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# Spillovers to Exchange Rates from Monetary and Macroeconomic Communications Events

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## Abstract

We study the tightness of the link between U.S. monetary and macroeconomic communication events and the exchange rate movements against the USD of four major currencies—the euro, the Swiss franc, the Brazilian real and the Mexican peso—since the global financial crisis (GFC). We find three main results. Approximately 20 percent of the U.S. communications events were associated with statistically significant exchange rate effects. Unconventional and conventional monetary policy announcements had equal impacts. The reactions of the advanced countries' currencies were more in line with each another than with those of the emerging markets' currencies.

**JEL classification:** C22, E58, F31, G14.

**Keywords:** Central bank communication, macroeconomic news, exchange rates, event study.

## 1 Introduction

An important channel through which changes in monetary policy affect the economy is the value of the currency. In the wake of the global financial crisis (GFC), the Federal Reserve (Fed), faced with high unemployment, low inflation and a slow recovery, implemented a series of unconventional monetary policy measures (UMP), including holding short-term interest rates near zero for an extended period, providing forward guidance to market participants, and engaging in three rounds of quantitative easing (QE). This policy was not always met with approval.<sup>1</sup> One complaint was that the U.S. was engaging in a currency war, also known as competitive depreciation. The other was that the Fed was creating spillover effects on international asset prices and capital flows that were buffeting financial markets in emerging market economies (EMEs).<sup>2</sup>

This background motivated us to study the tightness of the link between monetary policy communications and the exchange rate movements against the USD of four major currencies since the GFC. This is a key question for policymakers. Indeed,

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<sup>1</sup>See Bernanke (2017).

<sup>2</sup>An important voice on this issue was Rajan (2014).

one may even argue that overconfidence in the tightness of this link lies at the core of the global race to the bottom on interest rates as countries reduce rates in hopes of depreciating their own currencies relative to others.

Our work contributes to the literature on the exchange rate effects of official communications by broadening it in four respects. First, while previous research on spillover effects from Fed policies focused on developed countries, we examine exchange rate reactions of both advanced- and emerging-economy currencies. Specifically, we compare spillovers to the dollar value of the Swiss franc and the euro, on the one hand, and the Brazilian real and the Mexican peso, on the other. Second, we study the currencies' reactions to all Federal Open Market Committee (FOMC) announcements from 2007 to 2015. Third, to put the evidence from Fed communications into perspective, we also analyze how the currencies responded to releases of key U.S. macroeconomic variables. Fourth, we compare the exchange rate effects of U.S. communications with those arising from communications by the European Central Bank (ECB), the Swiss National Bank (SNB), the Banco Central do Brasil (BCB), and the Banco de México (Banxico).

Our estimation is nested in an event-study approach and makes use of market data at daily frequency. The estimations rely on pseudo out-of-sample forecasts based on autoregressive models and various forecast periods. A comparative analysis between the actual values on communication days and the forecasts is used to assess the estimates' significance. Five main results emerge.

As the main contribution of the paper, we find that 21 percent of U.S. communication events were statistically significant (Table 1). FOMC communications were more relevant than macroeconomic news, except for the Employment Report. Approximately one-third of FOMC communications and Employment Report releases were associated with statistically significant exchange rate effects. While the effect of FOMC announcements was concentrated during the heights of the GFC, Employment Report releases affected the currency markets throughout the sample period. No systematic trend can be observed. Appreciations and depreciations were balanced over time. Another result is that there is no evidence that unconventional policy announcements (decisions) were any less effective in triggering market reactions than conventional policy announcements. A further result is that the Swiss franc and the euro reveal reaction patterns that are more in line with one another than with those of the Mexican peso and the Brazilian real. We interpret the latter as a variant of the exchange rate puzzles regarding EME currencies that have been reported in the literature. Finally, the communication events covered capture approximately 40 percent of the strongest appreciations and depreciations for the four currencies.

Table 1: Average reactions to monetary and macroeconomic news

FOMC- Statements	22%	Employment Report	35%	Retail Sales	14%
Uncon- ventional	31%	Consumer Price Index	22%	Durable Goods	7%
Un- scheduled	40%	GDP	25%	Total	21%

The remainder of the paper is structured as follows. After the literature review in section two, section three explains the data set, followed in section four by the exposition of the statistical framework and the empirical approach. Section five

presents the results. Section six concludes the paper.

## 2 Related Literature

The question of whether and how financial markets react to various types of information flowing into them has long been a subject of intense research. Several studies have documented large and significant effects of U.S. monetary policy announcements on U.S. financial markets. For instance, Kuttner (2001) and Fleming & Piazzesi (2005) show evidence for Treasury rates, Bernanke & Kuttner (2005) for stock prices, Gürkaynak *et al.* (2004) for a variety of assets, and Fatum & Scholnick (2008) and Rosa *et al.* (2016) for exchange rates.

Other papers have studied how U.S. monetary policy affects foreign asset prices. However, these studies focus on only a few countries, typically developed countries, and a single asset class.<sup>3</sup> An exception is Hausman & Wongswan (2011), who investigates the response of global equity indexes, short- and long-term interest rates, and exchange rates to U.S. monetary policy announcements in 49 countries.

Another strand of literature has looked at the asset-price response to the release of FOMC statements after the GFC. Taylor (2009), J. Gagnon *et al.* (2011) and J. E. Gagnon *et al.* (2017), for example, have studied the Fed’s 2008-09 QE programs. Given the international reactions mentioned in the introduction, an important question is the effect of Fed UMP actions on exchange rates. To the extent that these actions do have such impacts, they have direct spillover effects. The exchange rate impacts of UMP are relatively unexplored. Spillovers from the U.S. to global financial markets were thrown into sharp relief during the “taper tantrum” in 2013 (Eichengreen & Gupta (2015) and Mishra *et al.* (2018)). Haldane *et al.* (2016) show that most QE announcements by the Fed, the Bank of England, the ECB, and the Bank of Japan led to a depreciation of effective exchange rates within a two-day window around the communications. Fratzscher *et al.* (2018) analyze the effects of the Fed’s UMP on U.S. and 65 foreign financial markets and find that Fed measures in the early phase of the crisis (QE1) were highly effective in boosting bond and equity prices, especially in the US, and led to U.S. dollar appreciations. Conversely, QE2 boosted equity prices worldwide and led to U.S. dollar depreciations.

Another research question is whether the effects on exchange rates of conventional monetary policy are any different from those of unconventional policy. The evidence is not clear. Neely (2015) finds that QE announcements had larger effects on the dollar and on foreign yields than non-QE announcements. Glick & Leduc (2013) and Glick & Leduc (2017) compare the effects of FOMC meeting statements on the U.S. dollar prior to the GFC with those in the post-GFC era, which included announcements related to QE and forward guidance. The result is that monetary policy surprises had much larger effects on the value of the U.S. dollar in the post-GFC era. Similarly, Ferrari *et al.* (2017) and Curcuru (2017) show that the responsiveness of exchange rates to U.S. monetary policy announcements rose after the GFC. By contrast, Curcuru *et al.* (2018) suggest that changes in expected U.S. interest rates—whether stemming from announcements on conventional policy adjustments, forward guidance, or other forms of signaling—exerted effects on exchange rates that were as large as or larger than the effects of QE announcements, contradicting the view that the latter had greater international spillovers than communications on conventional monetary

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<sup>3</sup>Faust & Rogers (2003), T. G. Andersen *et al.* (2007), and Wongswan (2009).

policies. Finally, Inoue & B. Rossi (2018) show that the effects of monetary policy communications on exchange rates are similar in the conventional and unconventional periods.

Exchange rates may respond not only to monetary policy announcements but also to developments in the real economy that are channeled to the market via macroeconomic news releases. T. Andersen *et al.* (2003), Evans & Lyons (2005), T. G. Andersen *et al.* (2007), and Bartolini *et al.* (2008) find that macroeconomic surprises have the strongest impact on interest rates, while the impact is less pronounced for exchange rates and equity prices. However, the effects on exchange rates (and interest rates) appear to be longer lasting than the effects on equity prices. Rosa (2013) documents that from January 2005 to March 2011, the response of ten-year Treasury rates and S&P500 stock prices to nonfarm payrolls was smaller than the response induced by FOMC statements, whereas the U.S. dollar exchange rate against the euro, Swiss franc, and yen was more sensitive to nonfarm payrolls than to monetary news.<sup>4</sup>

### 3 Data

To measure the statistical significance of the effects of communication events on exchange rates, we collected four currency pairs and 2,166 communication events from the U.S., the euro area, Switzerland, Brazil and Mexico. The sample period runs from January 2007 to December 2015 and can be divided into two phases. The first comprises the period from the outbreak of the GFC in August 2007 until March 2009, when the most intense phase of the crisis had come to an end (at least in the U.S.) and market liquidity conditions had started to improve.<sup>5</sup> The second part covers the post-crisis years from April 2009 until the end of 2015.

The extent to which an announcement affects the currency depends on whether market participants expect its content. For this reason, the event-study literature typically controls for market expectations to identify the surprise component. Fatum & Scholnick (2008) show that consistent with standard asset-pricing theory applied to exchange rates, the expected component of a monetary policy change has no impact on the exchange rate, while the unexpected component of a tightening (loosening) of U.S. monetary policy is associated with a same-day appreciation (depreciation) of the U.S. dollar. However, with UMP, there is no clear measure of the central bank's policy stance, and it is not straightforward to determine policy expectations (Rogers *et al.* (2014)). Given the difficulties involved in properly identifying surprises, especially during our sample period, we decided not to assess the expected part of the announcements.<sup>6</sup>

A related issue is the frequency of the data. We opt for daily frequency. While intraday data help pin down the direct response of exchange rates to announcements because one can attribute an exchange rate's movement to the announcement in a sufficiently small window around the announcement, too narrow a window is likely to miss part of the effect of the monetary policy news.<sup>7</sup> This issue needs to be

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<sup>4</sup>Cavusoglu (2011) surveys the relevant literature and provides extensive evidence that developments in macroeconomic fundamentals are important for exchange rate movements.

<sup>5</sup>Similar dating of the financial crisis has been proposed by Kontonikas *et al.* (2013).

<sup>6</sup>There are ways to get around the difficulties of quantifying the surprise component of communication. For instance, Sack & Kohn (2004) look at whether and to what extent the volatility of asset prices is higher on release days than on nonevent days. Our procedure is explained below.

<sup>7</sup>For instance, Ranaldo & E. Rossi (2010) analyze the effects on asset prices of communications

considered in the post-financial crisis environment, when announcements became complicated, took time to digest, and were often explained in subsequent press conferences. That said, if too wide a window is used, the monetary policy news effects will be contaminated by other shocks arising from coincident events.<sup>8</sup>

To take the latter into account, we control for contemporaneous communications in the other four currency areas on U.S. event days. This raises the probability that significant currency movements result from market surprises related to the underlying announcement and not from other events. Hence, if the effect of an event turns out to be significant, we are confident that either the communication was not expected (in the case of unscheduled FOMC announcements) and/or its content came as a surprise and the market had enough time to digest the news component.<sup>9</sup> This assumption is justified by the important empirical result that foreign exchange markets react to news within less than a day (Ederington & Lee (1993), Bonser-Neal *et al.* (1998), Cheung & Chinn (2001), T. Andersen *et al.* (2003), Chaboud *et al.* (2004), Simpson *et al.* (2005), Fatum & Scholnick (2008), Rosa (2013), Babecká Kucharčuková *et al.* (2016)).<sup>10</sup>

### 3.1 Exchange Rates

We collected via Bloomberg daily exchange rate data of the U.S. dollar to the euro, the Swiss franc, the Brazilian real, and the Mexican peso. For every trading day, we compiled four data points: the opening, closing, highest and lowest quotes. The closing quotes, collected by Bloomberg, are taken at 5 pm EST.<sup>11</sup> This means that irrespective of the timing of central bank communication, an announcement falls within the 24 hours of an exchange rate trading day. The timing of the communications varied, especially during the height of the financial crisis. This implies that the time interval between the information release and the closing quote may differ. The same applies to communications from the other central banks. The time interval in hours between the communication release and the closing quote is longer for both the SNB and the ECB and similar to that of the Fed for the Banco de México and the BCB. Macroeconomic news is always published at the same time of day.

The opening price had to be excluded because markets opened in the vast majority of cases ahead of the relevant announcements.<sup>12</sup> For our forecast estimations, we assume that the use of three points a day is precise enough to capture trading movements and provide acceptable estimates. We computed the exchange rate

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by the Swiss National Bank using intraday high-frequency data and Jäggi *et al.* (2019) the effects of macroeconomic surprises on the Swiss franc and the Japanese yen.

<sup>8</sup>The use of daily data is justified if the main interest is to investigate the effectiveness of central bank communication (Jansen & De Haan (2005)), although that is not the main objective of this paper.

<sup>9</sup>Otherwise, if forward-looking market participants anticipated the occurrence of the event or the content of the news, no additional information is revealed, and market prices should not move at the time of an announcement.

<sup>10</sup>Others report delayed effects. Eichenbaum and Evans (1995) and Lewis (1995) do not find evidence in support of an immediate exchange rate response to monetary policy changes. Faust & Rogers (2003), in the context of identified (recursively or not) VAR models, show confidence intervals consistent with exchange rate responses occurring anywhere from instantaneously to five years after the news announcement. Similarly, Evans & Lyons (2005) find delayed exchange rate responses several days after the emergence of news.

<sup>11</sup>Trading hours in New York span from 8 am to 5 pm EST (1 pm to 10 pm UTC).

<sup>12</sup>We made use of the opening quotation if a statement was published over the weekend, which occurred in some instances during the peak of the GFC.

variations for all three quotations and each currency. A communication event is considered to be significant if at least one quote exhibited a significant reaction. The exchange rate is the U.S. dollar price of a foreign currency. Thus, an increase in the exchange rate corresponds to an appreciation of the U.S. dollar (a depreciation of the foreign currency).

## 3.2 U.S. Communication Events

We collected and analyzed 598 U.S. communication events, including FOMC announcements and publications of key macroeconomic variables.<sup>13</sup> Among these 598 events, 140 are FOMC announcements, which we further parse into three categories: FOMC statements (101), unconventional FOMC announcements (29), and unscheduled policy announcements (10).

### 3.2.1 FOMC Announcements

**FOMC Statements** include every scheduled announcement related to FOMC meetings. Fifty-nine FOMC statements (60 percent) were issued during the financial crisis.

In the second category, which we denote as **unconventional**, we grouped announcements of exceptional policy measures. An example is the statement on November 25, 2008, in which the FOMC announced that it would initiate a program to purchase the direct obligations of housing-related government-sponsored enterprises and mortgage-backed securities. Twenty-two out of the 29 unconventional announcements (76 percent) occurred during the period of time we associate with the financial crisis.

In the third category, termed **unscheduled**, we collected all FOMC meetings that were not scheduled.<sup>14</sup> An example is the joint statement of central banks on October 8, 2008. All ten unscheduled FOMC statements were released during the financial crisis.

Overall, the phrasing of the FOMC communication of exceptional monetary policy measures shows a predominance of calendar-based forward guidance.<sup>15</sup> In December 2008, the statement added the FOMC’s expectation that “*weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time.*” Two meetings later, this guidance was strengthened when “*for some time*” was upgraded to “*for an extended period.*” On August 9, 2011, “*extended period*” was replaced by a more forceful and explicit variant of calendar guidance. The statement said that rates were expected to remain exceptionally low “*at least through mid-2013*”. Six months later, the guidance was extended to “*at least late 2014*”. In September 13, 2012 it was extended even further, to “*at least mid-2015*”.

Note that although we focus on single FOMC announcements, what we obtain is a measure of their composite effect on exchange rate returns, without decomposing it into the effects of specific policies, such as forward guidance or asset purchases. It

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<sup>13</sup>There are additional Fed communications, such as minutes of the FOMC meetings, press conferences, and FOMC speeches and testimonies. We limit the scope of analysis by assuming that these other forms have—in line with findings from Feroli *et al.* (2017)—played two roles: to further amplify the FOMC’s central policy message and to indicate the range of conflicting views about current policy and policy prospects among FOMC participants. For the potential problems arising from central bank cacophony, see Lustenberger & E. Rossi (2020).

<sup>14</sup>When a statement involved the announcement of an unconventional policy measure on an unscheduled day, we categorized it as an unscheduled rather than an unconventional event.

<sup>15</sup>See Feroli *et al.* (2017).



is difficult to separate the effects of these different types of unconventional policy since many announcements covered policies of multiple types.<sup>16</sup>

### 3.2.2 Macroeconomic News

We analyzed news about a variety of important macroeconomic indicators. The motivation for examining macro news is that, a priori, markets may react differently to this type of news than to monetary policy communications because of a fundamental difference between the two types. While monetary policy announcements are forward-looking, the vast majority of macro announcements pertain to previous economic activity and are backward-looking. Moreover, the Fed’s objectives are maximum employment and stable prices (in addition to moderate long-term interest rates). For this reason, we were interested in market reactions to releases of the Employment Report and the Consumer Price Index (CPI). In addition, we considered announcements of gross domestic product (GDP)—the most comprehensive measure of real economic activity and, as such, potentially important to financial markets as well—as well as announcements of orders for durable goods and retail sales. We collected a total of 458 U.S. macro announcements, 107 related to the Employment Report, 100 to the Consumer Price Index, 36 to GDP releases, 108 to retail sales and 107 to orders of durable goods.

Employment statistics have long been considered an important driver of market prices. Early research, such as that by Harris and Zabka (1995) and Moorthy (1995), recognized the importance of the U.S. Employment Report.<sup>17</sup> Unexpectedly, strong employment increased the foreign exchange value of the dollar, perhaps because it increased expected short-term interest rates.<sup>18</sup> In our sample, the Employment Report is likely to have attracted special attention for two reasons. First, a low rate of unemployment is an objective of the Fed. Second, and more importantly, starting on December 12, 2012, the FOMC changed the orientation of its forward guidance from explicit calendar-based forward guidance “*at least through mid-2015*” to threshold-based language (which sounded more data-dependent).<sup>19</sup> The statement read: “*This exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee’s two percent longer-run goal, and longer-term inflation expectations continue to be well anchored*”. In December 2013, the FOMC began tapering off its monthly asset purchases and redrafted its forward guidance to explain how it intended to react to future economic conditions. The statement was changed from “*at least as long as unemployment remains above 6-1/2 percent*” to “*it likely will be appropriate to maintain the current target range for the federal funds rate well past the time that the unemployment rate declines below 6-1/2 percent*”. On March 19, 2014, reference to the 6-1/2 percent unemployment threshold for liftoff was dropped altogether.

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<sup>16</sup>A similar caveat is raised by Rogers *et al.* (2014) and Thornton (2017).

<sup>17</sup>At 8:30 am EST on the first Friday of every month, the U.S. Department of Labor’s Bureau of Labor Statistics releases the Employment Situation Summary, otherwise known as the Employment or Jobs Report. The data on nonfarm payrolls as part of the report are often referred to by market participants as the “king” of announcements (T. G. Andersen & Bollerslev (1998)).

<sup>18</sup>Ederington & Lee (1993) Ederington and Lee (1993, 1995) support the claim that employment news affects foreign exchange returns through expectations of future interest rates.

<sup>19</sup>Feroli *et al.* (2017) argue that this period was characterized by some softening of calendar-based guidance and directed towards more data-dependent forward guidance.

Another potentially important macro variable is the CPI. Tanner (1997) finds that the response of DEM/USD markets to U.S. CPI announcements was insignificant from 9 to 10 am but became significant for several periods later in the day. Tanner (1997) suggests that market participants require hours to digest the complexity of the CPI report. This explanation is inconsistent with other studies of the CPI, such as Hakkio & Pearce (1985), Tandon & Urich (1987), and Faust *et al.* (2007), who find no significant effect of CPI releases.

### 3.3 Control Variables

To control for other events that may affect the exchange rates on a U.S. communications day, we also compiled a large quantity of central bank communications and key macroeconomic indicators from the euro area, Switzerland, Brazil and Mexico, totaling 1,122 observations. All control variables except for the central bank events were obtained via Bloomberg.

For the euro area, we recorded a total of 633 announcements— 151 (24 percent) by the ECB, divided into 87 regular statements and 64 unconventional policy announcements. The other publications cover fundamental macroeconomic series such as the CPI (64), GDP (36), Economic Sentiment Indicator (35), retail sales (41), the Employment Report (56), the Eurocoin growth indicator (98), the composite PMI (54), and nominal exports to extra-EA 18 countries (98). For Switzerland, we have a total of 369 announcements; 75 (20 percent) are by the SNB—34 regular, 30 unconventional<sup>20</sup> and 11 unscheduled statements. The other 294 communication events relate to macroeconomic variables: CPI (47), GDP (10), KOF Economic Barometer (43), PMI (98), and trade figures (96). For Brazil and Mexico, we accounted for the communications of the BCB and the Banco de México. The number for Brazil is 73 and for Mexico 47. We only checked for recent macroeconomic news events if a U.S. event did not give rise to a market reaction similar to that observed in the other currency pairs. For instance, if three currency pairs except for the peso or the real did not react following a U.S. event or the reactions were in opposing directions, we checked for the issuance of Brazilian or Mexican macro news. This turned out to be mostly unnecessary.

## 4 Methodology

### 4.1 Pseudo Out-of-Sample Forecasts

We use a time-series event study to evaluate the effects of communications on exchange rates. An event is defined as an FOMC announcement or the publication of U.S. macroeconomic indicators described in the previous section. The day of publication becomes the event day.

Unlike previous event studies, we deploy a pseudo out-of-sample forecast approach.<sup>21</sup> This approach involves estimating point forecasts with the corresponding confidence intervals and comparing them to the realized values on the event day. The predicted point forecast of the first difference is in expectation zero (the usual random walk benchmark). We determine a confidence interval at the 95 percent level.

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<sup>20</sup>Unconventional policy undertaken by the SNB includes the measures it took alone or in coordination with other central banks to address pressures in money markets during the heights of the financial crisis as well as the announcement related to the introduction of the minimum exchange rate at CHF 1.20 per euro.

<sup>21</sup>See Stock & Watson (2011), page 56ff.

If the realized value lies outside of the confidence interval, we assess it as significant. Since the period preceding each event day drives the confidence interval, we conduct the pseudo out-of-sample approach for four different forecast periods preceding each event day. This yields four independent forecasts and their corresponding confidence intervals. We opted for 100 trading days as the upper bound and ten trading days as the minimum quantity to generate a reasonable forecast. Intermediate period lengths are 50 and 25 trading days ahead of an event.

Following the common modeling of exchange rates, we assume that the four USD exchange rate time series are integrated of order one. The first difference yields covariance stationarity in the time series. Based on Augmented Dickey-Fuller tests for unit roots, we reject the null that the series are random walks without drift.<sup>22</sup> The alternative is that the series follow an AR(p) process with zero mean. We test whether the residuals are white noise with the Portmanteau test so that forecasting and inference are predicted on consistent estimators. We run  $p^{th}$ -order autoregressions based on the Schwarz or Bayesian information criterion (SBIC) for each forecast period. The regression equation reads

$$Y_{j,t} = \beta_0 + \beta_1 Y_{j,t-1} + \beta_2 Y_{j,t-2} + \dots + \beta_p Y_{j,t-p} + u_{j,t} \quad (1)$$

where  $Y_{j,t}$  is the first difference of the exchange rate measured by three distinct daily quotes  $j = \text{“high”}, \text{“low”}, \text{“close”}$  relative to those of the previous trading day. With these data, we estimate  $Y_{T+1}$ , using data up to period T, where T represents the event day. Thus, our estimate is the one-day-ahead forecast of the first difference in the dollar exchange rate vis-à-vis the four currency pairs.

Overall, we examined 598 U.S. communication event days over four different forecast periods ahead of an event for four currency pairs and three data points a day, which adds up to 28,704 significance tests.<sup>23</sup> We found that the results on the 100-, 50-, and 25-day forecast periods yield the same significant event days, while the 10-day forecast period produces, in addition, approximately eight percentage points more significant reactions. An event day is defined as significant if at least one of the three quotes in one of the forecast intervals is significant based on the 95 percent confidence interval.

Our procedure is visualized in Figure 1. We show, as an example, the effect of the U.S. Employment Report issued on 3/9/2007 with a forecast period of 50 trading days, running from 12/29/2006 to 3/9/2007. The USD/EUR forecast is denoted by a blue dot together—for illustration purposes—with two corresponding confidence intervals marked by two differently shaded areas. The lighter area denotes the 95 percent confidence interval, and the darker blue denotes the 80 percent interval. Three lines are drawn, representing the first-differenced exchange rate measured with respect to the high, the low and the close quotation. When a line lies outside the shaded area, the communication event significantly affected the currency market. As Figure 1 shows, on 3/9/2007, the market reaction was significant. Two of the three lines (quotes) lie outside the two shaded areas.

## 4.2 Coincident Events

A potential problem with our estimates arises when a U.S. announcement coincides with other announcements, either from the U.S. or from the other four currency

<sup>22</sup>These results are available upon request.

<sup>23</sup>We performed an additional 17,664 tests for the 368 Swiss communication events. The results are available upon request.

Figure 1: 50 Days USD/EUR Forecast Period on 80% and 95% Confidence Intervals

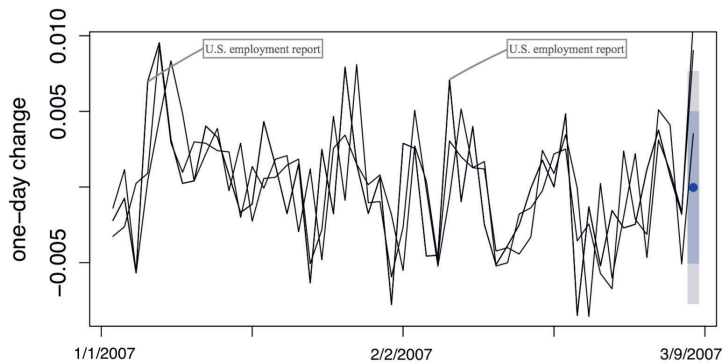


Figure 1 illustrates the two-sided 80% and 95% confidence interval. The three lines are the high, low and close over 50 trading days. The communication event is the Employment Report of March 9, 2007.

areas. To correct for coincident events, we proceeded in two steps based on the significant event days obtained in the regressions described above. First, we eliminated all coincident event days—for instance, when an FOMC announcement and the publication of the Euro Area Economic Sentiment Indicator occurred on the same day. Second, we recovered the event that we assumed to be the trigger of the currency fluctuation. In this example, it would be the FOMC announcement, as it is more likely for an FOMC announcement to move the market than the publication of the Euro Area Economic Sentiment Indicator. In general, we detected only very few coincident events. No overlap between U.S. Employment Report releases and FOMC announcements occurred.

## 5 Results

We organize the discussion of the results into six subsections. We start with a general overview of the results. In subsection two, we summarize the market impact of the main U.S. communication events. Subsection three provides a detailed analysis of FOMC announcements. Subsection four examines the currency reactions to domestic central bank communications. In subsection five, we embed our findings in the relevant literature and, in subsection six, give an account of the relative importance of communication events examined in this paper in explaining significant currency reactions.

### 5.1 Descriptive Statistics

Table 2 presents descriptive statistics for the event days in which FOMC announcements resulted in a currency reaction that was significant at the 95 percent confidence level. A positive (negative) reaction suggests an appreciation (a depreciation) of the U.S. dollar. On average, there is a small but insignificant pattern of depreciation against all four currencies after FOMC announcements. For instance, the U.S. dollar depreciated against the Swiss franc by one tenth of a cent. The sum of daily differences between the forecast level of the USD/CHF and the realized value points to a depreciation of the dollar of approximately 56 cents. The highest positive daily reaction was recorded for the Swiss franc (an appreciation of the dollar of nine cents). The highest negative reaction is observed for USD/MXN (a depreciation of the dollar

of 12 cents). In terms of standard deviation, the results are very similar across currencies.

Table 2: Summary Statistics of Market Reactions to FOMC Announcements in USD

	USD CHF	USD EUR	USD BRL	USD MXN
Mean	-0.001	-0.0001	-0.0004	-0.004
Median	-0.0001	-0.0005	-0.00001	-0.002
Sum	-0.564	-0.017	0.257	-0.317
Highest positive reaction	0.09	0.06	0.082	0.057
Highest negative reaction	-0.04	-0.04	-0.1	-0.122
Standard deviation	0.012	0.012	0.013	0.011

Table 2 shows the summary statistics of the difference between the realized and the forecast values following an FOMC announcement.

## 5.2 Significant Event Days

Table 3 lists the number and percentage of significant currency reactions to U.S. communication events, specifically, FOMC, Employment Report, CPI, and GDP announcements.<sup>24</sup> It can be inferred from the table that unscheduled FOMC announcements exhibited the most reactions across currency pairs in relative terms except for the Swiss franc. In fact, the largest share of the reactions of the Swiss franc (45 percent) were to the Employment Report. Further interesting results arise from a comparison across currencies. It becomes apparent that the Brazilian real reacted most often to FOMC statements (30 percent), to unconventional policy announcements (42 percent), to total FOMC communications (34 percent) and to U.S. GDP releases (28 percent). The Swiss franc exhibited more reactions to CPI releases than did the other currencies.

Table 3: Total Number of Significant Event Days

	FOMC- Statements	Uncon- ventional	Un- scheduled	Total FOMC	Employment Report	CPI	GDP
USD EUR							
Significant	26	7	6	39	44	18	8
Total	101	29	10	140	107	100	36
	26%	24%	60%	28%	40%	19%	25%
USD CHF							
Significant	28	9	4	41	48	29	9
Total	101	29	10	140	107	100	36
	28%	31%	40%	29%	45%	29%	25%
USD BRL							
Significant	30	12	5	47	32	22	10
Total	101	29	10	140	107	100	36
	30%	42%	50%	34%	30%	22%	28%
USD MXN							
Significant	22	9	4	35	37	22	9
Total	101	29	10	140	107	100	36
	22%	31%	40%	25%	35%	22%	25%

Table 3 shows all significant market reactions to the main U.S. communication events in absolute and relative terms.

Table 4 documents the market reactions to the main types of communications

<sup>24</sup>Announcements of retail sales and orders of durable goods had hardly any market impact and are not shown. The results are available upon request.

considered in this paper over time. The notable result is that the effects of communication events vary by the specific type of event considered, by currency, and over time. Overall, almost every third FOMC communication triggered a market response, and more than each third Employment Report yielded a significant currency response. FOMC events impacted the currencies mainly between 2007 and 2010. Their influence abated thereafter. The Employment Report was most significant for the euro and the Swiss franc from 2012 to 2014. This is noteworthy, given the importance of the labor market in FOMC communications from December 2012 to March 2014 (as explained in section 3.2.2.), especially the unemployment level of 6.5 percent, which may have been perceived by market participants as the threshold value to trigger a change in the Fed funds rate.<sup>25</sup> CPI and GDP announcements produced fewer surprises overall. Moreover, the currencies did not react uniformly. The Swiss franc was most affected by FOMC statements (30 percent) and the CPI (27 percent), the euro by unscheduled announcements (60 percent), and the Brazilian real by unconventional announcements (41 percent) and overall (33 percent).

Table 4: Significant Market Reactions

	FOMC- Statements	Un- scheduled	Uncon- ventional	Total FOMC	Employment Report	CPI	GDP
USD EUR							
2007	2 /10	2 /3	0 /2	4 /15	3 /12	4 /12	0 /4
2008	6 /16	4 /7	6 /14	16 /37	4 /12	0 /12	0 /4
2009	4 /14	0 /0	1 /12	6 /26	3 /12	1 /12	1 /4
2010	6 /12	0 /0	0 /0	6 /12	5 /12	2 /12	1 /4
2011	3 /9	0 /0	0 /1	3 /10	5 /12	1 /12	0 /4
2012	0 /10	0 /0	0 /0	0 /10	7 /12	3 /12	2 /4
2013	2 /11	0 /0	0 /0	2 /11	6 /12	2 /12	0 /4
2014	2 /11	0 /0	0 /0	2 /11	8 /12	1 /12	3 /4
2015	1 /8	0 /0	0 /0	1 /8	3 /12	4 /12	1 /4
USD CHF							
2007	1 /10	1 /3	0 /2	2 /15	4 /12	2 /12	1 /4
2008	5 /16	3 /7	7 /14	15 /37	3 /12	2 /12	0 /4
2009	5 /14	0 /0	2 /12	7 /26	6 /12	2 /12	1 /4
2010	6 /12	0 /0	0 /0	6 /12	6 /12	5 /12	2 /4
2011	3 /9	0 /0	0 /1	3 /11	4 /12	6 /12	1 /4
2012	2 /10	0 /0	0 /0	2 /11	8 /12	3 /12	2 /4
2013	3 /11	0 /0	0 /0	3 /10	6 /12	4 /12	0 /4
2014	2 /11	0 /0	0 /0	2 /10	7 /12	2 /12	1 /4
2015	3 /8	0 /0	0 /0	3 /8	4 /12	3 /12	1 /4
USD BRL							
2007	3 /10	2 /3	0 /2	5 /15	1 /12	7 /12	1 /4
2008	7 /16	3 /7	9 /14	19 /37	3 /12	1 /12	1 /4
2009	2 /14	0 /0	3 /12	5 /26	4 /12	2 /12	1 /4
2010	3 /12	0 /0	0 /0	3 /12	3 /12	3 /12	1 /4
2011	3 /9	0 /0	0 /1	3 /11	4 /12	3 /12	4 /4
2012	2 /10	0 /0	0 /0	2 /11	3 /12	3 /12	0 /4
2013	3 /11	0 /0	0 /0	3 /10	4 /12	1 /12	0 /4
2014	4 /11	0 /0	0 /0	4 /10	7 /12	1 /12	1 /4
2015	2 /8	0 /0	0 /0	2 /8	3 /12	1 /12	1 /4
USD MXN							
2007	0 /10	2 /3	0 /2	2 /15	3 /12	2 /12	1 /4
2008	6 /16	2 /7	5 /14	13 /37	5 /12	2 /12	1 /4
2009	4 /14	0 /0	4 /12	8 /26	3 /12	2 /12	0 /4
2010	3 /12	0 /0	0 /0	3 /12	2 /12	0 /12	3 /4
2011	1 /9	0 /0	0 /1	1 /11	4 /12	5 /12	1 /4
2012	2 /10	0 /0	0 /0	2 /11	10 /12	3 /12	1 /4
2013	1 /11	0 /0	0 /0	1 /10	4 /12	3 /12	0 /4
2014	3 /11	0 /0	0 /0	3 /10	4 /12	4 /12	1 /4
2015	2 /8	0 /0	0 /0	2 /8	2 /12	1 /12	1 /4

Table 4 shows all significant market reactions in each year and for each communication type. The first entry refers to the number of significant days, while the second reflects the total number of announcements in the given year.

Figure 2 offers a detailed picture of market reactions to FOMC announcements

<sup>25</sup>See Blinder (2018) for this interpretation of market perception.

over time and across currencies. It displays all significant deviations of realizations from the forecasts based on the 50-day forecast period. No particular pattern is visible. All four currencies fluctuated around zero and balance each other across time. Even during 2008, appreciations and depreciations were balanced. The highest overall deviation was on 10/9/2008, with the Mexican peso exhibiting the highest negative deviation (depreciation of the U.S. dollar).<sup>26</sup> On the same day, the Brazilian real posted the second highest positive deviation (appreciation of the U.S. dollar). The highest positive deviation occurred on 12/19/2008 and concerned the Swiss franc, which depreciated.<sup>27</sup>

Figure 2 also includes the evolution of the VIX. It can be inferred from the figure that at the height of the financial crisis, a strong increase in the VIX coincided with currency reactions on event days.

Figure 2: Evidence of Market Reactions to FOMC Announcements: All Currencies

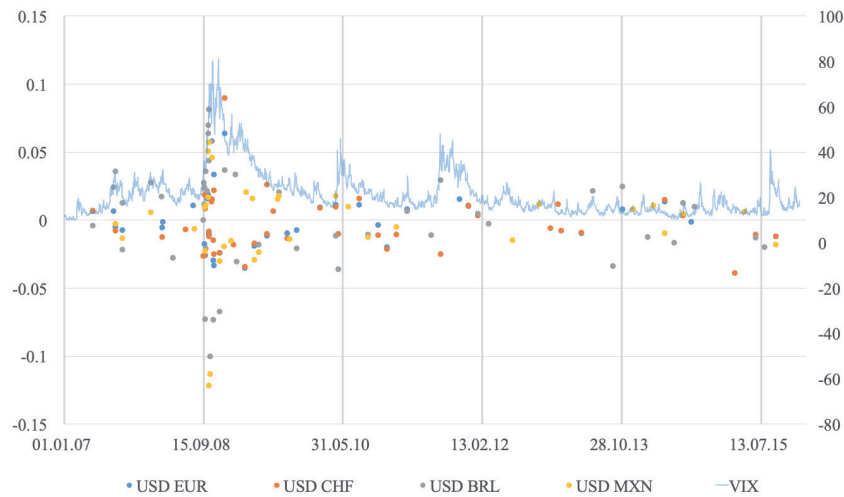


Figure 2 illustrates the significant reactions to FOMC announcements over time and across currencies in comparison with the VIX.

The interpretation of this observation is not straightforward. On the one hand, it may suggest that increasing market uncertainty leads to heightened sensitivity of currency markets to FOMC announcements. On the other hand, it may reflect endogeneity of policy actions to increased uncertainty reflected in the exchange rate.<sup>28</sup>

A crucial issue in empirical research on the impact of monetary policy surprises on asset prices is endogeneity. However, it should not be overemphasized in our context.

<sup>26</sup>Title of press release: "Federal Reserve and other central banks announce further measures to provide broad access to liquidity and funding to financial institutions".

<sup>27</sup>On 12/19/2008, the FOMC issued five press releases. The most influential was most likely the Fed's and other central banks' announcement of schedules for term auctions of U.S. dollar liquidity.

<sup>28</sup>This is a central problem for the literature on the effect of monetary policy on exchange rates (see, for instance, Zettelmeyer (2004)). A typical example is when interest rates are raised in response to depreciation. The data might then show a negative correlation between the level of interest rates and the value of the currency, even though the interest rate hike might have induced a recovery of the exchange rate or prevented it from depreciating further. This makes it very difficult to empirically assess the response of exchange rates to monetary policy, particularly in times when the exchange rate is under pressure.

As pointed out by Kontonikas *et al.* (2013), endogeneity should be less of a concern when daily data are used within an event-study framework. In particular, there is no reason to believe that the Fed changed monetary policy in response to exchange rate movements. It seems more plausible that exchange rates reacted to monetary policy changes. Ultimately, it is important to understand the motivation of FOMC actions. The most relevant source of information on this count is its press releases. It is difficult to argue from reading them that the FOMC was intervening in the markets with the aim of addressing pressure on the U.S. dollar. Rather, the Fed was reacting to turbulence in the domestic financial markets. It cannot be excluded that the foreign exchange markets were unsettled because of the stress in U.S. markets. In this (indirect) sense, there could be an endogeneity issue.<sup>29</sup> Note, however, that on several occasions, the VIX moved independently of FOMC announcements.<sup>30</sup>

### 5.3 Detailed Analysis of FOMC Announcements

In this subsection, we offer a more detailed analysis of the FOMC announcements and concomitant currency reactions. The results are summarized in Table A1 in the Appendix. Among 140 FOMC announcements, 95 had significant effects on at least one of the four currencies, 52 on at least two, 19 on at least three, and seven on all four currencies. Out of the 95 significant reactions, most occurred in 2008 (32) and 2009 (18). In terms of currencies, the Brazilian real reacted most often in a significant way (51 times), followed by the Swiss franc (48 times), the euro (43 times), and the Mexican peso (39 times).

To derive more precise results in terms of commonalities and differences between currency pairs, we focused on the 20 most significant and strongest reactions per currency. They are associated with 51 FOMC announcements, of which 25 are unconventional policy announcements, 19 are FOMC statements and all ten are unscheduled events. The results are summarized in Table 5. It presents those events that in at least one currency led to either an appreciation of the U.S. dollar, denoted by A, or a depreciation, denoted by D. Communication days in which at least two currency pairs reacted in the same direction as the U.S. dollar are marked in green. In pink are events highlighted with diverging reactions.

Several interesting results are notable.<sup>31</sup>

- (i) The bulk of the reactions occurred in 2008 (21) and 2009 (13). From 2012 onward, only very few events triggered strong market reactions.
- (ii) Only on November 25, 2008, did all four currencies react in the same direction—depreciating vis-à-vis the U.S. dollar. The underlying event was the an-

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<sup>29</sup>As explained in section 4.2, other news that became public on an event day is excluded from the sample.

<sup>30</sup>As shown by Haldane *et al.* (2016), some asset purchase programs have dampened the VIX, but this pattern was not uniform. There is also some evidence of the announcement of large QE programs generating a rise in financial market uncertainty, at least in the short term, perhaps because these interventions coincided with periods of significant financial market stress.

<sup>31</sup>We checked for foreign exchange interventions in Brazil and Mexico. The data are from Kohlscheen (2014). We found that only three out of 51 highly significant event days correspond to a day with a foreign exchange intervention: Mexico 9/19/2008 (Mexican peso appreciated; the other three currencies depreciated), Brazil 10/29/2008 (appreciation of all 4 currencies), and Mexico 1/16/2009 (appreciation of all 4 currencies). On the latter two event days, the currencies reacted significantly according to our estimates. Whether this is due to the FOMC communications or forex interventions cannot be determined. Note that the availability of intervention days is limited to the period from 2007 to 2011. In the case of the SNB, controlling for intervention days is not possible. The SNB does not comment on its forex interventions, except in exceptional cases. Hence, what we obtain is the minimum number of potentially significant market reactions.



nouncement of the creation of the Term Asset-Backed Securities Loan Facility (TALF).<sup>32</sup>

- (iii) On three days, two in October 2008 and one in December 2008, the U.S. dollar depreciated against three currencies. On October 6, the FOMC announced that it would begin to pay interest on depository institutions' required and excess reserve balances and increase the size of the TAF (Term Auction Facility), leading to the depreciation of the dollar against the euro, the peso, and the real.<sup>33</sup> On October 22, the FOMC announced that it would alter the formula used to determine the interest rate paid to depository institutions on excess balances. This led to a depreciation against the Swiss franc, the peso and the real. On December 19, the revised terms and conditions as well as questions and answers detailing operational aspects of TALF were accompanied by the dollar weakening against the euro, the Swiss franc, and the Brazilian real.
- (iv) When the currencies reacted in tandem, mostly only two currencies were involved. Twenty-one announcements led to a similar market reaction in at least two currencies. Ten were associated with an appreciation of the U.S. dollar and 11 with a depreciation, corroborating the general result of balanced effects.
- (v) Twenty-eight announcements were associated with a single-market reaction (events not highlighted in colors), 15 of them appreciations and 13 depreciations.
- (vi) Two clusters emerge, one comprising the Swiss franc and the euro and the other comprising the peso and the real. However, the cluster of the EME currencies demonstrates less uniformity. The Swiss franc and the euro moved in the same direction 13 times and never exhibited divergent patterns; 11 events led the euro and the Swiss franc to react simultaneously, while neither the peso nor the real exhibited any significant reaction on these occasions. By contrast, on six occasions, the peso and the real reacted when no reaction was observable for the euro and the Swiss franc. Moreover, the peso and the real moved in the same direction only six times, showing a single reaction 24 times and diverging on two occasions out of 20. Both of these occasions were associated with unconventional FOMC announcements. The first was on September 22, 2008, and the second was on October 9, 2008.<sup>34</sup> It follows from the table that the two emerging market currencies reacted synchronously only during the most critical phase of the financial crisis, in the autumn of 2008.

The cluster behavior is particularly interesting. Contrary to the general result based

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<sup>32</sup>TALF was a facility to help market participants meet the credit needs of households and small businesses by supporting the issuance of asset-backed securities (ABS) collateralized by student loans, auto loans, credit card loans, and loans guaranteed by the Small Business Administration (SBA). Moreover, a program to purchase the direct obligations of housing-related government-sponsored enterprises and mortgage-backed securities backed by Fannie Mae, Freddie Mac, and Ginnie Mae was initiated. This action had been taken to reduce the cost and increase the availability of credit for the purchase of houses, which in turn was intended to support housing markets and foster improved conditions in financial markets more generally.

<sup>33</sup>To meet the demand for term funding more directly, the Federal Reserve had previously established the Term Auction Facility (TAF), under which it auctioned loans to depository institutions, providing term funds to a broader range of counterparties and against a broader range of collateral than it could through open market operations.

<sup>34</sup>In the first, the Fed Board announced that based on consultation with the Department of Justice regarding the applications of Goldman Sachs and Morgan Stanley to become bank holding companies, the transactions could be consummated immediately without the application of the five-day antitrust waiting period. The second coincided with the joint announcement of the Fed and other central banks of further measures to provide broad access to liquidity and funding to financial institutions.

Table 5: 20 Strongest Reactions to FOMC Announcements per Currency Pair

Date	Statement	CHF	EUR	MXN	BRL
17.08.07	Unscheduled				-0.014
19.09.07	Unscheduled				0.012
07.03.08	Unconventional			-0.0012	
02.05.08	Unconventional	-0.011			
14.09.08	Unconventional	0.008			
18.09.08	Unconventional	0.023	0.022		
19.09.08	Unconventional	-0.023	-0.019		
22.09.08	Unconventional		0.011	0.0006	-0.010
24.09.08	Unconventional				-0.017
29.09.08	Unscheduled		-0.027		
06.10.08	Unconventional		-0.014	-0.0008	-0.008
07.10.08	Unscheduled			-0.0041	-0.033
08.10.08	Unscheduled			-0.0060	-0.022
09.10.08	Unconventional			0.0043	-0.012
14.10.08	Unconventional			0.0054	0.041
21.10.08	Unconventional	-0.011	-0.023		
22.10.08	Unconventional	-0.009		-0.0034	-0.029
29.10.08	FOMC Statement		0.034		0.017
30.10.08	Unscheduled	0.013	0.031		
31.10.08	Unscheduled	-0.022	-0.04		
25.11.08	Unconventional	0.009	0.018	0.0017	0.023
16.12.08	FOMC Statement			0.0009	
19.12.08	Unconventional	-0.048	-0.071		-0.007
16.01.09	Unconventional			0.0013	
28.01.09	FOMC Statement	-0.004			
03.02.09	Unconventional				0.001
10.02.09	Unconventional				-0.006
19.03.09	Unconventional	0.027	0.046		
23.03.09	FOMC Statement			0.0005	
21.04.09	Unconventional			-0.0007	
29.04.09	FOMC Statement		0.024	0.0019	
19.05.09	Unconventional			0.0020	
25.06.09	Unconventional	-0.023			
12.08.09	FOMC Statement			-0.0006	
17.08.09	Unconventional			-0.0013	
04.11.09	FOMC Statement				0.008
28.04.10	FOMC Statement		-0.011	-0.0010	
10.05.10	Unconventional				0.021
10.08.10	FOMC Statement	-0.012	-0.01		
14.12.10	FOMC Statement	0.021	0.025		
09.08.11	FOMC Statement	0.037			
21.09.11	FOMC Statement				-0.027
02.11.11	FOMC Statement		0.007		
13.12.11	FOMC Statement	-0.007			
28.06.12	Unconventional			0.0007	
15.01.13	FOMC Statement	-0.011			
18.09.13	FOMC Statement				0.014
09.05.14	Unconventional	-0.017	-0.018		
18.03.15	FOMC Statement	0.009	0.004		
29.04.15	FOMC Statement	0.02	0.076		
17.09.15	FOMC Statement			-0.0001	

Table 5 presents the 20 strongest market reactions to FOMC announcements for each currency. A positive difference denotes an appreciation of the U.S. dollar, a negative difference a depreciation of the U.S. dollar. A co-movement of at least two currencies in the same direction is marked in green, a countermovement in pink.

on the 95 significant FOMC announcements, focusing on the most significant events suggests that unlike the Swiss franc and the euro, the Mexican peso and the Brazilian real behave quite differently from one another and occasionally even move in opposite directions. The fact that the Swiss franc is more aligned with the euro could be attributable to the floor for the Swiss franc that the SNB introduced on September 6, 2011. However, this is arguably not the (main) reason. From the list of the most significant events displayed in Table 5, only seven occurred during this period. The most plausible explanation for the alignment of the Swiss franc with the euro is the similarity in the Swiss and euro area business cycles.

#### 5.4 Reactions to Domestic Central Bank Communications

In this subsection, we analyze how the domestic currencies reacted to communications by their respective central banks. Tables 6, 7 and 8 report the number of events with a significant effect on the domestic currency. Table 6 summarizes the evidence for the ECB, Table 7 for the SNB, and Table 8 for the BCB and the Banco de México.

It can be gleaned from these tables that ECB communications gave rise to significant effects on the euro-dollar exchange rate in 29 percent of cases (43 days out of 151), the same percentage recorded for FOMC announcements. The Swiss franc-dollar exchange rate reacted in a similar vein. In 28 percent of cases (21 days out of 75), it reacted to SNB communications, the same percentage of cases in which it reacted to FOMC communications. The euro-dollar exchange rate exhibits the strongest sensitivity to the Employment Report (38 percent), whereas the Swiss franc-dollar exchange reacted mostly to SNB announcements (32 percent).

The peso and the real reacted less often than the euro or the Swiss franc to communication events by the respective central banks, with the peso reacting to 22 percent of Banco de México communication events (11 days out of 51) and the real reacting to 21 percent of BCB communication events (15 days out of 73). Both also reacted less often to communications from their own central banks than to those of the FOMC. While the peso reacted to every fourth FOMC announcement (and thus at a similar rate as to Banco de México announcements), the Brazilian real reacted to every third FOMC announcement.

Table 6: Total Number of Significant Event Days of ECB and Euro Area Macro Communication on USD EUR Exchange Rate

	ECB Meeting		Unconventional		Total	Employment Report		CPI	GDP			
2007	3/8	38%	2/6	33%	5/14	36%	1/8	13%	2/7	29%	1/4	25%
2008	2/11	18%	6/13	46%	8/24	33%	2/5	40%	4/9	44%	0/4	0%
2009	2/9	22%	2/10	20%	4/19	21%	2/4	50%	0/8	0%	0/4	0%
2010	6/11	55%	3/9	33%	9/20	45%	4/9	44%	1/5	20%	1/4	25%
2011	2/7	29%	1/9	11%	3/16	19%	4/7	57%	2/10	20%	1/4	25%
2012	2/11	18%	3/8	38%	5/19	26%	1/7	14%	2/8	25%	0/4	0%
2013	0/11	0%	3/6	50%	3/17	18%	3/5	60%	2/8	25%	0/4	0%
2014	3/11	27%	1/3	33%	4/14	29%	3/6	50%	1/5	20%	2/4	50%
2015	2/8	25%	0	0%	2/8	25%	1/5	20%	0/4	0%	1/4	25%
Total	22/87	25%	21/64	33%	43/151	29%	21/56	38%	14/64	22%	6/36	17%

Table 6 shows the number of significant event days associated with announcements by the ECB and macroeconomic news over time.

Table 7: Total Number of Significant Event Days of SNB and Swiss Macro Communication on USD CHF Exchange Rate

	SNB Meeting		Unconventional		Un-scheduled		Total		CPI		GDP	
2007	0/4	0%	0/1	0%	1/2	50%	1/7	14%	5/12	42%	1/4	25%
2008	3/4	75%	3/12	25%	0/4	0%	6/20	30%	0/12	0%	1/4	25%
2009	0/4	0%	1/5	20%	0/1	0%	1/10	10%	4/12	33%	0/4	0%
2010	1/4	25%	1/4	25%	0/0	0%	2/8	25%	3/12	25%	1/4	25%
2011	1/3	33%	1/4	25%	1/3	33%	3/10	30%	1/12	8%	0/4	0%
2012	0/3	0%	0/1	0%	0/0	0%	0/4	0%	3/12	25%	1/4	25%
2013	2/4	50%	0/1	0%	0/0	0%	2/5	40%	3/12	25%	1/4	25%
2014	3/4	75%	1/1	100%	0/1	0%	4/6	67%	4/12	33%	0/4	0%
2015	1/4	25%	1/1	100%	0/0	0%	2/5	40%	2/12	17%	0/4	0%
Total	11/34	32%	8/30	27%	2/11	18%	21/75	28%	25/108	23%	5/36	14%

Table 7 shows the number of significant event days associated with announcements by the SNB and Swiss macroeconomic news over time.

Table 8: Total Number of Significant Event Days of Banco de México and BCB Communication on USD MXN and USD BRL Exchange Rate

Mexican Central Bank			Brazilian Central Bank		
2007	1/4	25%	2007	3/8	38%
2008	1/7	14%	2008	2/7	29%
2009	2/12	17%	2009	2/7	29%
2010	0/4	0%	2010	3/8	38%
2011	3/4	75%	2011	0/8	0%
2012	1/4	25%	2012	1/10	10%
2013	1/7	14%	2013	2/9	22%
2014	0/5	0%	2014	1/8	13%
2015	2/4	50%	2015	1/8	13%
Total	11/51	22%	Total	15/73	21%

Table 8 shows the number of significant event days associated with announcements by the Banco de México and the BCB over time.

## 5.5 Relation to the Literature

We link the two findings—diverging reactions between advanced and EME currencies to U.S. and domestic central bank communications—to work on exchange rates that documents puzzling phenomena. What we discover from this comparison is a variant of two puzzles. The first is the exchange rate response puzzle, and the second is the exchange rate puzzle.

The exchange rate response puzzle was noted by Hnatkowska *et al.* (2016) in a cross-country sample of 25 industrial and 47 developing countries. It refers to the finding that in response to monetary tightening, the domestic currency tends to appreciate in developed countries but depreciate in developing countries. The authors explain this by three key features of the monetary transmission mechanism: a demand-for-liquidity channel, a fiscal channel, and an output channel. The liquidity demand channel involves increased demand for domestic currency-denominated liquid assets and hence has a strengthening effect on the local currency when the policy-controlled interest rate is raised. The other two channels tend to weaken the currency in response to a rate hike: the output channel through a contractionary effect of higher interest rates on domestic activity, on the one hand, and the fiscal channel through the greater fiscal burden of higher interest rates, on the other. Both effects imply a higher required inflation rate that has a weakening effect on the local currency.

The exchange rate puzzle arises from the observation that domestic interest rate increases are not associated with exchange rate appreciations. Kohlscheen (2014) analyzes the impact on currency markets of scheduled monetary policy events in Brazil, Mexico and Chile between 2003 and 2011. His findings shore up the exchange rate puzzle, contrary to the results obtained for a number of developed economies. This dynamic contradicting the textbook relation holds irrespective of whether interest rate changes are anticipated or not or whether changes in the policy rate that were followed by exchange rate interventions are excluded from the sample. Moreover, the response of the exchange rate to domestic and U.S. interest rate shocks was asymmetric. While the responses to domestic rate changes defied the conventional wisdom, the responses to U.S. rate changes on FOMC meeting days were in accordance with it.

## 5.6 Share of Market Reactions to U.S. Communications

Finally, we computed for every currency and year the highest and lowest one-day change independent of any announcement and compared them with the event days that our analysis found to be significant. The results are shown in Table 9. The first column displays the share of strongest reactions of currency pairs to FOMC announcements. The second column reports the share explained by announcements from the other four central banks. The third column shows the results for the Employment Report, the fourth column shows those for the CPI, and the fifth column shows those related to GDP announcements. The last column indicates the sum of the strongest market reactions for each currency.

Table 9 shows that the U.S. announcements underlying our analysis explain up to 40 percent of the strongest appreciations and depreciations in each year for all four currencies, 60 percent of those of the USD/EUR rate and approximately 40 percent of those in the USD/CHF rate. From this, we infer that among the currencies investigated, the euro seems to be the most affected by U.S. communications relative to other market-driving events. The two EME currencies are the least affected. Nevertheless, more than 25 percent of overall significant reactions in the Brazilian real were associated with U.S. communications, as was every third reaction of the Mexican peso.

Table 9: Strongest Appreciations/Depreciations Explained by Announcements

Explained by:	Foreign					Total
	FOMC	Central Bank	Employment Report	CPI	GDP	
USD/EUR	22.2%	22.2%	5.6%	5.6%	5.6%	61.1%
USD/CHF	22.2%	5.6%	5.6%	5.6%	0.0%	38.9%
USD/MXN	16.7%	0.0%	11.1%	5.6%	0.0%	33.4%
USD/BRL	22.2%	0.0%	0.0%	0.0%	5.6%	27.8%
Total Currencies	20.8%	6.9%	5.6%	4.2%	2.8%	40.3%

Table 9 yields the share of strongest currency reactions arising from communication events to overall highest and lowest one-day changes over the whole sample period.

## 6 Conclusion

Central bank announcements and macroeconomic news releases can be considered events capable of inducing at least temporary changes in asset prices. Since the GFC and the adoption of unconventional monetary policy measures by central banks in advanced countries, the effectiveness of these measures on domestic markets has dominated the research agenda. More recently, attention has increasingly shifted to their spillovers to global asset prices, such as exchange rates.

We tested the effect of 598 U.S. communication events on four currencies. The events we considered were monetary policy announcements and the release of key U.S. macroeconomic indicators. The question is whether and to what extent these U.S. communications contained relevant information for the currency markets. To answer this question, we performed pseudo out-of-sample exchange rate forecasts and compared them with the realized values on communication days. For control reasons, we also compiled a large number of communication events from the euro area and Switzerland as well as a limited quantity from Brazil and Mexico. This added up to a total of 2,166 observations.

We found that a fifth of U.S. communication events considered in this analysis affected the four currencies. Additionally, the FOMC's conventional and unconventional monetary policy announcements had a similar effect, while appreciations and depreciations alternated without any clear trend. A focus on the most significant reactions reveals that the currencies did not move in sync. Only when TALF was disclosed in November 2008 did all four react in the same direction, depreciating against the dollar. However, the euro and the Swiss franc reacted more often and more in sync than the EME currencies. The latter reacted synchronously only during the most critical phase of the financial crisis, in the autumn of 2008. Moreover, they exhibit what we call a variant of the exchange rate puzzles found in previous work in the sense that their reactions to U.S. communication events often differed from one another and were more often significant after FOMC communications than after announcements from their domestic central banks. By contrast, the advanced currencies responded more similarly to each other and responded as often to FOMC communications as to those of their respective central banks.

The communication events covered in this paper capture approximately 40 percent of the strongest appreciations and depreciations of the four currencies during the observation period. This can be read in two ways. On the one hand, our simple estimation method seems to be able to capture relevant market reactions. On the other hand, it suggests a high impact of central bank communications and macroeconomic news releases on exchange rates. Overall, almost every third FOMC communication and more than every third Employment Report yielded a significant currency response. However, while FOMC communications caused significant reactions mainly during the GFC and lost significance over time, the Employment Report tended to give rise to significant effects more in the later phase of our sample. In comparison with the Employment Report, CPI and GDP announcements produced fewer effects.

Future work could expand the list of currencies included in the sample to examine the generality of the variant of the exchange rate puzzle that we have revealed here. Another venue for future research could be a comparison of our findings with those of papers that deploy another estimation method, with controls for market expectations. Additionally, it would be interesting to compare the market behavior after the Fed started increasing interest rates and trimming its balance sheet. The most novel contribution to the literature would consist of an analysis of what distinguishes

the significant FOMC communications that we have found from the insignificant ones, for instance, by performing a text analysis along the lines of that in Lombardi *et al.* (2019).

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# Appendix

Table A1: FOMC Announcements and Currency Reactions

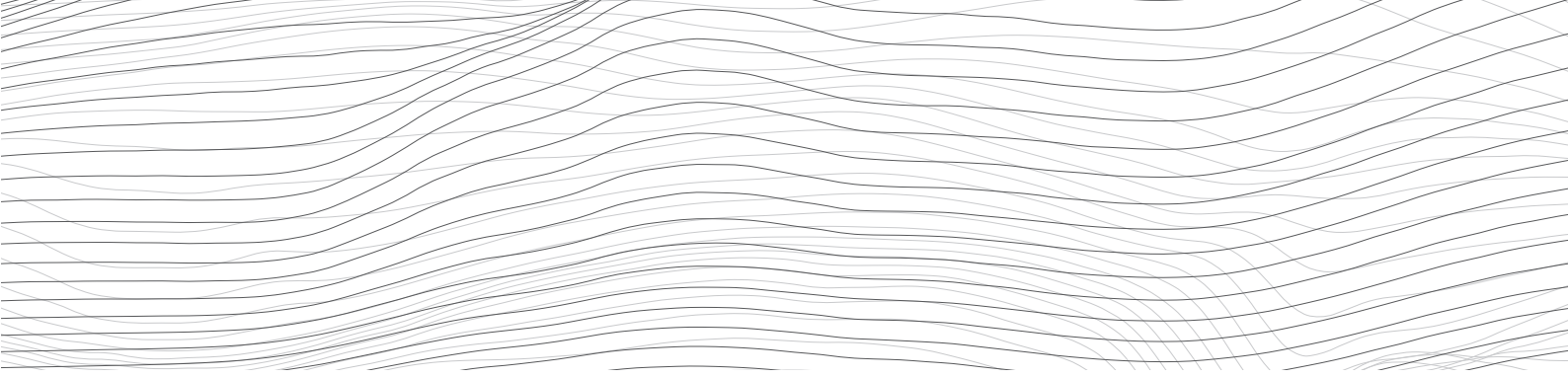
Date	Event	EUR	CHF	BRL	MXN	Date	Event	EUR	CHF	BRL	MXN
01/31/07	FOMC Statement					08/12/09	FOMC Statement				x
03/21/07	FOMC Statement					08/17/09	Unconventional			x	x
05/09/07	FOMC Statement	x	x	x		08/19/09	FOMC Statement			x	
06/28/07	FOMC Statement					09/23/09	FOMC Statement	x	x		
08/07/07	FOMC Statement					10/08/09	FOMC Statement		x		
08/10/07	FOMC Statement	x		x		11/04/09	FOMC Statement		x		x
08/17/07	Unscheduled	x	x	x	x	11/17/09	FOMC Statement	x		x	
09/18/07	FOMC Statement			x		12/16/09	FOMC Statement				
09/19/07	Unscheduled	x		x	x	01/27/10	FOMC Statement				
10/31/07	FOMC Statement					02/18/10	FOMC Statement	x	x		
12/11/07	FOMC Statement					03/16/10	FOMC Statement				
12/12/07	Unconventional				x	04/28/10	FOMC Statement	x	x	x	x
12/13/07	Unscheduled					05/09/10	FOMC Statement	x			
12/19/07	FOMC Statement					05/10/10	FOMC Statement		x	x	
12/21/07	Unconventional				x	06/23/10	FOMC Statement				x
01/22/08	FOMC Statement		x		x	08/10/10	FOMC Statement	x	x		
01/24/08	Unscheduled					09/21/09	FOMC Statement			x	x
01/30/08	FOMC Statement				x	11/03/10	FOMC Statement	x	x		
03/07/08	Unconventional					12/14/10	FOMC Statement	x	x		
03/11/08	FOMC Statement			x		12/21/10	FOMC Statement				
03/14/08	Unconventional	x	x			01/26/10	FOMC Statement	x	x		x
03/16/08	Unconventional		x	x		03/15/10	FOMC Statement	x		x	
03/18/08	FOMC Statement					04/27/10	FOMC Statement				
03/30/08	Unscheduled					06/22/11	FOMC Statement				
05/02/08	Unconventional			x		06/29/11	FOMC Statement			x	
06/25/08	FOMC Statement		x			08/09/11	FOMC Statement		x	x	
07/30/08	FOMC Statement	x				09/21/11	FOMC Statement				x
08/05/08	FOMC Statement				x	11/02/11	FOMC Statement	x			
09/14/08	Unconventional		x	x		11/30/11	Unconventional				
09/16/08	FOMC Statement			x		12/13/11	FOMC Statement	x	x		
09/18/08	Unconventional	x	x	x	x	01/25/12	FOMC Statement		x	x	
09/19/08	Unconventional		x	x		03/13/12	FOMC Statement			x	x
09/21/08	FOMC Statement		x	x		04/25/12	FOMC Statement			x	
09/22/08	FOMC Statement	x	x	x	x	06/20/12	FOMC Statement				
09/24/08	Unconventional			x	x	06/28/12	FOMC Statement				x
09/26/08	Unconventional			x		08/01/12	FOMC Statement				
09/29/08	Unscheduled	x		x		09/13/12	FOMC Statement				
10/06/08	Unconventional	x		x	x	10/24/12	FOMC Statement				x
10/07/08	Unscheduled			x	x	12/12/12	FOMC Statement				
10/08/08	Unscheduled	x	x	x	x	12/13/12	FOMC Statement		x		
10/09/08	FOMC Statement	x	x	x	x	01/15/13	FOMC Statement		x		
10/14/08	Unconventional			x	x	01/30/15	FOMC Statement	x	x		
10/21/08	Unconventional	x	x			03/20/13	FOMC Statement				
10/22/08	Unconventional		x	x	x	04/26/03	FOMC Statement				
10/29/08	FOMC Statement	x	x	x		05/01/13	FOMC Statement	x	x		
10/30/08	Unscheduled	x	x			06/19/13	FOMC Statement			x	
10/31/08	Unscheduled	x	x			07/31/13	FOMC Statement	x			
11/25/08	FOMC Statement	x	x	x	x	09/18/13	FOMC Statement			x	
12/02/08	FOMC Statement					10/30/13	FOMC Statement				
12/16/08	FOMC Statement				x	10/31/13	FOMC Statement	x		x	
12/19/08	Unconventional	x	x	x		12/18/13	FOMC Statement				x
12/30/08	FOMC Statement					01/29/14	FOMC Statement				
01/07/09	Unconventional					02/21/14	FOMC Statement			x	
01/16/09	Unconventional				x	03/19/14	FOMC Statement				x
01/28/09	FOMC Statement		x			04/30/14	FOMC Statement	x			
01/30/09	Unconventional					05/09/14	FOMC Statement	x	x		x
02/03/09	Unconventional			x		06/18/14	FOMC Statement			x	
02/10/09	FOMC Statement					07/30/14	FOMC Statement			x	x
03/02/09	Unconventional					09/04/14	FOMC Statement	x			
03/18/09	FOMC Statement					09/17/14	FOMC Statement			x	
03/19/09	Unconventional	x	x			10/19/14	FOMC Statement				
03/23/09	FOMC Statement				x	12/17/14	FOMC Statement				
04/06/09	Unconventional					01/28/15	FOMC Statement				
04/21/09	Unconventional				x	03/18/15	FOMC Statement	x	x	x	
04/29/09	FOMC Statement	x	x		x	04/29/15	FOMC Statement	x	x		x
05/01/09	Unconventional					06/17/15	FOMC Statement		x	x	
05/19/09	Unconventional			x	x	07/29/15	FOMC Statement			x	
06/24/09	FOMC Statement	x	x	x		09/17/15	FOMC Statement	x	x		x
06/25/09	Unconventional		x			10/28/15	FOMC Statement				
07/24/09	FOMC Statement		x			12/16/15	FOMC Statement				

Table A1 lists all FOMC announcements. An "x" indicates a significant reaction on the 95% confidence interval for the respective currency. Colors highlight specific reaction patterns.

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