big, given the magnitude of cross-border flows like trade flows.[49] This is in similar essence as the inelastic market hypothesis, pioneered by Gabaix and Koijen (2021). In models that feature financial intermediaries' roles in FX determination, it is intermediaries' limited risk-bearing capacity that determines the elasticity of the foreign exchange rate to capital flows. That being said, reconciling the price impact estimates with other cross-border statistics in a quantitative model is left as future research.

[48] https://www.cmegroup.com/education/courses/introduction-to-fx/what-is-fx.html

[49] It is worth noting that a significant portion of trade flows are invoiced in USD. Therefore, their FX impact may not be as big at face value.

Table 1: Stock Market Size and Foreign Ownership

This table provides summary statistics about the size and foreign ownership of stock markets in G10 countries/currency areas, including Australia (AUS), Canada (CAN), Switzerland (CHE), Euro area (EUR), United Kingdom (GBR), Japan (JPN), Norway (NOR), New Zealand (NZL), Sweden (SWE), and the United States (USA). All numbers are the average of annual data from 2001 to 2022. *Stock Market to GDP* is the year-end stock market capitalization divided by nominal GDP, where the market capitalization data is from Bloomberg (after 2003) and the World Bank (before 2023). The nominal GDP is from the World Bank. *Foreign Ownership of Domestic Stock Market* is calculated from the Balance of Payments. Columns *by G10* and *by USA* under *Out of Foreign Ownership* are calculated from the Coordinated Portfolio Investment Survey. See Appendix A for more details.

	Stock Market to GDP	Foreign Ownership of Domestic Stock Market	Out of Foreign Ownership by G10	Out of Foreign Ownership by USA
AUS	1.03	28.8	93.3	46.5
CAN	1.16	22.4	96.8	77.3
CHE	2.14	60.0	96.9	48.7
EUR	0.55	32.1	90.0	46.0
GBR	1.19	51.7	89.2	46.7
JPN	0.92	26.0	93.5	52.4
NOR	0.64	26.3	95.5	38.3
NZL	0.36	31.9	96.2	39.8
SWE	1.23	33.8	93.7	35.4
USA	1.31	17.6	85.1	-

Table 2: Calendar Days Between Dividend Announcement and Payment

This table shows the number of calendar days between the dividend announcement date and the dividend payment date at the firm level across G10 countries/currency areas. All dividend information is released on the dividend announcement date, including dividend amount and other dividend-related dates except for Japan. Companies in Japan typically do not confirm the dividend amount before the ex-date, though the guidance of dividends is usually available almost one year in advance. For Japan, I calculate the lead time of the ex-date vs. the payment date.

		Calendar Days			
	Observations	Mean	p25	p50	p75
AUS	17,991	48.3	32	43	58
CAN	55,640	39.4	27	31	44
CHE	2,703	52.1	35	48	63
EUR	35,598	62.9	41	58	83
GBR	32,993	68.0	43	63	84
JPN	106,307	82.6	72	87	93
NOR	2,142	70.3	37	72	97
NZL	2,789	36.4	24	32	44
SWE	4,406	92.7	68	84	97
USA	133,672	43.1	28	37	52
All	394,241	58.0	32	55	80

Table 3: Comparison Between Dividend and Portfolio Flows

This table compares average dividend flows with other financial flows and trade flows from the Balance of Payments (BOP) between 2001 and 2022. All numbers are in billions of USD. *Dividends on Equity To Foreign Investors* is investment income on equity and investment fund shares on the debit side (BMIPIPE), while *Dividends on Equity From Foreign Investors* on the credit side (BXIP-IPE), both under the primary income in the current account. Under *Portfolio Investment of Equity*, *Net Acquisition of Assets* is a country's purchase of foreign countries' equity and investment fund shares (BFPAE), while *Net Incurrence of Liabilities* is foreign countries' purchase of a country's equity and investment fund shares (BFPLE). Similarly, under *Portfolio Investment of Debt*, *Net Acquisition of Assets* is a country's purchase of foreign countries' debt securities (BFPAD), while *Net Incurrence of Liabilities* is foreign countries' purchase of a country's debt securities (BFPLD). These four items are from the financial account. *Net Exports* is exports minus imports of goods and services (BGS) under the current account.

	Dividends on Equity		Portfolio Investment Equity		Portfolio Investment Debt		
	To Foreign Investors	From Foreign Investment	Net Acquisition of Assets	Net Incurrence of Liabilities	Net Acquisition of Assets	Net Incurrence of Liabilities	Net Exports
AUS	12.0	10.6	26.9	13.8	17.9	49.9	6.2
CAN	10.1	13.5	18.9	11.2	14.3	58.4	-2.9
CHE	22.0	12.7	7.9	-2.8	15.4	2.2	50.8
EUR	139.8	62.1	118.8	238.4	289.4	173.2	252.6
GBR	51.0	35.0	-6.8	8.7	37.9	142.3	-45.9
JPN	22.9	36.5	31.2	26.6	98.6	82.4	2.0
NOR	3.8	18.0	26.4	3.1	26.2	14.4	44.9
NZL	0.8	0.9	1.5	0.9	1.6	4.4	0.2
SWE	6.9	9.4	9.6	1.5	8.7	17.7	23.3
USA	98.3	160.7	137.2	91.5	130.5	525.8	-580.5

Table 4: FX Cut-off Time and Stock Market Closing Time

This table shows the primary stock market closing time of the regular trading hour in different countries/currency areas. The data is sourced from Bloomberg. The FX cut-off time is the closest hour equal to or immediately after the stock market closing time.

	Time Zone	Stock Market Close	FX Cut-Off Time
AUD	Australia/Sydney	16:00	16:00
CAD	U.S./Eastern	16:00	16:00
CHF	Europe/Zurich	17:20	18:00
EUR	Europe/Paris	17:30	18:00
GBP	Europe/London	16:30	17:00
JPY	Asia/Tokyo	15:00	15:00
NOK	Europe/Oslo	16:20	17:00
NZD	Pacific/Auckland	16:45	17:00
SEK	Europe/Stockholm	17:25	18:00
USD	U.S./Eastern	16:00	16:00

Table 5: Performance of Dividend-Based Currency Strategy

This table presents the performance profiles for the dividend-based currency strategy under different parameters, before and after the transaction costs. The transaction cost, i.e., bid-ask spread, is assumed to be 1 basis point for all currencies at all times. The dividend-based currency strategy takes the following form: for each country/currency area k and date t, if in the previous l days, the combined dividend payments in the country k rank in its top p-percentile in the rolling 1-year window, then we sell currency k against USD, and hold the position for one day. If there are several currencies that satisfy this criterion, then each position is of $1 size. The excess return on date t is calculated from summing across excess returns for each position. The numbers in the brackets are t-statistics. Alpha, DOL, CAR, MOM, VAL are the coefficients from factor-spanning regression Eq (1) at the monthly frequency. The standard errors of the Sharpe ratio are calculated using Lo (2002).

Top $p = 5\%$	Before TC			After TC		
Lookback Period l	1 day	2 days	1 week	1 day	2 days	1 week
Annualized Returns	3.0%	4.4%	3.3%	2.3%	3.6%	2.3%
	[2.65]	[3.25]	[2.16]	[2.08]	[2.66]	[1.51]
Annualized Sharpe ratio	0.56	0.68	0.45	0.44	0.56	0.32
	[2.65]	[3.25]	[2.16]	[2.08]	[2.66]	[1.51]
Zero Position Days	79%	75%	71%	79%	75%	71%
Alpha	0.22	0.36	0.30	0.17	0.3	0.22
	[2.32]	[3.22]	[2.49]	[1.78]	[2.65]	[1.85]
DOL	0.28	0.41	0.59	0.28	0.41	0.59
	[5.42]	[6.91]	[9.19]	[5.41]	[6.94]	[9.24]
CAR	0.09	0.07	0.05	0.09	0.07	0.04
	[1.64]	[1.11]	[0.68]	[1.59]	[1.03]	[0.58]
MOM	0.01	0.03	0.05	0.01	0.03	0.04
	[0.22]	[0.58]	[0.86]	[0.23]	[0.60]	[0.87]
VAL	-0.07	-0.08	0.10	-0.07	-0.08	0.1
	[-1.57]	[-1.42]	[1.74]	[-1.56]	[-1.40]	[1.79]

Table 6: Price Impact of Large Dividends on the Foreign Exchange Rate

This table compares estimates of the price impact of dividends on the foreign exchange rate using different identification strategies. Panel *OLS* reports β_h estimated from Eq (3), without controls and fixed effects. Panel *OLS with Controls* is estimated from Eq (3), without fixed effects. Panel *Two-Way Fixed Effects with Controls* is estimated from the baseline regression Eq (3). The controls include stock market returns and FX implied volatility. The standard errors for these three specifications are clustered at the date level. Panel *Synthetic Control* is estimated from the alternative identification strategy in Section 5.2. Panel *Difference-in-Difference* is estimated from the alternative identification strategy in Section 5.2.

	Days Relative to Dividend Payment Date										
	0	1	2	3	4	5	6	7	8	9	10
OLS											
Coefficients	0.04	-1.77	-5.73**	-6.11**	-5.54*	-7.76**	-7.99**	-9.30**	-9.26**	-7.36	-5.89
Standard Errors	(1.46)	(2.14)	(2.58)	(3.01)	(3.27)	(3.61)	(3.92)	(4.25)	(4.44)	(4.72)	(5.07)
OLS with Controls											
Coefficients	0.13	-1.65	-5.60**	-5.97**	-5.38*	-7.58**	-7.81**	-9.12**	-9.05**	-7.15	-5.67
Standard Errors	(1.45)	(2.12)	(2.56)	(3.00)	(3.26)	(3.60)	(3.91)	(4.24)	(4.42)	(4.70)	(5.05)
Two-Way Fixed Effects with Controls											
Coefficients	-1.48	-2.30	-4.70**	-5.18**	-4.83**	-6.32**	-5.83**	-6.20**	-6.48**	-5.03	-4.73
Standard Errors	(1.24)	(1.62)	(1.88)	(2.09)	(2.31)	(2.57)	(2.75)	(2.96)	(3.02)	(3.21)	(3.41)
Synthetic Controls											
Coefficients	-2.07	-4.57**	-5.76**	-6.22**	-9.10***	-9.72***	-10.52***	-11.83***	-12.51***	-12.45***	-11.99***
Standard Errors	(1.61)	(2.17)	(2.50)	(2.84)	(3.14)	(3.40)	(3.68)	(3.94)	(4.10)	(4.33)	(4.55)
Difference-in-Difference											
Coefficients	-1.81	-4.84**	-6.54***	-7.15**	-8.21***	-9.16**	-10.02**	-10.76**	-12.55***	-11.91***	-11.57**
Standard Errors	(1.47)	(2.14)	(2.48)	(2.82)	(3.16)	(3.56)	(3.91)	(4.26)	(4.34)	(4.50)	(4.65)

(Continued on the next page)

Table 6 (Continued): Price Impact of Large Dividends on the Foreign Exchange Rate

	Days Relative to Dividend Payment Date										
	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
OLS											
Coefficients	-2.63	-2.77	-2.64	-2.63	-1.80	-1.50	-1.81	-1.34	0.98	-	0.04
Standard Errors	(4.58)	(4.26)	(4.02)	(3.70)	(3.35)	(2.92)	(2.57)	(2.12)	(1.53)	-	(1.46)
OLS with Controls											
Coefficients	-2.37	-2.54	-2.42	-2.42	-1.62	-1.37	-1.69	-1.26	1.03	-	0.13
Standard Errors	(4.59)	(4.26)	(4.03)	(3.71)	(3.34)	(2.92)	(2.57)	(2.11)	(1.53)	-	(1.45)
Two-Way Fixed Effects with Controls											
Coefficients	4.52	2.66	2.82	2.69	2.89	2.59	1.44	2.10	3.04**	-	-1.48
Standard Errors	(2.99)	(2.80)	(2.70)	(2.48)	(2.28)	(2.04)	(1.81)	(1.51)	(1.21)	-	(1.24)
Synthetic Controls											
Coefficients	4.35	4.86	5.06	2.62	4.32	4.20	3.31	3.29*	1.18	-	-2.07
Standard Errors	(3.85)	(3.61)	(3.43)	(3.21)	(2.96)	(2.66)	(2.29)	(1.84)	(1.36)	-	(1.61)
Difference-in-Difference											
Coefficients	0.58	1.87	3.00	2.39	4.99	4.52	3.67	4.03*	2.05	-	-1.81
Standard Errors	(4.32)	(4.08)	(3.85)	(3.51)	(3.19)	(2.85)	(2.50)	(2.08)	(1.54)	-	(1.47)

(Continued from the previous page)

Table 7: Time Variation of Price Impact of Dividend Flows on FX Rates

This table reports the price impact coefficients of dividends paid out to foreign investors on the foreign exchange rate in Eq(12). The variable $DivOut_{i,t}$ is country i's dividends paid out to foreign investors on date t, calculated using total dividend payments from Compustat Global/CRSP multiplied by the foreign ownership, then normalized by the previous year-end its stock market capitalization, both in local currency. The controls include stock market returns and FX implied volatility. Columns 1-4 are on different subsamples. For regressions with interaction terms with subsample indicators, the fixed effects and controls are fully saturated. Column 5 reports results in Eq (13). The standard errors are clustered at the date level.

Panel A. Intermediary Capital Ratio

$\Delta_2 e^{US/LC}_{t+2}$	(1) All	(2) CR $\geqslant$ p50	(3) CR $<$ p50	(4) All	(5) All
$DivOut_{i,t}$	-0.806***	-0.192	-1.209***	-0.192	-2.123**
	(0.259)	(0.348)	(0.363)	(0.348)	(0.845)
$\mathbb{1}\{\text{CR} < \text{p50}\} \times DivOut_{i,t}$				-1.018**	
				(0.503)	
CR $\times$ $DivOut_{i,t}$					20.513*
					(11.643)
Observations	50463	25245	25218	50463	50463
Adjusted R^2	0.518	0.522	0.516	0.518	0.518

Panel B. CIP Deviation

$\Delta_2 e^{US/LC}_{t+2}$	(1) All	(2) $\|\text{CIP}\| <$ p50	(3) $\|\text{CIP}\| \geqslant$ p50	(4) All
$DivOut_{i,t}$	-0.806***	-0.302	-1.259***	-0.302
	(0.259)	(0.360)	(0.417)	(0.360)
$\mathbb{1}\{\|\text{CIP}\| \geqslant \text{p50}\} \times DivOut_{i,t}$				-0.957*
				(0.555)
Observations	50463	24290	24749	49039
Adjusted R^2	0.518	0.568	0.552	0.558

Panel C. Currency Implied Volatility

$\Delta_2 e^{US/LC}_{t+2}$	(1) All	(2) IV $<$ p50	(3) IV $\geqslant$ p50	(4) All
$DivOut_{i,t}$	-0.806***	-0.359	-1.290***	-0.359
	(0.259)	(0.311)	(0.429)	(0.311)
$\mathbb{1}\{\text{IV} \geqslant \text{p50}\} \times DivOut_{i,t}$				-0.931*
				(0.531)
Observations	50463	24797	24425	49222
Adjusted R^2	0.518	0.538	0.548	0.545

Table 8: Comparison Among Estimates of FX Semi-Multiplers

This table compares my estimates using dividend flows with estimates in the literature, which are converted into semi-multiplier, i.e., the dollar value of capital flows that can move the exchange rate by 1%. See the footnotes in the main text for details of the conversion.

	Semi-Multipler		Sample	
	Methodology	Est	Currencies	Freq
This paper	Dividend flows	8.1	G10	D
Camanho et al.	GIV on MF rebalancing flows	7.1	USD, EUR, GBP, CAD	Q
Hau et al.	MSCI Global Equity Index redefinition	2.6	33 DM & EM	D
Evans-Lyons	Order flows	1.9	DEM	D
Pandolfi-Williams	Cap 10% in GBI-EM Global Diversified Index induced rebalancing	1.4	16 EM	D
Broner et al.	Addition to WGBI & GBI-EM	5.0	6 EM	D
Aldunate et al.	Chilean FyF induced rebalancing	1.4	CLP	D

Table 9: Price Impact by Foreign Exchange Regime

This table reports the price impact coefficients of dividends paid out to foreign investors on the foreign exchange rate in Eq(12) under different FX regimes. FX regimes are the fine classifications from Ilzetzki, Reinhart, and Rogoff (2019). The variable $DivOut_{i,t}$ is country i's dividends paid out to foreign investors on date t, calculated using total dividend payments from Compustat Global/CRSP multiplied by the foreign ownership, then normalized by the previous year-end its stock market capitalization, both in local currency. The controls include stock market returns and FX implied volatility. The standard errors are clustered at the date level.

$\Delta_2 e^{US/LC}_{t+2}$	(1) All	(2) Non-Freely Floating	(3) Freely Floating	(4) All
$DivOut_{i,t}$	-0.806***	-0.353	-1.689***	-0.353
	(0.259)	(0.335)	(0.644)	(0.335)
$\mathbb{1}\{\text{FreeFloat}\} \times DivOut_{i,t}$				-1.336*
				(0.721)
Observations	50463	24364	26099	50463
Adjusted R^2	0.518	0.645	0.470	0.567

Figure 1: Time-Series of Cash Dividend Payments

This figure shows the dividend payments in G10 countries/currency areas from January 2018 to December 2022. I focus on cash dividends and keep common/ordinary shares that are primarily listed in a country/currency area. Dividends are aggregated to payment dates and converted to billion USD using exchange rates on the payment dates.

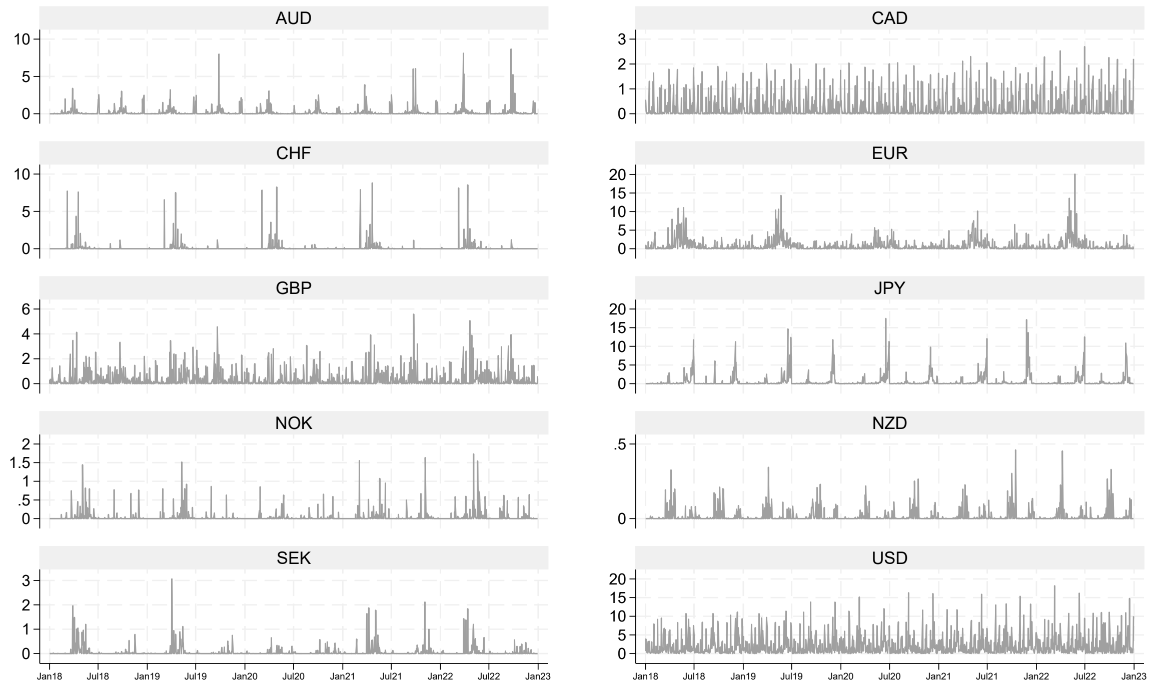


Figure 2: Comparison Between Estimates of Dividends to Foreign Investors: Compustat Global/CRSP vs. Balance of Payments

This figure compares the dividends paid out to foreign investors, calculated from Compustat Global/CRSP (y-axis) vs imputed from the Balance of Payments (x-axis), at an annual frequency in billion USD. Each dot in the figure represents currency-year. For dividends paid out to foreign investors calculated from Compustat Global/CRSP, I first aggregate dividend payments by payment date in each currency area, then I multiply by the foreign ownership calculated imputed from the Balance of Payments. For dividends paid out to foreign investors imputed from the Balance of Payments, if the country reports Dividends on Equity Excluding Investment Fund Shares (BMIPIPED), I use it directly. Otherwise, I use Investment Income on Equity and Investment Fund Shares (BMIPIPE), multiplied by the ratio of ILPEEO/ILPE, where ILPEEO represents Equity and Investment Fund Shares, Equity Securities Other Than Investment Fund Shares, and ILPE represents Equity and Investment Fund Shares, both under Liabilities of Portfolio Investment.

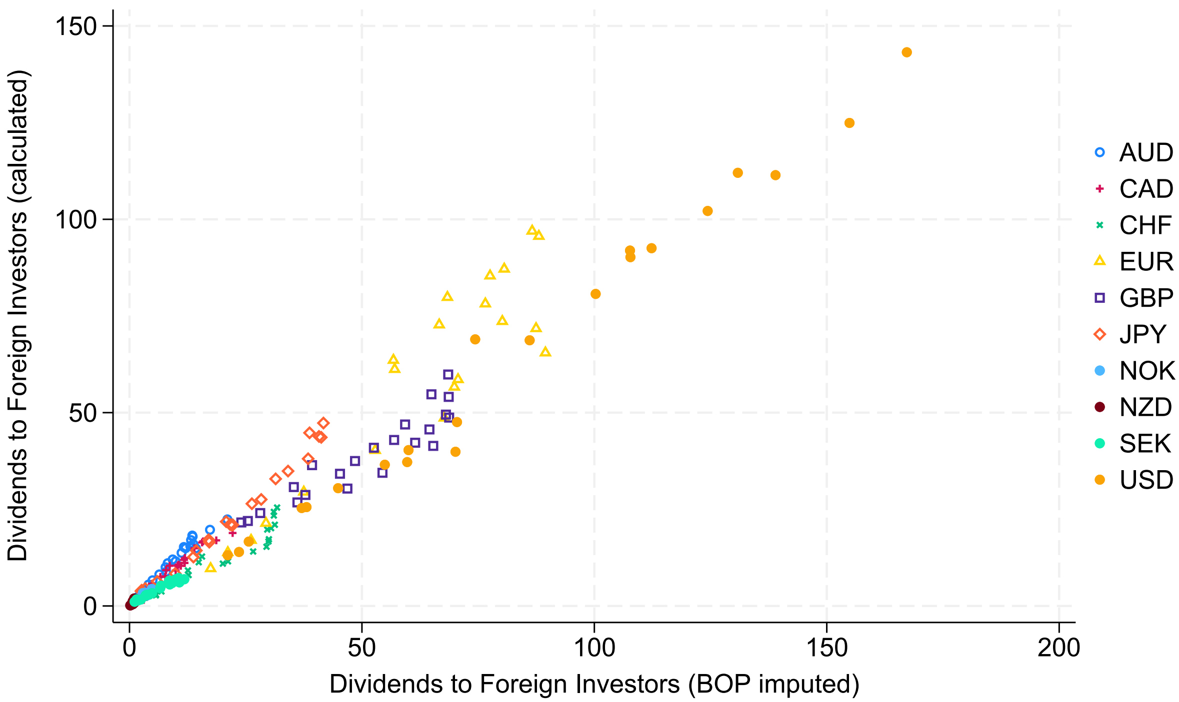


Figure 3: Cumulative Return on the Dividend-Based Currency Strategy

This figure shows the cumulative log returns of the dividend-based currency strategy in percentage points, both before the transaction cost (blue line) and after the transaction cost (orange line). The transaction cost, i.e., bid-ask spread, is assumed to be 1 basis point for all currencies at all times. The dividend-based currency strategy takes the following form: for each country/currency area k and date t, if in the previous l days, the combined dividend payments in the country k rank in its top p-percentile in the rolling 1-year window, then we sell currency k against USD, and hold the position for one day. If there are several currencies that satisfy this criterion, then each position is of \$1 size. The excess return on date t is calculated from summing across excess returns for each position. In this figure, $l = 2, p = 5\%$. The sample period is from January 2001 to June 2023.

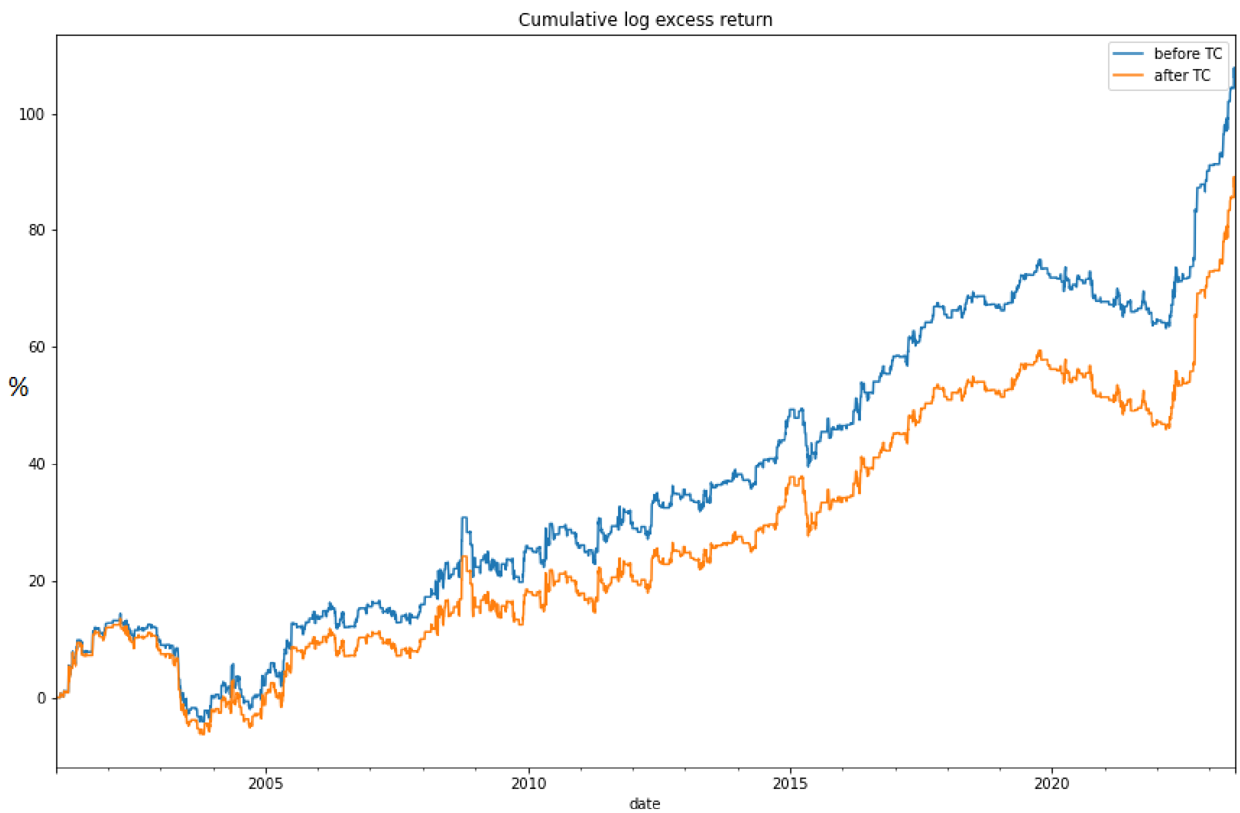


FIGURE 4: PRICE IMPACT OF LARGE DIVIDENDS ON THE FOREIGN EXCHANGE RATE

This figure shows the coefficients β_h estimated in the baseline regression Eq (3) with controls and two-way fixed effects, i.e., the currency fixed effect and the date fixed effect. The controls include stock market returns and FX implied volatilities. The sample period is from January 2001 to June 2023. The standard errors are clustered at the date level.

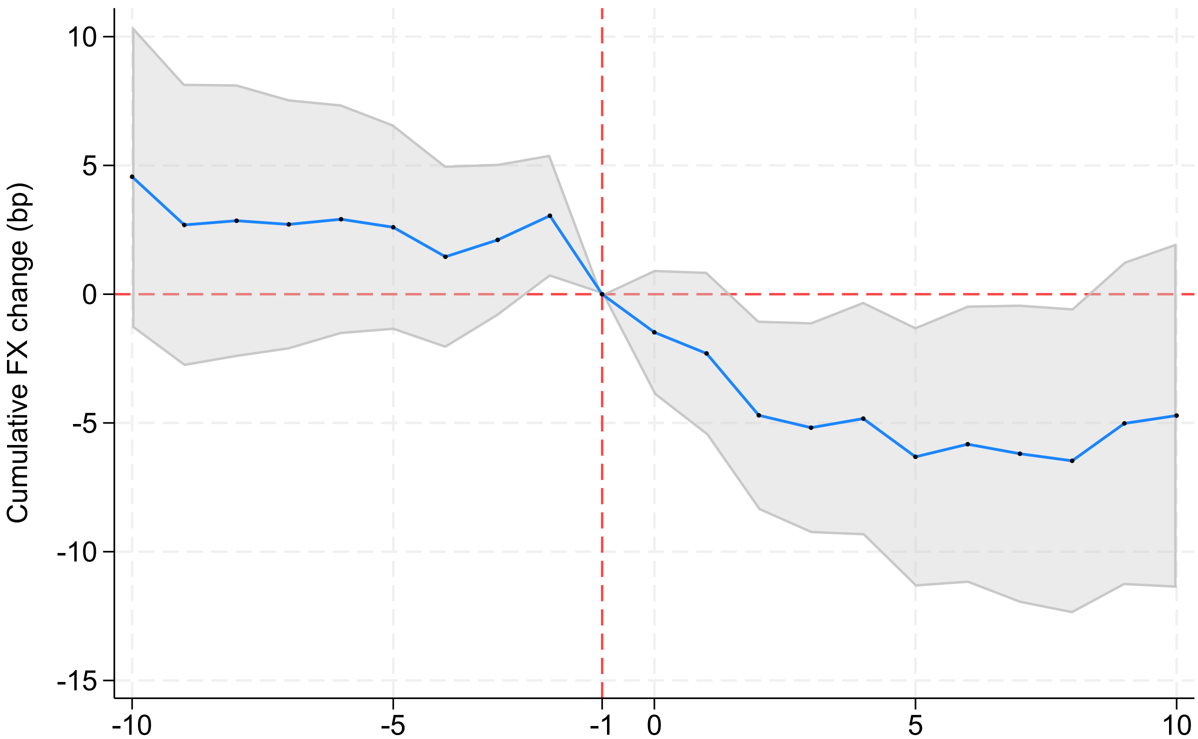


Figure 5: Price Impact of Large Dividends on the Foreign Exchange Rate: Pre-GFC vs. Post-GFC

This figure compares the coefficients β_h in the baseline regression Eq (3) with controls and two way fixed effects, estimated separately before and after the 2007–2008 Global Financial Crisis (GFC). The pre-GFC subsample is from January 2001 to December 2007, and post-GFC subsample is from June 2009 to June 2023, inclusive. The standard errors are clustered at the date level.

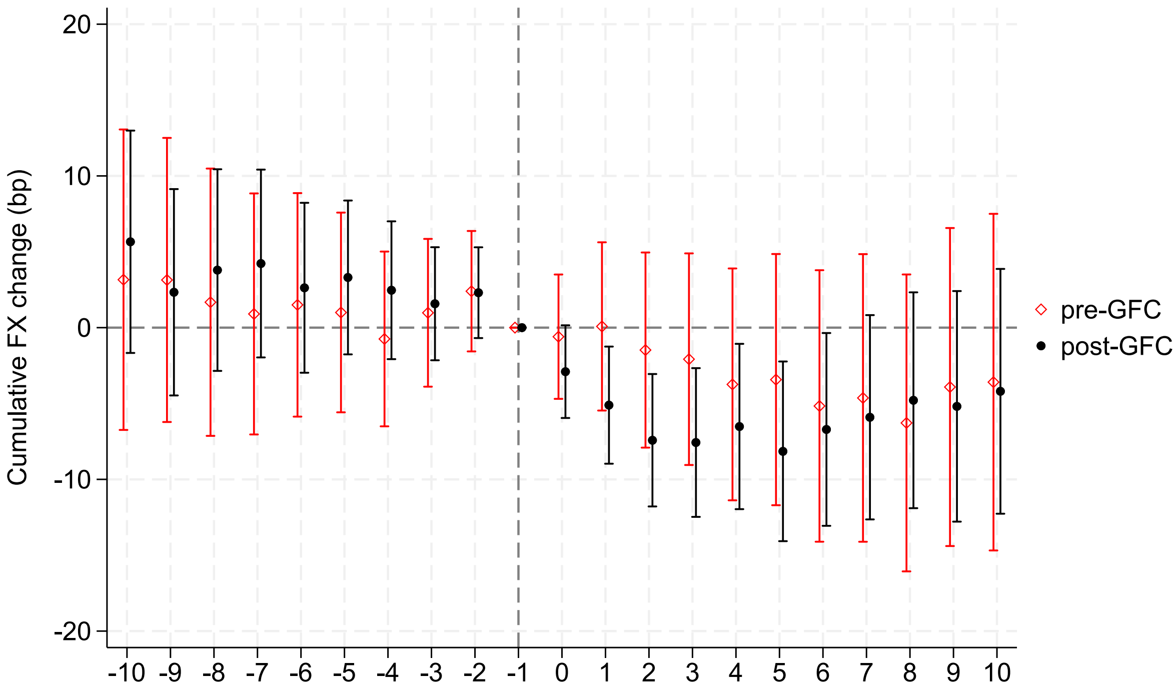


FIGURE 6: ILLUSTRATION OF THE SYNTHETIC CONTROL METHODOLOGY

This figure illustrates the methodology of estimating the synthetic control, i.e., the best linear combination of control group currencies that best mimics the movement of the treated currency in the estimation window [-70,-11]. The treated unit is the currency that has a top 5% largest dividend payment within a currency-year on the event date. The control group currencies are defined as currencies that do not have top 10% largest dividend payments within a currency-year over the [-10,10] event window. One currency from the control group units is randomly selected to be the placebo. The remaining control group currencies are used for estimation in Eq (4).

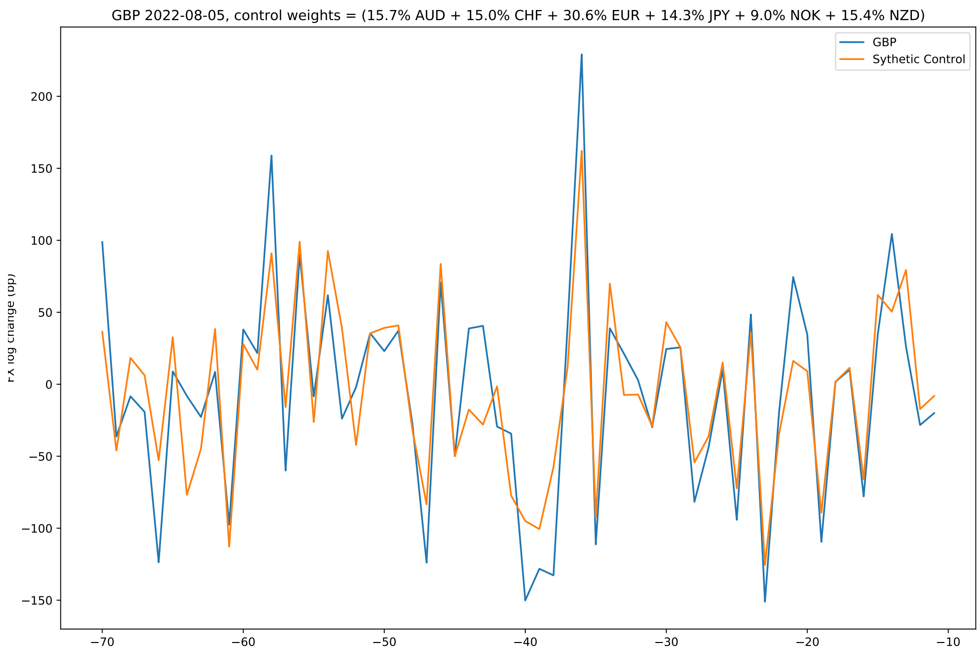
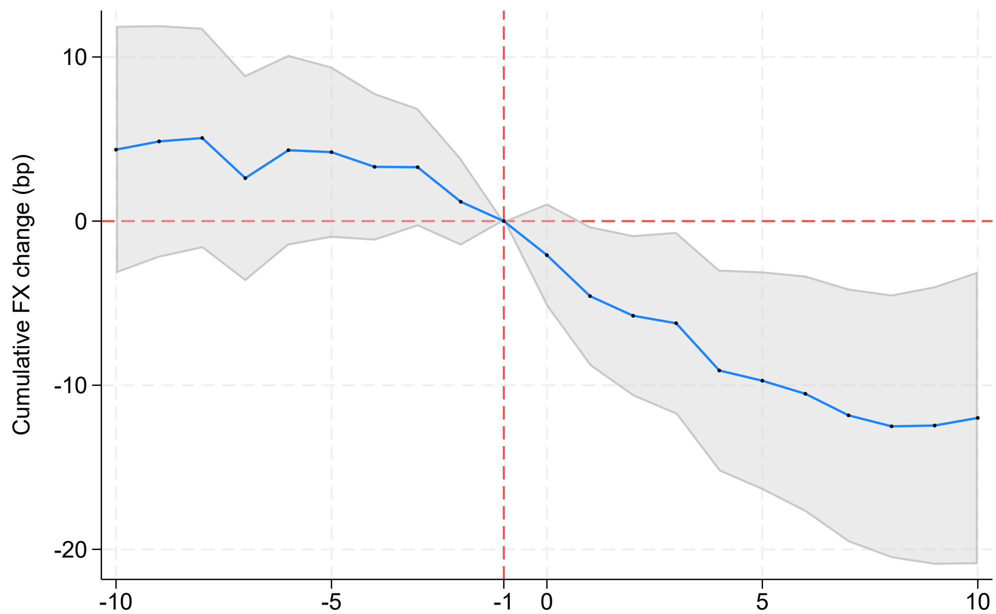


Figure 7: Price Impact of Large Dividends on the Foreign Exchange Rate: Estimates from Synthetic Controls

Panel A. Average Treatment Effect



Panel B. Placebo Test

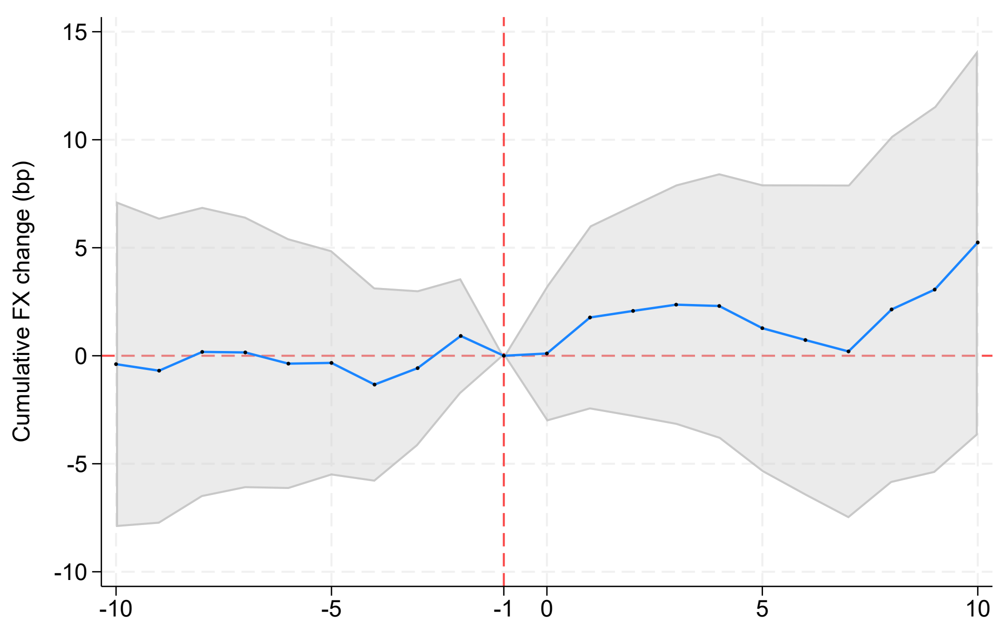


Figure 8: Price Impact of Large Dividends on the Foreign Exchange Rate: Estimates from Difference-in-Difference (DiD)

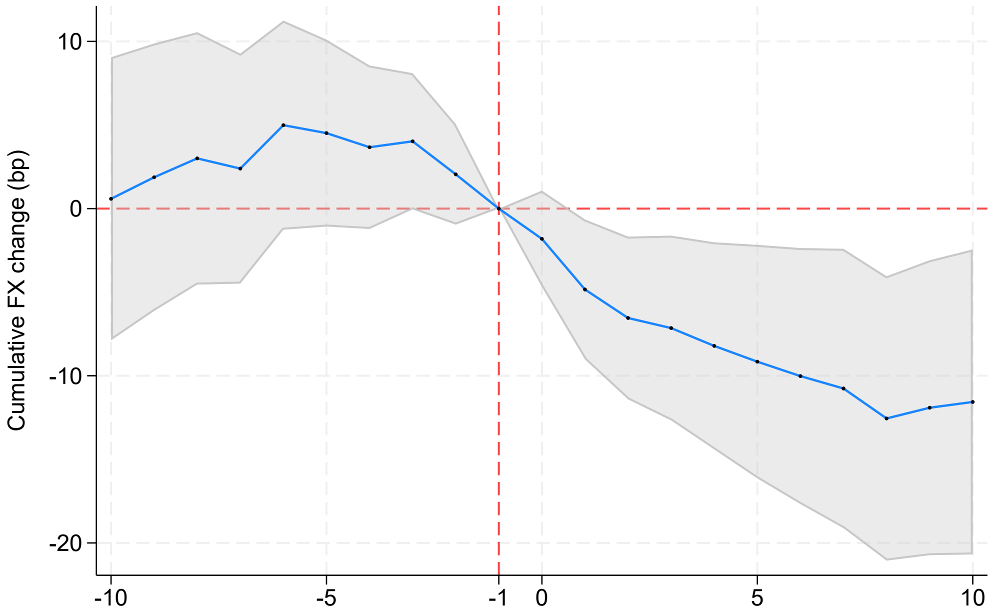


Figure 9: Dividend Repatriation Channel - A Case Study

This figure shows the cash position evolution of First Trust Developed Markets ex-US AlphaDEX® Fund (FDT) from Nov 30, 2022 to Dec 9, 2022. During this period of time, there are no fund inflows or outflows, no change in underlying stock positions, and no distributions to the ETF investors. Calculated from FDT's portfolio holdings and the dividend payment information, the fund should receive dividend payments in JPY (orange bar) from its portfolio holdings of Japanese companies from Nov 30, 2022 (Wednesday) to Dec 2, 2022 (Friday), with the dividend payment on Dec 1, 2022 (Thursday) being the largest. In the meantime, dividends received in other currencies are negligible. The JPY dividends appeared on FDT's JPY cash account (red line) on Dec 5, 2022 (Monday), after which the JPY cash position decreased while the USD cash position (blue line) increased by a similar amount.

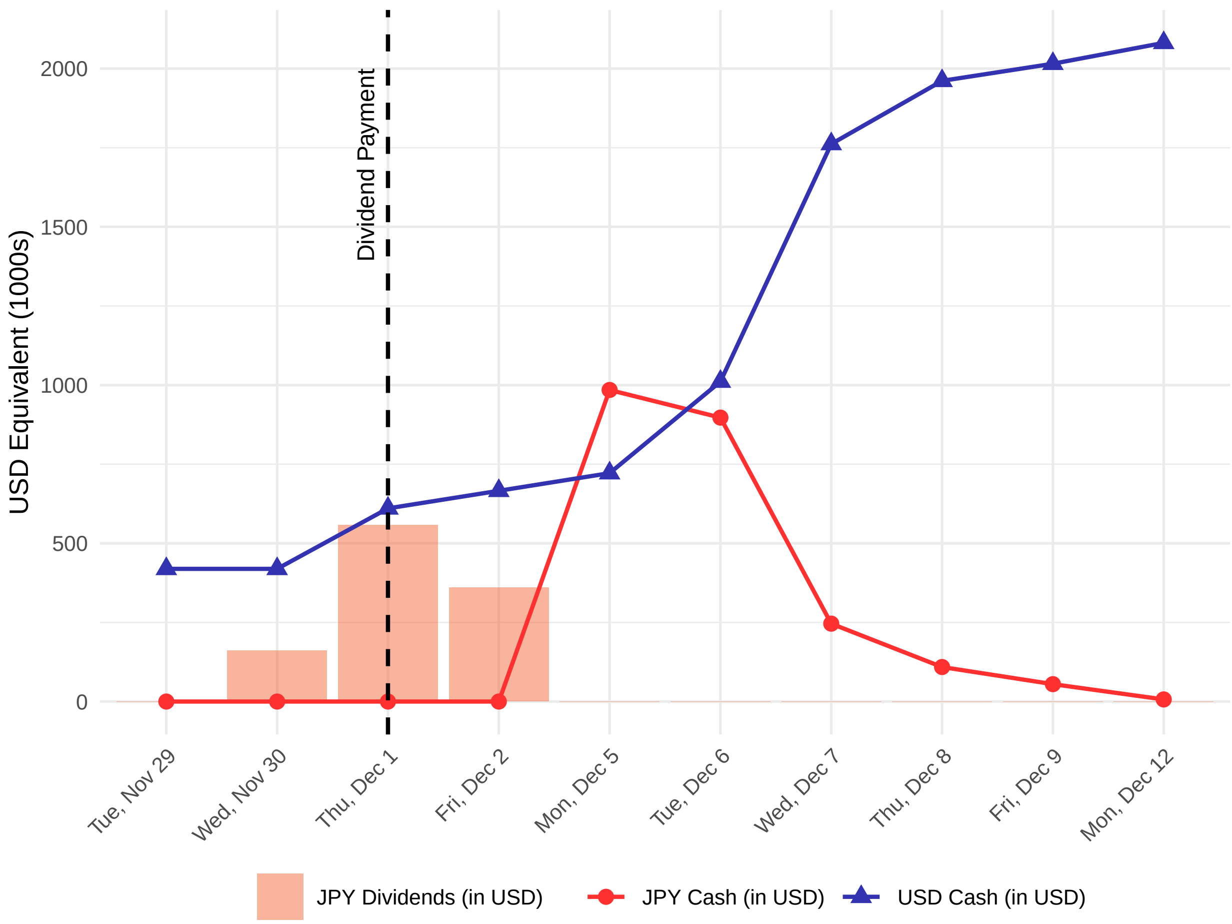


Figure 10: Model Timeline and Equilibrium

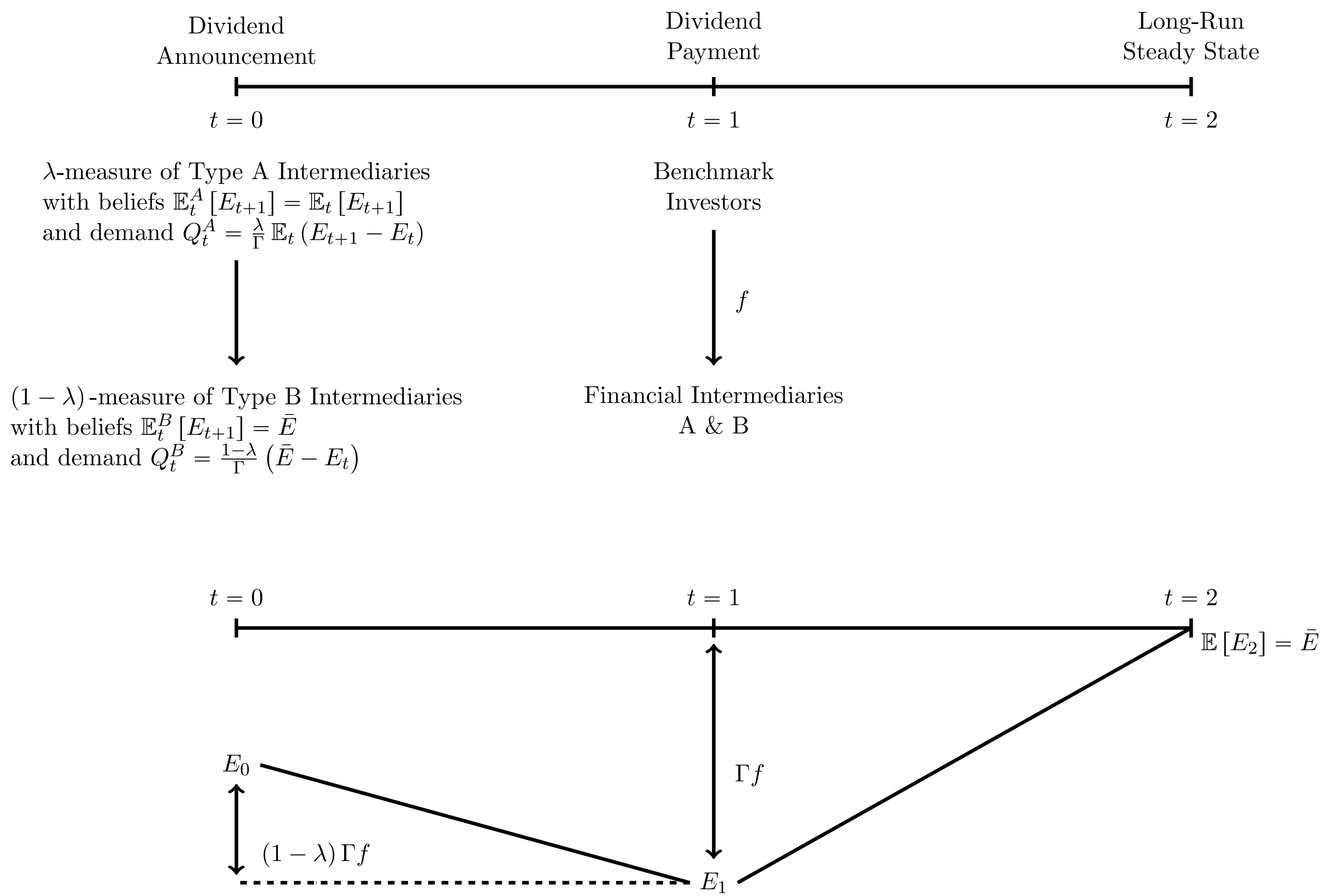


Figure 11: U.S.-Domiciled ETFs and Mutual Funds: Foreign Holdings as Share of the Local Stock Market

This figure shows the market value of US-domiciled ETFs and mutual funds equity holdings as a percentage of each country's aggregate market capitalization. The holdings of US-domiciled ETFs and mutual funds are from Morningstar, focusing on asset class being Equity or REITs. For ETFs, the sample period is from 2011 to 2020. For mutual fund, the sample period is from 2002 to 2020. The year-end aggregate market capitalization for each country is from Bloomberg.

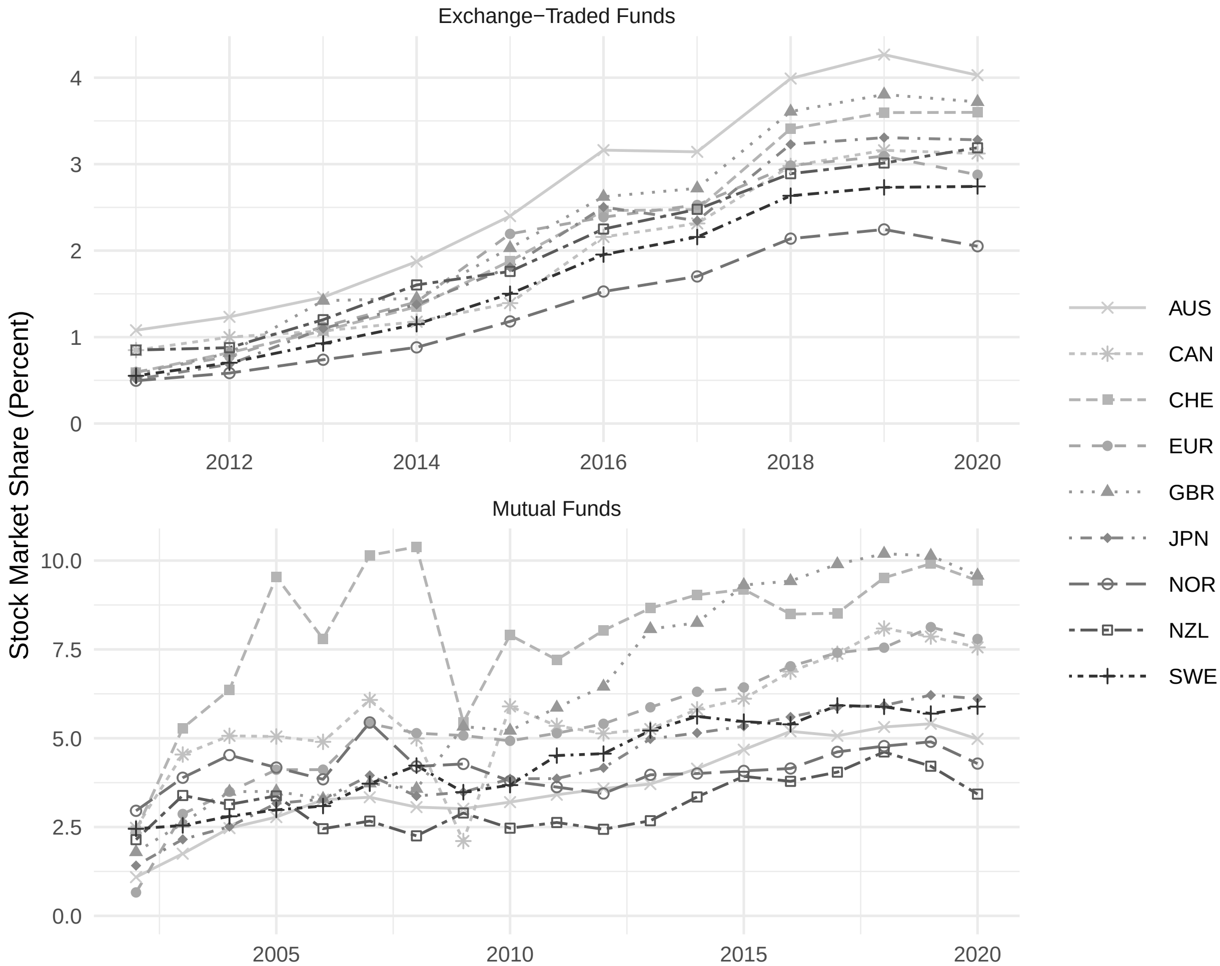
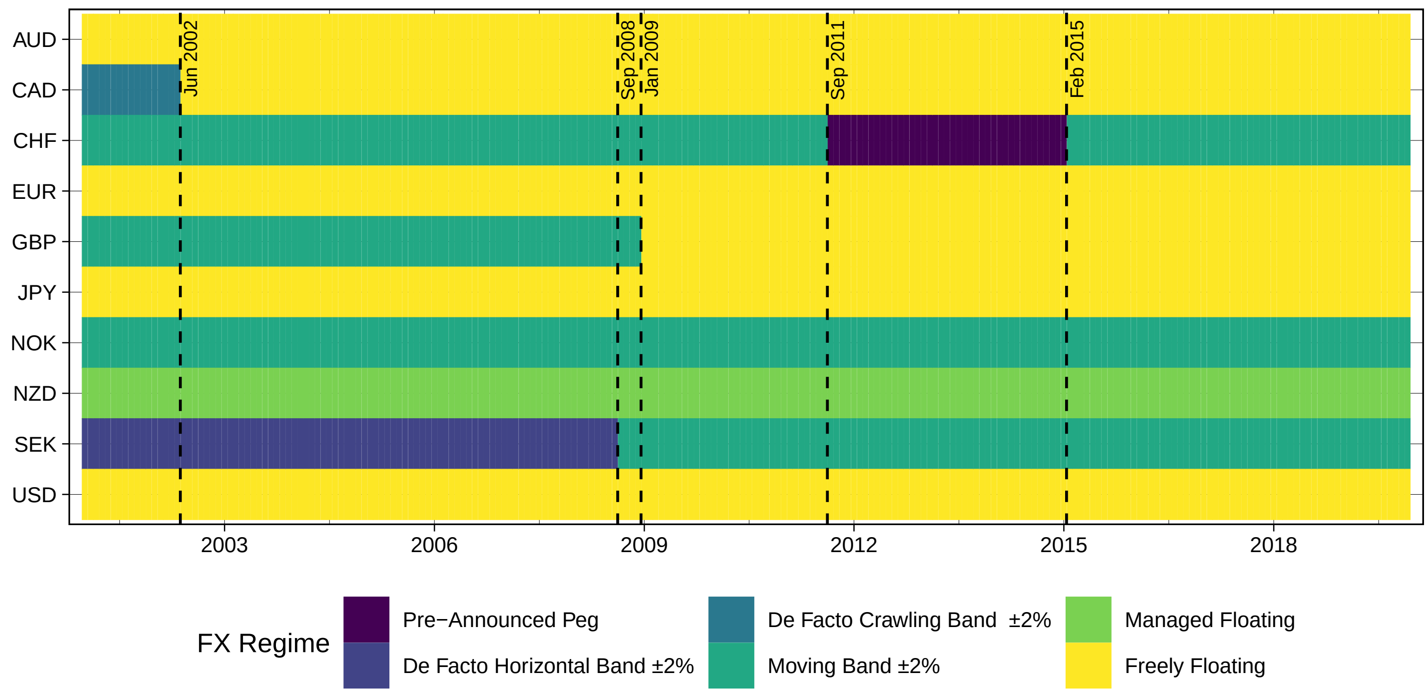


Figure 12: Time-Series of FX Regimes

This figure reports the fine classification of FX regimes by Ilzetzki, Reinhart, and Rogoff (2019). AUD, EUR, JPY, USD have always been in the freely floating regime, NOK has always been managed floating (anchoring to AUD), and NOK has always been de facto moving band ±2% against Euro. CAD switched from de facto moving band (±2% band against US dollar) to freely floating in June 2002. GBP switched from de facto moving band (±2% band against Euro) to freely floating in January 2009. SEK switched from de facto horizontal band (±2% band against Euro) to de facto moving band (±2% band against Euro) in September 2008. CHF switched to pegging to Euro during September 2011 to January 2015, while in other time, de facto moving band (±2% band against Euro).



Appendix for
"Dividend Flows and the Foreign Exchange Rate"

Jingtao ZHENG

A Calculation of Foreign Ownership

In this section, I provide further details on the imputation of foreign ownership underlying Table 1 and the construction of $DivOut_{i,t}$ in Eq (12).

Foreign ownership is calculated by external liabilities of equity securities other than investment fund shares in portfolio investment (ILPEEO) divided by the stock market capitalization. If the country does not report ILPEEO in the Balance of Payments (BOP), I impute it from external liabilities of equity and investment fund shares in portfolio investment (ILPE) scaled by the backfilled ILPEEO/ILPE ratio. Backfilled ILPEEO/ILPE ratio fills the missing values by the last non-missing values. If ILPEEO is missing throughout the sample, I use ILPE instead. In most countries, ILPEEO/ILPE ratio is high. The major exception is Eurozone, where on average ILPEEO/ILPE ratio is 42%.

The stock market capitalization data is from Bloomberg (after 2003) and the World Bank (before 2023). The Bloomberg market capitalization is calculated from all shares outstanding. It does not include ETFs and ADRs as they do not directly represent companies. Also, it includes only actively traded, primary securities on the country's exchanges to avoid double counting. For years before 2003, I use data from the World Bank.

For the breakdown of foreign ownership into by G10 and by USA, I use data from the Coordinated Portfolio Investment Survey (CPIS). CPIS has bilateral equity holdings data, from which I can calculate a country's external liabilities of equity by other G10 countries and by USA. Note CPIS equity holdings include both equity and investment fund shares, hence it is similar to ILPE in terms of concept. In cases where external equity liabilities aggregated from bilateral equity holdings in CPIS is larger ILPE reported in BOP, I scale down CPIS equity holdings proportionally. The foreign ownership of the stock market by other G10 countries is calculated from foreign ownership calculated in BOP, scaled by the ratio of equity held by other G10 (from CPIS) and ILPE (from BOP). The foreign ownership of the stock market by USA is calculated similarly.

B Proofs

Proof. At time 1, the currency market clearing condition in terms of demand for GBP at time 1 is:

$$Q_1^A + Q_1^B - f + \eta = 0 \tag{A1}$$

where $-f$ is the benchmark investor's selling GBP to repatriate a certain proportion of dividends out of GBP. Plug in the demand curves for both types of intermediaries, Eq (9) and Eq (10), we have

$$\lambda \mathbb{E}_1[E_2] + (1-\lambda)\bar{E} - E_1 = \Gamma f + \Gamma(-\eta) \tag{A2}$$

Plug Eq (8) into Eq (A2), we have:

$$\bar{E} - E_1 = \Gamma f + \Gamma(-\eta) \implies \bar{E} - \mathbb{E}_0[E_1] = \Gamma f, \quad Var_0[E_1] = \Gamma^2 \sigma_\eta^2$$

That is to say, if the dividend flow f is larger, then the time $t = 1$ exchange rate will be lower.

Going backward to time $t = 0$, the currency market clearing condition in terms of demand for GBP is:

$$Q_0^A + Q_0^B = 0$$

i.e., the trade can only happen between two types of intermediaries.

$$E_0 = \lambda \mathbb{E}_0[E_1] + (1-\lambda)\bar{E} \tag{A3}$$

Re-arrange Eq (A3), we can write the expected change:

$$\mathbb{E}_0 E_1 - E_0 = (1-\lambda)(\mathbb{E}_0 E_1 - \bar{E})$$

Therefore,

$$\mathbb{E}_0 \Delta E_1 = \mathbb{E}_0 E_1 - E_0 = -(1-\lambda)\Gamma f \tag{A4}$$

which completes the proof.

As a side note, for $Var_0[E_1] = \Gamma^2 \sigma_\eta^2$ to be σ_E^2, the strength of the noise trader is $\Gamma \sigma_\eta = \sigma_E$.

□

C Additional Identification Strategies

C.1 Currency-by-Year-Month Fixed Effect

C.2 Interactive Fixed Effect

D Additional Tables and Figures

Table A1: Own-Effect and Cross-Effect of Dividends on Exchange Rates

This table reports the coefficients β_h and γ_h in Eq (7).

	Days Relative to Dividend Payment Date										
	0	1	2	3	4	5	6	7	8	9	10
No FE											
Coefficients β	-0.057	-1.470	-5.046**	-5.410**	-4.958*	-7.263**	-7.490**	-8.666**	-8.794**	-7.060*	-5.781
Standard Errors	(1.352)	(1.941)	(2.323)	(2.705)	(2.933)	(3.237)	(3.506)	(3.802)	(3.944)	(4.187)	(4.505)
Coefficients γ	0.848	-0.817	-2.510	-2.547	-1.925	-1.457	-1.471	-2.061	-1.166	-0.421	0.504
Standard Errors	(1.153)	(1.751)	(2.189)	(2.554)	(2.871)	(3.138)	(3.383)	(3.637)	(3.895)	(4.123)	(4.338)
Currency FE											
Coefficients β	-0.059	-1.471	-5.047**	-5.409**	-4.956*	-7.260**	-7.487**	-8.665**	-8.792**	-7.056*	-5.777
Standard Errors	(1.352)	(1.941)	(2.324)	(2.705)	(2.932)	(3.236)	(3.504)	(3.800)	(3.943)	(4.186)	(4.503)
Coefficients γ	0.839	-0.828	-2.522	-2.560	-1.939	-1.471	-1.484	-2.074	-1.179	-0.433	0.493
Standard Errors	(1.153)	(1.751)	(2.189)	(2.554)	(2.871)	(3.138)	(3.383)	(3.638)	(3.895)	(4.123)	(4.338)

Figure A1: Price Effect of Dividends on FX using Synthetic Control Estimates by Currency

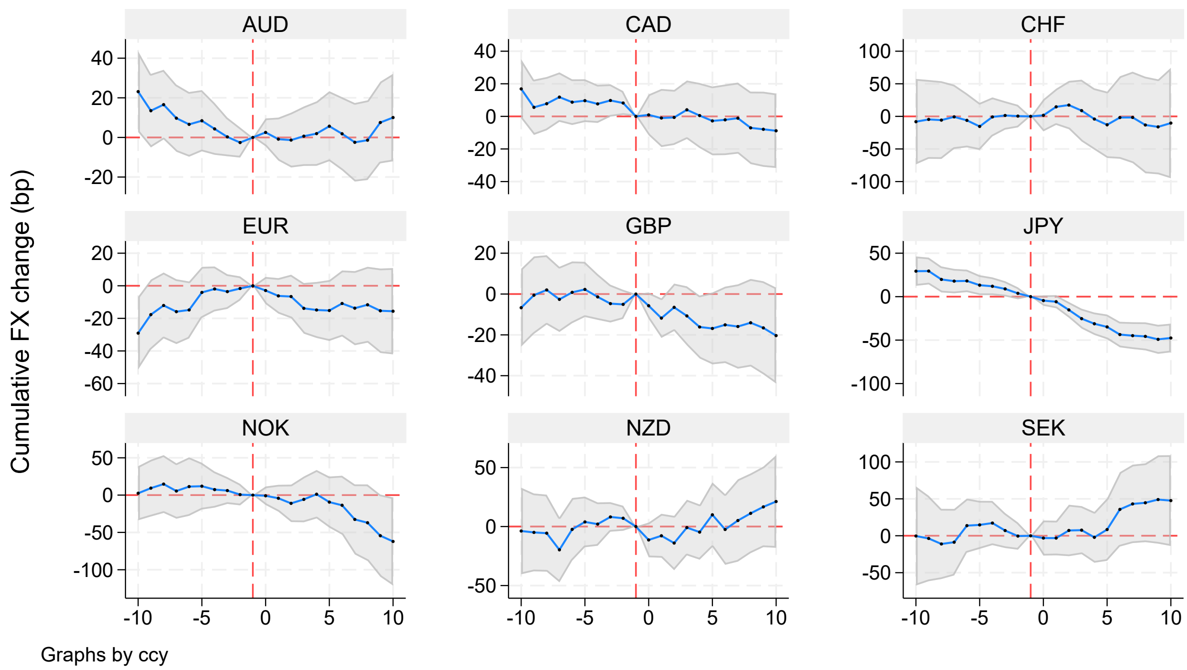
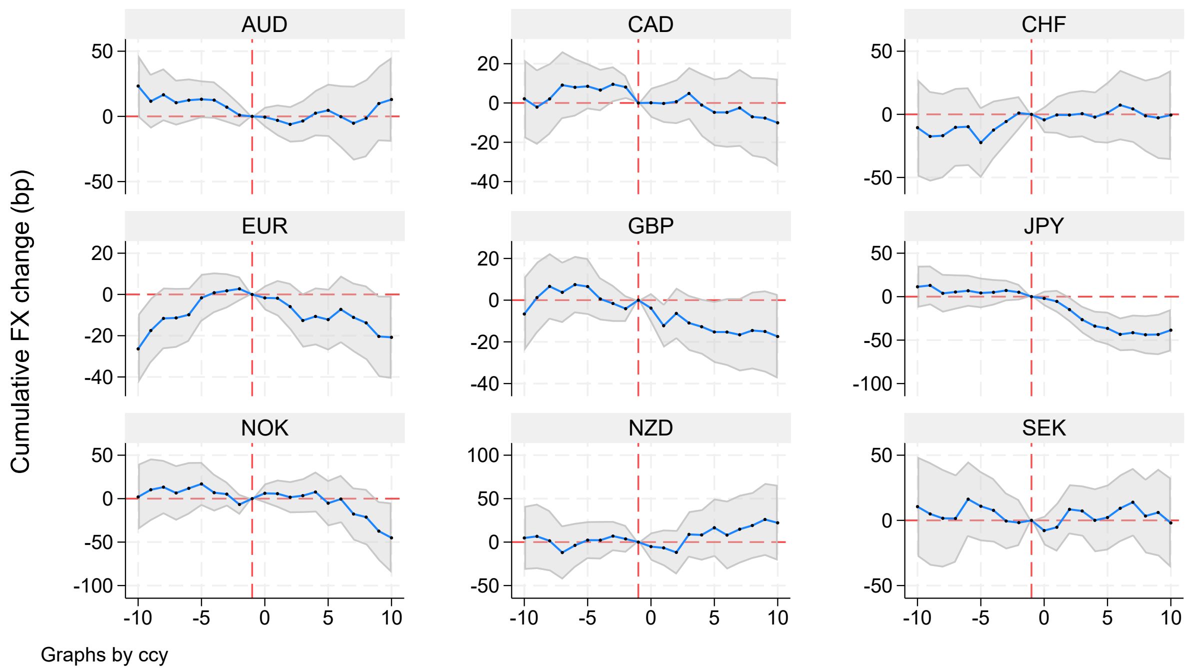


Figure A2: Price Effect of Dividends on FX using DiD Estimates by Currency



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