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Interpreting Currency Movements During the Crisis: What's the Role of Interest Rate Differentials?

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Interpreting Currency Movements during the Crisis: What's the Role of Interest Rate Differentials? [1]

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Abstract

Using an adaptation of the Uncovered Interest Parity (UIP) condition, this paper analyzes the drivers behind the large, symmetric exchange rate swings observed during the financial crisis of 2008–2010. Employing a Nelson-Siegel model, we estimate yield curves and decompose the exchange rate movements into changes we attribute to monetary policy and a residual. We find that the depreciation phase of the currencies in our sample was largely dominated by safe-haven effects rather than carry trade activity or other return considerations. For some countries, however, the appreciation that began at the end of 2008 seems largely to reflect downward movement in the cumulative revisions to nominal forward differentials, suggesting carry trade.

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[1] We are grateful to Rodrigo Valdès for useful conversations. All errors and omissions are ours.

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I. Introduction

The financial turmoil of 2008-2010, which had as its epicenter the United States, has been accompanied by sharp changes in the bilateral parities among the currencies of many advanced and emerging market economies (EMEs) and the U.S. dollar (Figure 1).

While the response of bilateral exchange rates vis-à-vis the U.S. dollar has been largely heterogeneous across the world, recent studies have shown that such heterogeneity can be in part explained on the basis of: (i) the size of countries' financial liabilities vis-à-vis the United States, i.e. those in which U.S. investors held relatively large portfolio investments (both in equities and in bonds); (ii) the size of a country's FX reserves; and (iii) the size of countries' current account positions.[2] Typically, countries with greater financial exposure to the United States; and/or with foreign reserves below a cross-country average; and/or with higher-than-average current account deficits have experienced significantly larger depreciations vis-a-vis the U.S. dollar (averaging about 22–23 percent between July 2008 and February 2009).

This paper focuses on an additional potential driver of the observed changes in bilateral parities during the 2008–2010 crisis: the relationship between exchange rate movements and monetary policy. A floating exchange rate—that is, the price of one country's currency in terms of another's country's currency—may change in response to developments either at home or abroad. Looking at this relationship is particularly interesting because while heterogeneous, the movement of bilateral exchange rates is puzzling given prior financial crises. The early stages of the 2008–2010 crisis were marked by a sharp depreciation of currencies worldwide vis-à-vis the U.S. dollar. Then, in late 2008 and early 2009, these currencies began appreciating, nearing pre-crisis levels by the end of the first quarter of 2010. This is in stark contrast to the Asian crisis of 1997–98 and the crisis following the Russian debt default in 1998 during which investors fled the currencies of the countries in crisis. To explain this phenomenon, Fratzcher (2009) tells a safe-haven story in which the global nature of the slowdown led investors to believe that negative shocks originating in the U.S. would affect foreign markets even more acutely. Kohler (2010), however, argues that exchange rate movements during this crisis were characterized by both safe-haven effects and carry trade that resulted from interest rate differentials.

More specifically, this paper uses the uncovered interest parity (UIP) condition to assess the contribution of monetary policy news in the United States to exchange rate developments in five inflation-targeting advanced economies (Australia, Canada, the Euro Area, New Zealand, and the United Kingdom) and three inflation-targeting EMEs (Brazil, Chile, and

[2] Fratzcher (2009).

Mexico) during the crisis.[3] Employing the instantaneous forward interest rate differentials for each country in an adapted UIP framework, we decompose exchange rate movements into changes attributable to monetary policy and a residual.

For analytical purposes, we mark the beginning of the financial crisis as February 27, 2007.[4] This allows us to focus on exchange rate changes over a timeframe more than one year longer than used in other studies of crisis-related exchange rate movements. On that day, the Federal Home Loan Mortgage Corporation (Freddie Mac) announced that it would no longer buy the most risky subprime mortgages and mortgage-related securities, spurring a wave of panic toward such assets that in turn led to a series of bankruptcies and the subsequent cascade of well-known events.

We find that the depreciation phase of the currencies in our sample during the 2008–2010 financial and economic crisis was largely dominated by safe-haven effects rather than carry trade activity or other return considerations. For some countries, however—notably the Euro Area, Brazil, Mexico, and Chile—the appreciation that began at the end of 2008 seems largely to reflect downward movement in the cumulative revisions to nominal forward differentials, suggesting carry trade. This movement is attributable to the widening between such rates, the Fed's open commitment to prolonged easing, and the lowering of the Fed Funds rate (which was slashed to near zero on December 16, 2008). We also find that the Fed's emergency cut on October 8, 2008 of 50 basis points surprised most currency markets (emerging and advanced) and seems responsible for large volumes of foreign exchange trading on that day.

One implication of the analysis is that given an unchanged balance of risks, these currencies should decline in value against the U.S. dollar to pre-crisis levels if markets begin to expect a faster withdrawal of monetary stimulus relative to the United States, apart from the euro which remains weak as a result of the European sovereign credit scare. This has occurred recently in Chile where the central bank raised the policy rate by 50 basis points in June 2010.

The paper is organized as follows: Section 2 describes the methodology that we use and the data; Section 3 presents results; Section 4 draws conclusions and offers policy implications.

A. Methodology and Data

To determine the interaction between interest rates and exchange rates, we use the UIP condition. Exchange rate analysis is notoriously fraught with uncertainty; however, in this

[3] Some of these countries are commodity exporters, with currencies that tend to appreciate during bull cycles in commodity markets and vice versa thus making them valuable additions to the sample.
[4] The Federal Reserve Bank of St.Louis (2009) also chooses this date to mark the beginning of the crisis.

respect the UIP is a useful tool because it allows us to approximate the contributions of different types of shocks to exchange rates and is particularly suited to study day-to-day changes in the relationship between interest rates and exchange rates. Since market interest rates and exchange rate data are available daily we are able to measure the impact of a certain policy announcement on a specific date. The UIP's underlying assumptions enable us to identify the contribution of these shocks over a single day (as the UIP condition holds for any period of time), thereby reducing the amount of noise and allowing for better identification.

In symbols, the UIP condition can be expressed as:

$$E_t s_{t+1}^x - s_t^x = i_t^{US} - i_t^x + \rho_t \qquad (1)$$

Where s_t^x is the spot exchange rate (using the national currency per U.S. dollar); $E_t s_{t+1}^x$ is the expectation of the spot exchange rate in time *t+1* of country *x* made at time *t*; $i_{t,m}^x$ is the nominal interest rate in country *x* at time *t*; $i_{t,m}^{US}$ is the U.S. nominal interest rate at time *t*; and ρ_t is a currency risk premium that varies across periods. The term *m* requires the interest rates to be comparable, i.e. maturity, type of instrument, etc. Equation (1) states that the expected change in the exchange rate between the country's *x* currency and the U.S. dollar is equal to the difference in interest rates between these two countries, adjusted for risk.

In theory, the UIP condition is accepted as intuitive, but debate over whether or not UIP is empirically valid continues. Several studies, however, are supportive of the uncovered interest parity hypothesis over very short windows that encompass the timeframe of the discrete interest payments we are interested in here (see Chaboud and Wright, 2003 and Frankel and Poonawala, 2006 for evidence on forward markets in emerging currencies). Importantly, most of the debate typically surrounds the empirical proposition that excess returns in foreign currency are predictable, which itself is not evidence against the UIP, but suggests that the UIP probably does not hold jointly with the assumptions of rational expectations and risk neutrality. Whether or not these assumptions hold in practice is independent of the use of the UIP condition for the purpose of decomposition into its components, since we need only to assume that interest rate differentials and exchange rate movements have a one-to-one relationship, an assumption that seems plausible (see Fisher et al, 1990).

To quantify the contribution of changes in U.S. monetary policy on our sample of eight bilateral exchange rates using the UIP condition we follow five steps.

<u>First</u>, we identify the trough and peak of each currency vis-à-vis the U.S. dollar from the beginning of the financial crisis until April 1, 2010. The trough is defined as the minimum exchange rate (currency of country *x*/U.S. dollar) from the start of the crisis to April 1, 2010. The peak is defined as the maximum exchange rate from the trough to April 1, 2010. Our first set of decomposition results will examine how much of the trough-peak depreciation

against the U.S. dollar and how much of the peak-to-April 1, 2010 appreciation can be explained using the UIP condition (Section III.A).[5] To conduct additional analysis, we select a set of dates during the timeline of the recent financial turmoil when exchange rate changes were simultaneously strong in our eight U.S. dollar bilaterals. We then choose a subset of these dates for which large changes in the exchange rate coincided with statistical releases or policy announcements and are likely to reflect changes in the expectations that analysts had about the path of the Fed Funds rate. Our remaining UIP decomposition results interpret currency movements over such dates (Section III.B).

Second, for the trough-peak-April 1, 2010 dates and for the selected subset of dates, we obtain forward differentials by fitting zero-coupon rates to forward curves for each country following the parametric estimation methodology of Nelson-Siegel. One crucial caveat is that data on zero-coupon rates do not exist for all maturities needed for the estimation of the forward curves and therefore the interpretation of such curves demands particular caution.

Third, we obtain a measure of "news". This quantifies what proportion of the change in the overnight nominal exchange rate that can be attributed to an expected change—the exchange rate change implied by the interest rate differential according to the UIP— and to an unexpected change over the dates that we examine. This unexpected change is what we will call "news".

Fourth, we decompose the news into: (i) changes in the differential between expected domestic and overseas interest rates up to some arbitrary terminal point and (ii) a residual term that includes changes in the expected value of the nominal exchange rate at that terminal point and changes in the currency risk premium.

Fifth, we attribute the "news" to monetary policy and non-monetary policy factors, based on a set of assumptions about the impact of monetary policy on interest rates at various maturities. This step implies a judgment about the ultimate cause of the change in the exchange rate, which is why we focus specifically on announcements during the crisis that pushed analysts to modify their expectations about the path of official rates (see below).

In the next three subsections, we offer additional details about the steps that we have just described.

B. Selecting Dates for the Decomposition

To select dates for the decomposition, we need to identify significant dates during the crisis. The general pattern of U.S. dollar bilateral exchange rates in our sample of countries was

[5] For Canada January 29, 2010 was used due to data availability,

unusual when compared to previous global financial crises such as the Asian crisis of 1997–98 and the crisis following the Russian debt default in 1998, in which the currencies at the center of the crises experienced sharp depreciations. At the height of the most recent crisis, around July 2008, following a slew of bad financial news including the bailout of Bearn Sterns, the FRBNY announcement of emergency lending to Fannie Mae and Freddie Mac, and the downgrading of U.S. monoline bond insurers' currencies, most currencies in our sample depreciated sharply as investors moved *into* the U.S. dollar. But, this depreciation was quickly followed by a period of appreciation starting around March 2009 (with the exception of Brazil and Chile, whose currencies began appreciating about three months earlier).

The financial crisis was accompanied by strong exchange rate volatility in all of the countries in our sample and some particularly sharp exchange rate movements between October 3 and October 29, 2008 as shown in the following charts. Figure 2 plots the *bilateral exchange rates* vis-à-vis the U.S. dollar for the eight countries in our sample (where a rise indicates a depreciation in country's *x* currency), while Figure 3 plots their daily first differences over the period March 1, 2007– April 30, 2010. Figure 4 zooms in on the period of highest volatility during the crisis for each country's currency and tags three dates on which the change in the exchange rate for each country was particularly large.

To derive our first set of UIP decomposition results (Section III.A), Table 1 lists the trough (lowest value against the U.S. dollar) and peak (highest value against the U.S. dollar) since the beginning of the financial crisis for each currency in our sample. To derive our second set of results (Section III.B), this table also lists a subset of two or three dates per currency on which the change in the exchange rate was particularly large over the period of largest volatility that occurred during the crisis. The dates also take into account when the largest changes occurred *simultaneously* in various countries. Finally, Table 1 also indicates key U.S. statistical releases and policy announcements that occurred on those dates.[6]

C. Fitting Forward Curves to Zero-coupon Rates

1. *Obtaining zero-coupon rates*

The UIP decomposition requires the use of instantaneous forward rates to calculate the cumulative revision to nominal forward interest differentials. Following Svensson (1994), zero-coupon rates are needed to estimate these instantaneous forward rates. Australia, Brazil, Canada, Chile, and Mexico required zero-coupon rates for the estimation. Canada's zero-coupon rates were obtained directly from the Bank of Canada. Australia, Brazil, Chile, and Mexico's rates were obtained from Bloomberg, but data does not exist for all maturities

[6] In decomposing the UIP, we chose to use solely U.S. events. These tend to be the most important in driving the exchange rate in certain time zones, but for highly liquid currencies such as the Australian dollar where price discovery is important in the Asian, European, and U.S. time zones, the incorporation of local news effects could also be important. Therefore, the interpretation of our results warrants particular caution.

needed for the estimation of the forward curves. A cubic spline interpolation was used to fill in missing data and construct the zero-coupon yield curves following Adams and van Deventer (1994).

2. *Obtaining instantaneous forward rates*

The instantaneous forward rates are provided for the United States (Federal Reserve Bank), United Kingdom (Bank of England), Euro Area (European Central Bank), and New Zealand.[7,8] The rates for Australia, Brazil, Canada, Chile, and Mexico are estimated using the parsimonious Nelson-Siegel (1987) parametric method, which is preferable to other types of estimation when fitting Nelson-Siegel models as explained in Gurkaynak et al. (2007). The zero-coupon rates are used to estimate the instantaneous forward rates in a two-step process according to the model:

$$r(t,T) = \alpha + \beta_1 \frac{(1-e^{-\lambda T})}{\lambda T} + \beta_2\{\frac{(1-e^{-\lambda T})}{\lambda T} - e^{-\lambda T}\} \tag{3}$$

Where $r(t,T)$ is the interest rate at time t, for maturity T; α is a constant that represents the rate as T approaches infinity; β_1 and β_2 are parameters that define the curvature of the yield curve; and λ is a decay parameter that represents the persistence of short and medium term rates into the long run.

To fit Equation (3), we first estimate the parameters α, β_1, β_2, and λ using ordinary least squares (OLS) iteratively to minimize the sum of squared residuals by varying the parameters with $r(t,T)$ equal to the zero-coupon rates at time t. The initial value for each parameter is set at 1. We then derive the forward rates from Equation (3) by varying T over the maturities desired using the estimated parameters.

D. Obtaining a Measure of "News"

We assume that Equation (1) holds indefinitely in the future for every period *t*, where *t* represents a trading day (i.e. a weekday). We can then map the evolution of the exchange rate expectations based on the forward interest rate differentials for any of our eight exchange rates using data on spot exchange rates, domestic and overseas market interest rates, and the estimated instantaneous forward rates. For illustrative purposes, let us consider the profile for the bilateral exchange rate between the Brazilian real and the U.S. dollar on October, 6, 2008—a day in which the Brazilian real depreciated vis-á-vis the U.S. dollar by over 6 percent. Figure 5 plots the exchange rate expectations for our selected bilateral on that day and for the day predating by one day our selected date. On 10/3/2008, the dashed line indicates the expected path of the exchange rate from its spot rate on that day of 2.0 Brazilian

[7] New Zealand rates were kindly provided by Leo Krippner at Reserve Bank of New Zealand.
[8] Krippner and Thorsrud (2009).

real per U.S. dollar due to Brazilian-U.S. interest rate differentials.[9] The exchange rate was expected to fall according to the differential between one-year Brazilian and U.S. market spot interest rates between October 3, 2008 and October 2, 2009. Likewise, between October 3, 2009 and October 2, 2010 the exchange rate was expected to fall with the one-year Brazilian-U.S. forward differential. On Monday, October 6, 2008, the Brazilian real depreciated instead and the solid line indicates the rise in the spot exchange rate and the expected evolution given a new set of interest rates in Brazil and the United States. Interest rates in Brazil rose between Friday and the following Monday vis à vis U.S. rates and therefore, the new exchange rate, coupled with the new interest rate expectations, traced an expected exchange rate that appreciates faster in the near term period.

Following Bridgen et al. (1997), we assume that the expected change in the overnight exchange rate is equal to zero. This seems reasonable given the size of differentials that would be required by the UIP condition to imply a significant exchange rate shift over such a short period. Therefore, we can take the entire exchange rate movement as "news" for the decomposition.

E. Calculating the Portion of the "News" Related to Interest Rate Differentials

The next step is to use the methodology of the Bridgen et al. (1997) paper to quantify how much of the "news" is attributable to interest rate differentials. The remainder, if any, gives us our residual. In the appendix of the Bridgen et al. (1997) paper, the authors apply forward substitution to the log-linearized UIP up to some arbitrary period *n*. This adaptation allows us to derive the cumulative revision to the UIP which we will use to perform the decomposition. This is expressed mathematically as:

$$s_{t+k}^{x} - E_t s_{t+k}^{x} = \sum_{j=k}^{n-1} \left(E_{t+k}\mu_{t+j}^{x} - E_t \mu_{t+j}^{x}\right) + \left(E_{t+k} s_{t+n}^{x} - E_t s_{t+n}^{x}\right) - \sum_{j=k}^{n-1} \left(E_{t+k}\rho_{t+j}^{x} - E_t \rho_{t+j}^{x}\right) \tag{2}$$

where $\mu_{t+j}^{x} = \left(i_{t+j}^{x} - i_{t+j}^{US}\right)$ represents the interest differential between country *x* and U.S. forward rates. In our example above, *t* is October 3, 2008; *t*+*k* is October 6, 2008; and *t*+*n* is the arbitrarily chosen terminal point (eg. *n* = 10 years).

[9] October 6, 2008 was a Monday so the preceding trading day was Friday, October 3, 2008.

In Equation (2), the first RHS term is the forward interest differential, precisely, the cumulative revision to nominal forward interest differentials which expresses the expected difference between interest rates in country x and U.S. interest rates over some period. The forward differential is a measure of how much the expected rate of depreciation/appreciation of country *x*'s currency changed between t and $t+k$, subject to the choice of n. The next term on the RHS is the expected value of the nominal exchange rate of country *x*'s currency at time n. The last term on the RHS is the net change in country *x*'s currency risk premium between t and $t+k$, also subject to the choice of n. Since only the first term is observable, we treat the two other terms as a single residual.

Table 2 summarizes what we have discussed so far. Line one lists the actual percentage change of the bilateral exchange rate of country x vis-á-vis the United States. Lines two and three show the breakdown of the exchange rate movement on $t+k$ into the expected change (which we have stated is zero) and the "news". The fourth and fifth rows of Table 2 summarize the results obtained by applying the above cumulative forward revision and reflect the first term of the RHS of Equation (2). We calculate the term with n=8 and n=12 to generate a sensitivity band of 8 to 12 years since the value of the term depends on the n chosen. Put otherwise, these rows show how much of the "news" can be explained by changes in the forward nominal differential, once we assume that changes in the risk premium are independent of the changes in the long-run forecast of nominal exchange rates.

In our example of Brazil's rates on October 6, 2008, changes in interest rate differentials explain between 5.31 and 7.58 percentage points of the depreciation of the Brazilian real against the U.S. dollar between October 3 and October 6, 2008.

Figure 6 is a graphical representation of the role played by interest rate differentials in our example. In particular, Panel A plots Brazil's and U.S. forward rates for October 3, 2008 and October 6, 2008. On both dates Brazilian interest rates were higher than U.S. rates, producing the implied appreciation paths for the real shown in Figure 5. Figure 6 also suggests that U.S. forward rates fell slightly until the 10 year maturity then plateaued at a level about 4.5 percentage points higher than the 1 year rate. In contrast, Brazilian rates rose rather uniformly for all maturities starting at about the 3 year rate. Panel B in Figure 6 plots instead the one day interest rate differential, namely the *difference* between Brazilian and U.S. forward rates for each of the two dates, highlighting the impact of the greater rise in Brazilian forward rates relative to U.S. rates. Panel C in the same figure plots the total change in the differential between October 3 and October 6, 2008 (this is the difference of the curves in Panel B). The first term on the RHS of Equation (2) corresponds to the area under the curve in Panel C according to the numbers in rows four and five of Table 2 (with differently-sized areas corresponding to different terminal dates).

F. Calculating the Portion of the "News" Related to Expected Monetary Policy

The long-run neutrality of money maintains that monetary policy only affects nominal variables such as the level or growth rate of output in the long run, and has no effect on real variables. However, it can affect real variables—including real interest rates—in the short-run as long as prices are sticky. One corollary is that monetary policy has no effect on the real exchange rate in the long run, but that it can affect expected nominal exchange rates by influencing inflation expectations over a certain period.

These concepts are embedded in the UIP decomposition that we presented inasmuch as:

- Changes in expectations about nominal interest rate differentials in the short run reflect a reconsideration of short-term real interest rate differentials (over which monetary policymakers have some control), but in the longer term they reflect a reassessment of expected relative inflation;
- Changes in expected prices relative to U.S. prices have no impact on long-term real exchange rate expectations.

In order to use these assumptions to attribute the portion of interest rate differentials (in rows four and five of Table 2) into those driven by monetary policy and those driven by "other factors," we must define the short-run by choosing a point *p* that separates the short-run from the long-run (Brigden et al. set *p*=6 years). We then presume, in line with long-run money neutrality, that the impact of relative inflation expectations equals 0 percent at time *t* and 100 percent at time *p* through *n*. In other words, changes in the real component are taken to dominate short-term expectations of nominal interest rate differentials, while the inflation component explains all of the movement in the long-run beyond time *p*. One further assumption that results from the inflation component in the long-run is that relative real interest rates do not change past *p*. As a result, we can identify the effects of monetary policy on the change in exchange rate as the real component of our decomposition.

Figure 7 provides a chart detailing this working assumption for the aforementioned Brazil-U.S. example. Panel A shows the total change in the nominal interest rate differential (same as Panel C in Figure 6); Panels B and C show how the technique decomposes this into changes in relative inflation expectations (Panel B) and relative real interest rates (Panel C), with the pass-through parameter *p* set equal to 6 years. Row six in Table 2 shows the exchange rate shift implied by the shaded area in Panel C.

One caveat to the analysis, of course, is that this is a very stylized model with fairly strong assumptions. The decomposition allows us to gain a view of the drivers of exchange rate changes but cannot offer an exact estimation of the components of exchange rate change. Importantly, for many countries, the forward curves derived here are merely theoretical because no bonds at the implied maturities exist (this is the case for Australia, Brazil, Chile, Mexico, and New Zealand) and capital markets in the EMEs tend to be relatively shallow.

Last but not least, as interest rates are subject to many other variables than monetary policy alone, although we argue for the link between real interest rate changes and monetary policy, this relationship is not one for one. It follows that the prudent interpretation of results in this case is that monetary policy news can perhaps account for a significant proportion of the increase in the value of the Brazilian real vis-à-vis the U.S. dollar on October 6, 2008, but that to say anything further would be imprudent.

II. RESULTS

A. UIP Decomposition Applied to Longer Periods during the Crisis

The UIP decomposition can be used to understand broad drivers of currency movements over longer spans of time during the 2008–2010 financial crisis. By and large all exchange rates in our sample depreciated for a few quarters at the onset of the crisis up to approximately mid-2008, but then appreciated as the U.S. economy slid further into recession.

Figure 8 plots for each country the log change in that country's currency during the initial depreciating phase against the log change in the currency during the subsequent appreciating phase (a negative value indicates a depreciation of the currency against the U.S. dollar). The trough is defined as the minimum exchange rate (currency of country *x*/U.S. dollar) from the start of the crisis to April 1, 2010. The peak is defined as the maximum exchange rate from the trough to April 1, 2010. The chart shows that the Australian dollar is the closest to have regained its pre-crisis value against the U.S. dollar, while sterling is the furthest from returning to its pre-crisis level. (The underlying interest rate and exchange rate trends are shown in Figure 9 plotting the Fed Funds rate, the monetary policy rate,[10] and the bilateral exchange rate against the U.S. dollar where, as usual, a rise indicates depreciation).

Table 3 summarizes UIP decompositions in the initial depreciating phase and the subsequent appreciating phase, suggesting the following results:

- **In the majority of countries, the initial *depreciating phase* against the U.S. dollar cannot be explained in terms of changes in expected relative real interest rates.** (In the best cases, i.e. UK, Mexico and Brazil, these explain less than 30 percent of the fall in the exchange rate).

- **The UIP decomposition suggests that the depreciating phase was the result of a portfolio shock.** This is in line with the view of most commentators at the time that saw the U.S. dollar's strength as a sign of real panic and risk aversion, as investors liquidated investments bought at a time when interest rates heavily favored European

[10] Since Mexico began using the overnight lending rate as a policy tool only in 2008, we use the 28-day TIIE rate.

assets. Institutional investors, faced with losses suffered on U.S. investments, were also liquidating overseas assets to meet margin calls. In this initial phase of the crisis these factors added to the U.S. dollar's strength as foreign currencies were sold for U.S. dollars: returns ceased being the driver for investors, instead paving the way for strategies aimed at capital protection. Indeed, implied volatility—a measure of risk—rose during this period as shown in Figure 10. The chart lends support to the view that the currencies in our sample were seen as more risky over this period.

- **The wave of initial depreciations came in a staggered fashion**, likely reflecting markets' sentiments about the strength and sequence with which the financial and economic crisis originating in the United States would hit individual countries. Investors started moving out of the euro, the New Zealand dollar, and the Chilean peso first (so these currencies were the first (March 2008) to weaken against the U.S. dollar); followed by the Australian dollar, the Brazilian real, and the Mexican peso (July and August 2008, respectively). Last to start their depreciation cycle were the Canadian dollar and sterling (November 2008). Over this window (March–November 2008), the U.S. dollar nominal effective exchange rate strengthened substantially (-13 percent) as short-term capital flew out of all the above currencies into the U.S. dollar. The great exception to the strength of the U.S. dollar at this time was the Japanese yen (not analyzed in the current version of our analysis), which appreciated by 14 percent, largely as a result of flight-to-safety buying of its own even though the Bank of Japan's main interest rate target, then at 0.5 percent, was the lowest of any major economy. (The yen had been trend-appreciating in nominal terms against the U.S. dollar since June 2007, a trend that was not reversed during the financial crisis).

- **By contrast, the *appreciating phase* of some currencies (EUR, BRL, CLP, MXN) can be largely explained through changes in expected nominal rate differentials with the Fed Funds rate**. The Fed slashed its policy rate practically to zero (0.125 percent) in December 2008. Soon after, most central banks in our sample moved to an emphasis on supporting economic growth from a focus on inflation and started cutting their policy rates rapidly. With the Fed Funds rate firmly near zero, and the Fed openly committed to prolonged easing, cuts in these countries' elevated policy rates brought their rates closer to their U.S. and Japanese counterparts, which made investing in short-term European, Brazilian, Chilean and Mexican assets less of a draw. In line with the UIP logic, the resulting downward cumulative revisions to the nominal forward differentials between such rates and the Fed Funds rate[11] sparked

[11] Monetary policy rates in Brazil, Chile and Mexico, when their currencies hit their lowest value against the U.S. dollar during the crisis, ranged between levels of 8 and 13 percent. An exception is the policy rate in the Euro Area which was at 3 ¼ percent when the euro hit is lowest value against the U.S. dollar (i.e. on November 20, 2008) during the crisis.

upward expectations of exchange rate changes in these countries. Over this period of appreciation, changes in the expectations of nominal rate differentials explain 100 percent of changes in the euro, the Brazilian real, and the Mexican peso, while explaining around 70 percent of the fluctuation in the Chilean peso. We estimate that 30 (Brazil, Mexico), to 60 (Chile), to 100 percent (Euro Area) of these revisions relates to revisions in the real interest rate component of the nominal differentials, i.e., expectations about monetary policy factors.

- **However, risk rather than return considerations seem to have been behind the small appreciation of sterling, or the stronger appreciations of the Canadian and New Zealand dollars**. All these countries made clear commitments to particularly low levels of policy rates (Canada's, for example, through an explicit commitment to hold its monetary policy rate at ¼ of a percent until mid 2011), ruling out revisions to nominal rate differentials vis-á-vis the Fed Funds rate going forward. Thus, policy analysis lends support to the view that the Canadian and New Zealand dollars became safe havens in early 2009 (when their appreciations started), as emerging Asia—notably China—marched out of the crisis in early 2009, triggering an upturn in the prices of commodities. This added to the already good 2009 Q1 economic news in Australia, New Zealand and Canada—all strong commodity-exporters—boosting investors' expectations of early recoveries in such countries—while concerns continued to linger over the United States and Euro Area recoveries.[12] In the U.K. case, the modest appreciation may instead be interpreted as a sign that the government's huge bank rescues at the beginning of the crisis gained public trust, as did the extraordinary monetary and fiscal stimulus put in place to support the financial system more generally, reviving foreign capital flows into Great Britain. Again, this is confirmed by the change in implied volatility as shown in Figure 10.

B. UIP Decomposition Applied to Our Selection of Dates

Table 2 summarizes results from decomposing exchange rate movements for the other countries in our sample (and Brazil) at our chosen dates during the 2008-2010 financial crisis. Results can be summarized as follows:

- **In emerging market economy countries—with the exception of Chile—the largest daily changes in expectations in exchange rates during the crisis seem to have been driven by changes in forward differentials**. For example, looking at the previous example for Brazil, the entire exchange rate appreciation vis-à-vis the U.S.

[12] One could argue that the U.S. and Euro Area economic recoveries looked to be picking up at that stage, as indicated by the strengthening in the U.S. and European equity markets. Hence, the appreciation in the New Zealand and Australian dollars could have also been linked to spillover effects from an improvement in the outlook for the major developed economies including Asia.

dollar on October 6, 2008 can be rationalized through revisions to forward differentials (of which almost 30 percent can be ascribed to monetary policy news). In Chile, movements of the peso, however, seem uncorrelated to shifts in expectations of the monetary policy rate or in inflation expectations relative to the United States.

- **By contrast, in advanced countries, the largest daily changes in expected exchange rates seems to have been dominated by changes in investors' sentiment toward those countries' currencies vis-à-vis the U.S. dollar (portfolio shocks), and hence to be risk-related**. In other words, for advanced countries, cumulative revisions to nominal forward interest rate differentials for most chosen dates are unable to explain the large appreciation/depreciation seen in their bilateral with the U.S. dollar over these dates. Taking Canada, for example, the Canadian dollar depreciated by 3.28 percent on October 22, 2008 relative to the previous FX trading day (Tuesday, October 21, 2008), but forward differentials cumulating over a 8-year horizon only moved by 69 basis points.

- **The Fed's emergency cut on October 8, 2008, however, surprised most currency markets, both emerging and advanced, and seems responsible for large FX trading on that day.** Most of our sample currencies' jumped on October 8, 2008, a day in which the Federal Reserve's Open Market Committee, working in coordination with other central banks worldwide, voted to reduce its target for the Federal Funds rate 50 basis points to 1.50 percent, stating that the move was necessary because of the worsening crisis in global financial markets. In addition, on that same day, the Federal Reserve Board also authorized the Federal Reserve Bank of New York to borrow up to US$37.8 billion in investment-grade, fixed-income securities from American International Group (AIG) in return for cash collateral that can be interpreted as an additional form of unconventional easing.[13] Thus, changes in expected exchange rates for all countries in our sample on that date can be largely explained through cumulative revisions to forward differentials, and in turn, through changes in expectations about real rates in those countries relative to the United States.

III. Conclusions

Focusing on the relationship between exchange rate movements and monetary policy to explain currency movements in a sample of advanced and emerging countries during the recent financial turmoil, we find that these have been largely dominated by safe haven effects, rather than carry trade activity or other return considerations. Over the coming years, as and if confidence in United States and U.S. denominated assets returns, appreciating

[13] Earlier in the week, the Fed had taken steps that potentially made trillions of dollars available to banks and the nation's leading businesses. That came on top of the controversial US$700 billion Wall Street bailout approved by Congress on the same week.

trends in all these currencies should subside—as is indeed already the case in a number of countries.

However, for some countries, notably the Euro Area, Brazil, Mexico, and Chile, the appreciation begun at the end of 2008 seems to have largely reflected downward cumulative revisions to the nominal forward differentials between such rates and the Fed Funds rate following the slashing of the fed Funds rate near zero in December 2008, and the Fed open commitment to prolonged easing. Apart from the euro which is still suffering in its own right as a result of the European sovereign credit scare, these currencies should also weaken again the U.S. dollar going forward to the extent that the withdrawal of the stimulus from these countries will be faster than in the United States (like in the case of Chile where already in June 2010 the central bank has started raising the policy rate by 50 basis points).

Finally, looking at individual dates, we also find that the Fed's emergency cut on October 8 however surprised most currency markets (emerging and advanced) and seems responsible for large foreign exchange rate trading on that day.

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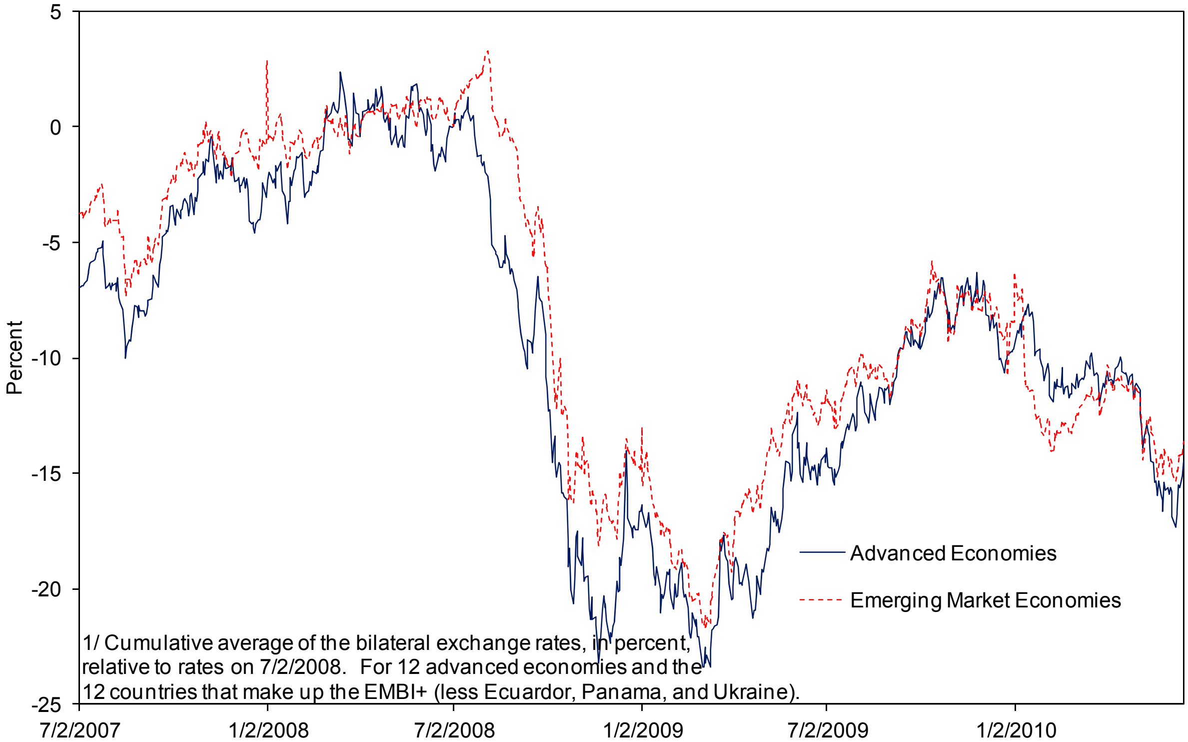
Tables and Figures

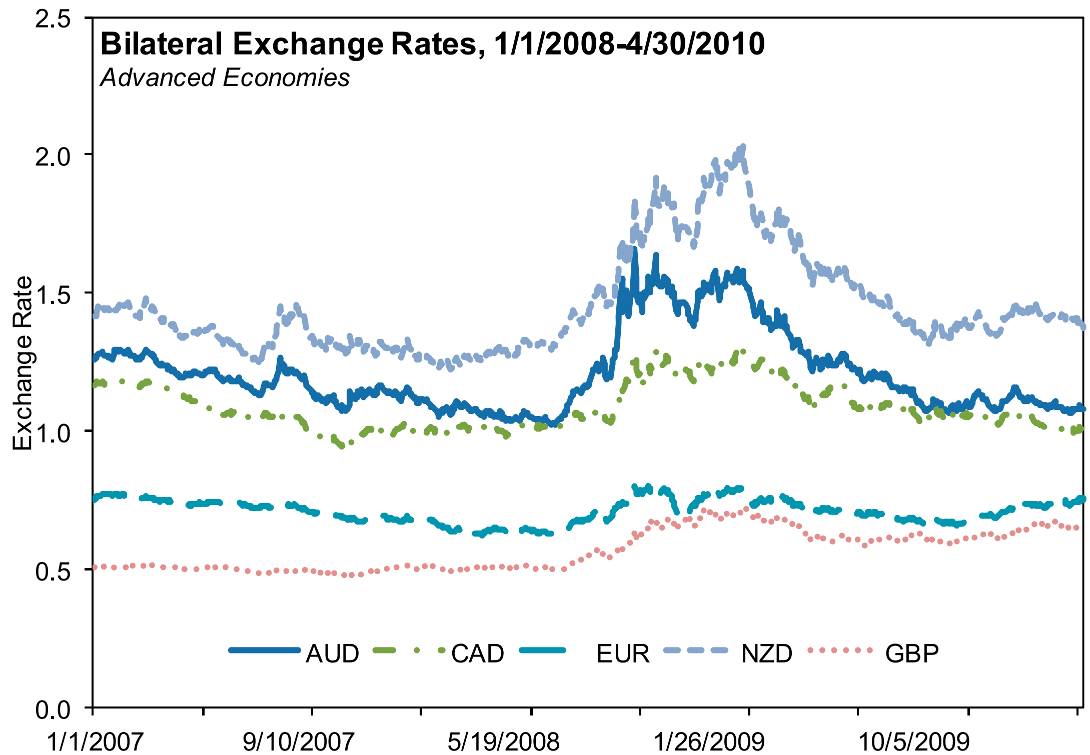
Figure 1. Bilateral Exchange Rate Movements During the Financial Crisis 1/

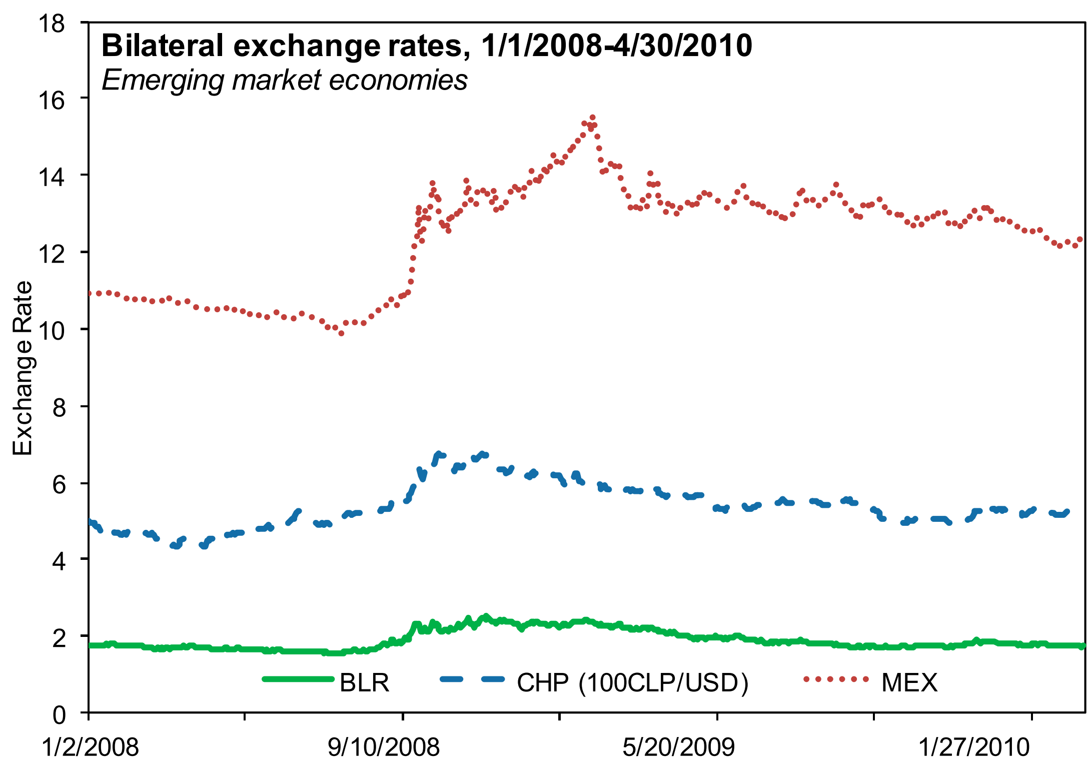


Sources: J.P. Morgan, Bloomberg LLC, and authors' calculations.

Figure 2. Bilateral Exchange Rates During Current Recession

NC/USD





Sources: Bloomberg LLC. and authors' calculations.

Table 1. Exchange Rate Troughs and Peaks January 1 2007-April 1 2010

Overall Crisis Period Exchange Rate Trough and Peak Dates

	Trough	Peak
Australia	7/15/2008	10/27/2008
Brazil	8/1/2008	12/8/2008
Canada	11/6/2007	3/9/2009
Chile	3/11/2008	11/21/2008
EU	4/22/2008	11/20/2008
Mexico	8/4/2008	3/9/2009
New Zealand	3/13/2008	3/2/2009
UK	11/8/2007	3/10/2009

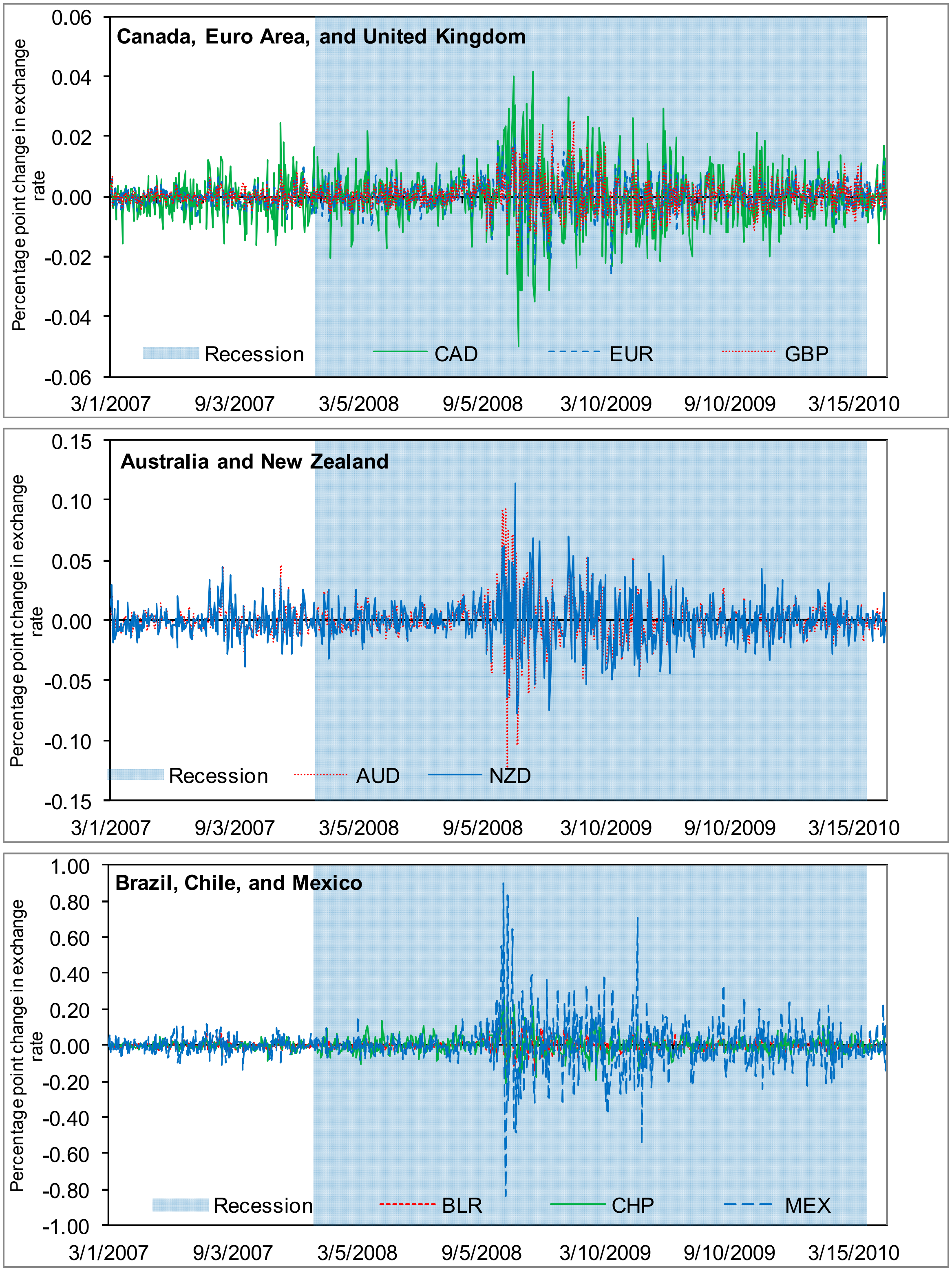
Single Day Percent Change Troughs and Peaks With Corresponding Events

	Percent change (day over day)	Major U.S. events	
Australia			
10/6/2008	7.1	EES Act including TARP signed into law 10/3/2008	
10/8/2008	6.3	37.8 bil AIG lending from FRBNY	FOMC cuts FFT to 1.5
10/29/2008	-4.0	FOMC drops FFT to 1, swaps est. with Bra, Mex, Kor, and Sing	IMF announces ST liquidity facility
Brazil			
10/6/2008	6.6	EES Act including TARP signed into law 10/3/2008	
10/22/2008	6.3	FRB sets new excess res bal interest rate	
Canada			
10/22/2008	3.3	FRB sets new excess res bal interest rate	
10/29/2008	-3.9	FOMC drops FFT to 1, swaps est. with Bra, Mex, Kor, and Sing	IMF announces ST liquidity facility
Chile			
10/8/2008	3.4	37.8 bil AIG lending from FRBNY	FOMC cuts FFT to 1.5
10/10/2008	4.4	37.8 bil AIG lending from FRBNY 10/8/2008	FOMC cuts FFT to 1.5 10/8/2008
10/22/2008	2.3	FRB sets new excess res bal interest rate	
EU			
10/22/2008	1.6	FRB sets new excess res bal interest rate	
10/29/2008	-2.2	FOMC drops FFT to 1, swaps est. with Bra, Mex, Kor, and Sing	IMF announces ST liquidity facility
Mexico			
10/6/2008	4.9	EES Act including TARP signed into law 10/3/2008	
10/22/2008	4.9	FRB sets new excess res bal interest rate	
New Zealand			
10/6/2008	4.0	EES Act including TARP signed into law 10/3/2008	
10/8/2008	3.8	37.8 bil AIG lending from FRBNY	FOMC cuts FFT to 1.5
10/29/2008	-3.5	FOMC drops FFT to 1, swaps est. with Bra, Mex, Kor, and Sing	IMF announces ST liquidity facility
UK			
10/22/2008	2.7	FRB sets new excess res bal interest rate	
10/29/2008	-2.9	FOMC drops FFT to 1, swaps est. with Bra, Mex, Kor, and Sing	IMF announces ST liquidity facility

Note: Dates for single day analysis were chosen based on the number of countries who had a large exchange rate shift on that day. Also taken into account was the news on that day that may have played a role in the exchange rate shift.

Figure 3. Exchange Rate Volatility, 3/1/2007-4/30/2010

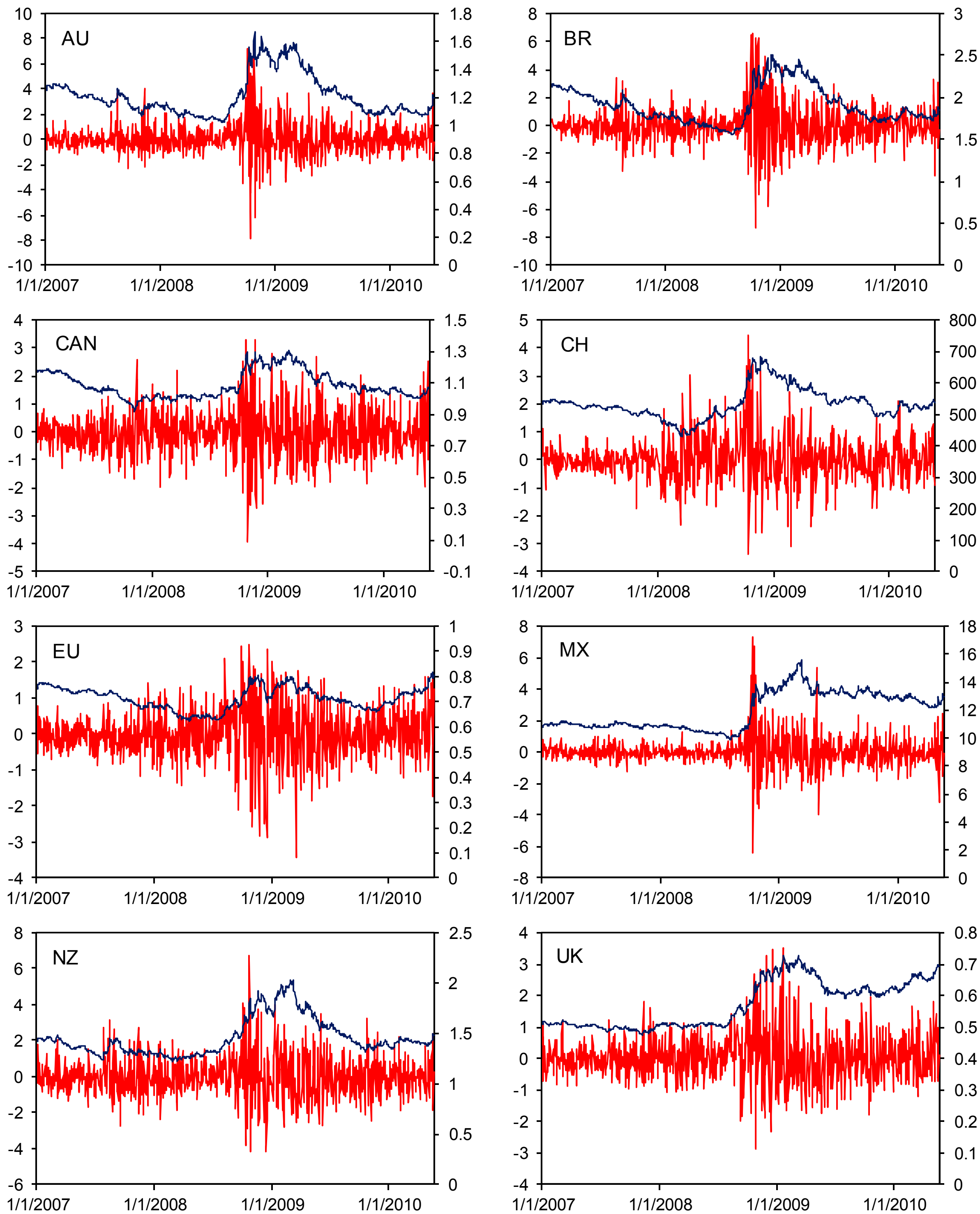
First differences, day-day.



Sources: Bloomberg LLC. and authors' calculations

Figure 4. Exchange Rates and Percent Changes, 1/1/2007-5/24/2010 1/

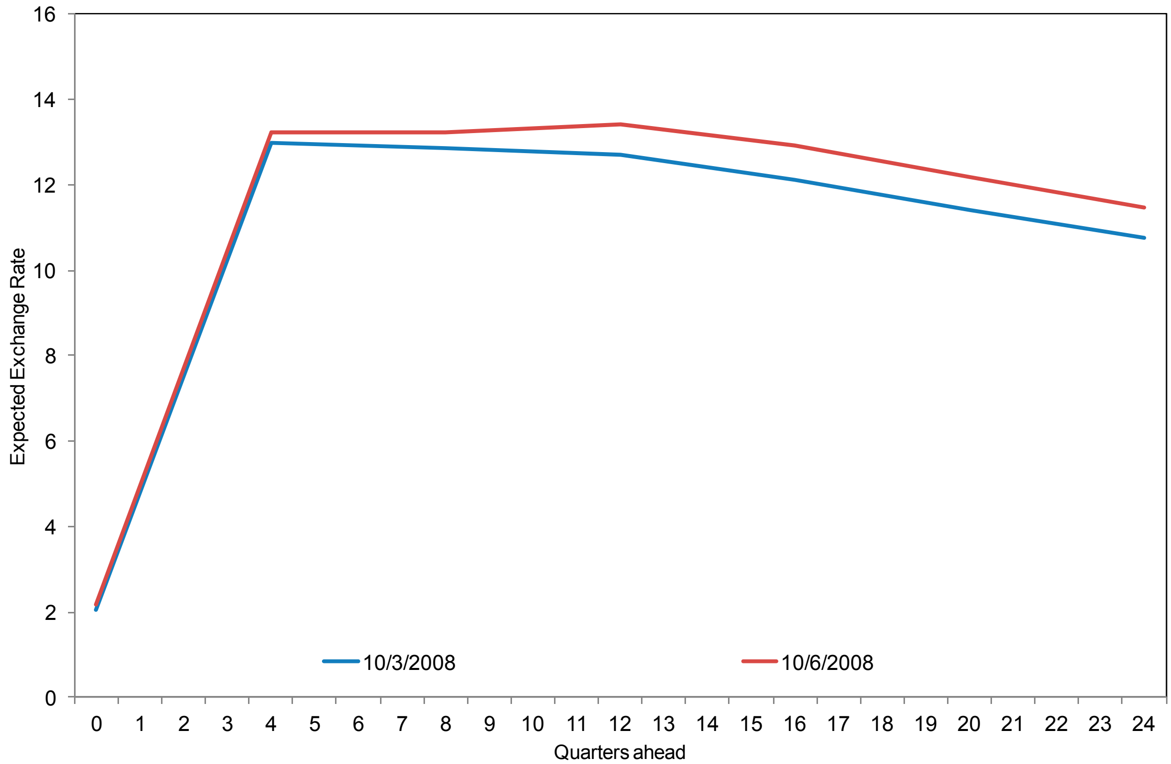
National Currency/USD



Sources: Bloomberg LLC. and authors' calculations.

1/ Day over day percent changes.

Figure 5. Brazil - U.S. Exchange Rate Profile, 10/3/2008-10/6/2008



Sources: Haver Analytics, Bloomberg LLC, and authors' calculations.

Table 2. Decomposition Tables for Selected Dates

Australia

		10/6/2008	10/8/2008	10/29/2008
Actual change against:		7.15	6.26	-4.00
of which				
Expected		0.00	0.00	0.00
"News"		7.15	6.26	-4.00
Cumulative revision to nominal forward interest differentials				
range as terminal horizon varies from 8 to 12 years	8 years	0.26	-3.60	-0.90
	12 years	-0.09	-4.50	-1.97
of which				
Estimated real component		0.51	-1.49	-0.04
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	0.36	-0.91	-0.20
	8 years	0.57	-2.18	-0.05
Residual		6.64	7.75	-3.96
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	6.79	7.18	-3.80
	8 years	6.58	8.44	-3.95

Table 2 (cont.) Decomposition Tables for Selected Dates

Brazil

		10/6/2008	10/22/2008
Actual change against:		6.60	6.27
of which			
Expected		0.00	0.00
"News"		6.60	6.27
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	5.31	9.20
	12 years	7.58	15.53
of which			
Estimated real component		2.02	3.42
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	1.09	2.64
	8 years	2.90	3.92
Residual		4.58	2.85
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	5.52	3.63
	8 years	3.71	2.35

Table 2 (cont.) Decomposition Tables for Selected Dates

Canada

		10/22/2008	10/29/2008
Actual change against:		3.28	-3.92
of which			
Expected		0.00	0.00
"News"		3.28	-3.92
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	0.69	-1.06
	12 years	0.88	-1.69
of which			
Estimated real component		0.08	-0.12
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	0.09	-0.13
	8 years	0.06	-0.14
Residual		3.20	-3.80
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	3.19	-3.79
	8 years	3.21	-3.78

Table 2 (cont.) Decomposition Tables for Selected Dates

Chile

		10/8/2008	10/10/2008	10/22/2008
Actual change against:		3.35	4.43	2.32
of which				
Expected		0.00	0.00	1.00
"News"		3.35	4.43	1.32
Cumulative revision to nominal forward interest differentials				
range as terminal horizon varies from 8 to 12 years	8 years	-4.78	-0.60	0.57
	12 years	-5.76	-1.15	0.94
of which				
Estimated real component		-2.20	0.30	-0.04
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	-1.44	0.24	0.05
	8 years	-3.08	0.15	0.11
Residual		5.55	4.14	1.36
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	4.79	4.19	1.27
	8 years	6.43	4.28	1.21

Table 2 (cont.) Decomposition Tables for Selected Dates

European Monetary Union

		10/22/2008	10/29/2008
Actual change against:		1.59	-2.16
of which			
Expected		0.00	0.00
"News"		1.59	-2.16
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-0.10	-0.06
	12 years	0.15	-0.39
of which			
Estimated real component		-0.15	0.30
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-0.14	0.31
	8 years	-0.22	0.23
Residual		1.74	-2.46
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	1.73	-2.46
	8 years	1.81	-2.39

Table 2 (cont.) Decomposition Tables for Selected Dates

Mexico

		10/6/2008	10/22/2008
Actual change against:		4.88	4.85
of which			
Expected		0.00	0.00
"News"		4.88	4.85
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	1.62	4.84
	12 years	2.54	9.78
of which			
Estimated real component		0.62	0.67
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	0.43	0.65
	8 years	0.79	0.79
Residual		4.26	4.19
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	4.45	4.20
	8 years	4.09	4.06

Table 2 (cont.) Decomposition Tables for Selected Dates

New Zealand

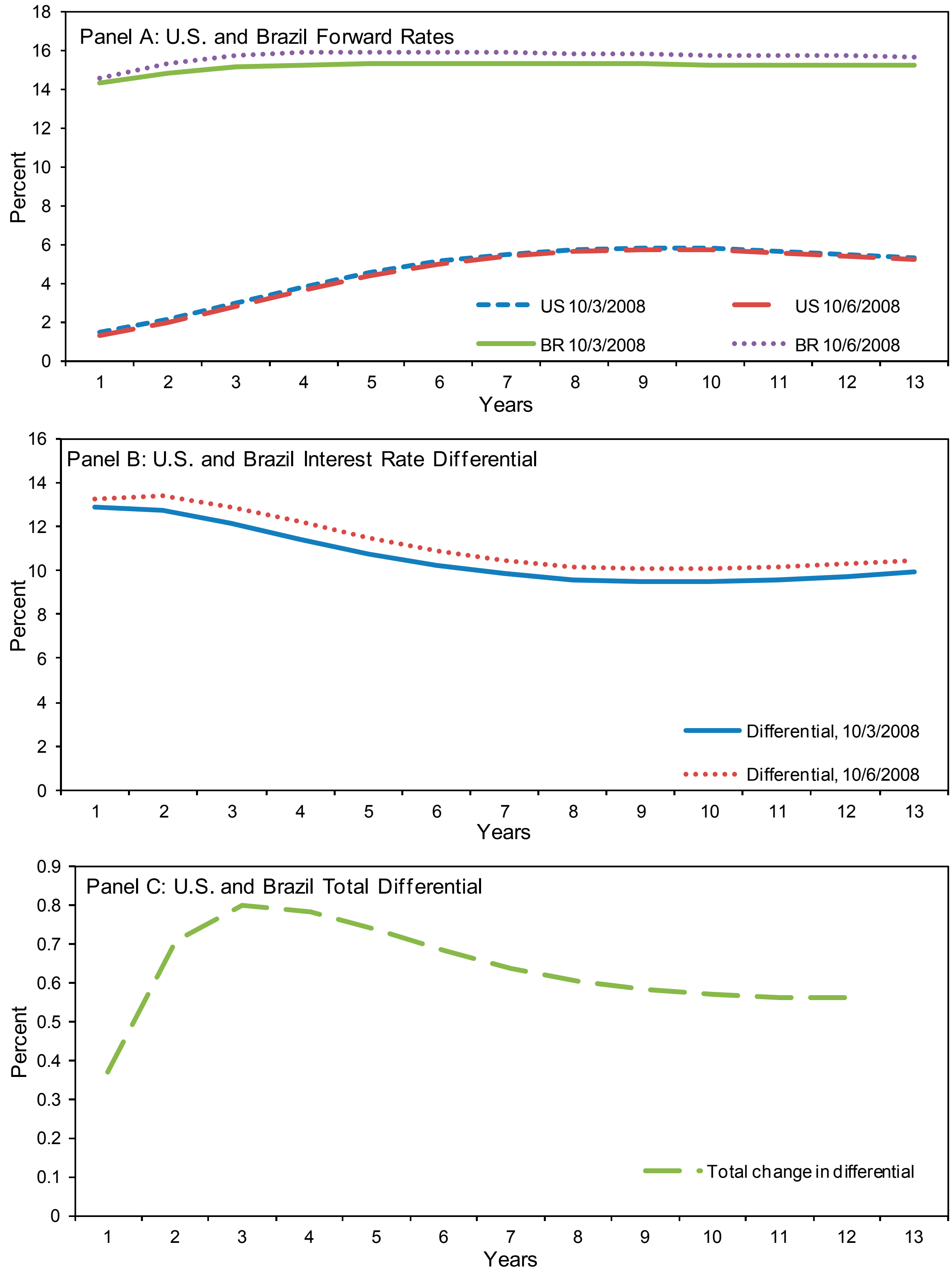
		10/6/2008	10/8/2008	10/29/2008
Actual change against:		4.04	3.83	-3.48
of which				
Expected		0.00	0.00	0.00
"News"		4.04	3.83	-3.48
Cumulative revision to nominal forward interest differentials				
range as terminal horizon varies from 8 to 12 years	8 years	0.54	-2.41	-0.23
	12 years	0.68	-2.70	-0.64
of which				
Estimated real component		0.35	-1.44	0.08
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	0.21	-0.96	0.01
	8 years	0.47	-2.00	0.13
Residual		3.69	5.27	-3.56
Sensitivity band				
estimated range as p-horizon varies from 4 to 8 years	4 years	3.84	4.79	-3.49
	8 years	3.57	5.83	-3.60

Table 2 (cont.) Decomposition Tables for Selected Dates

United Kingdom

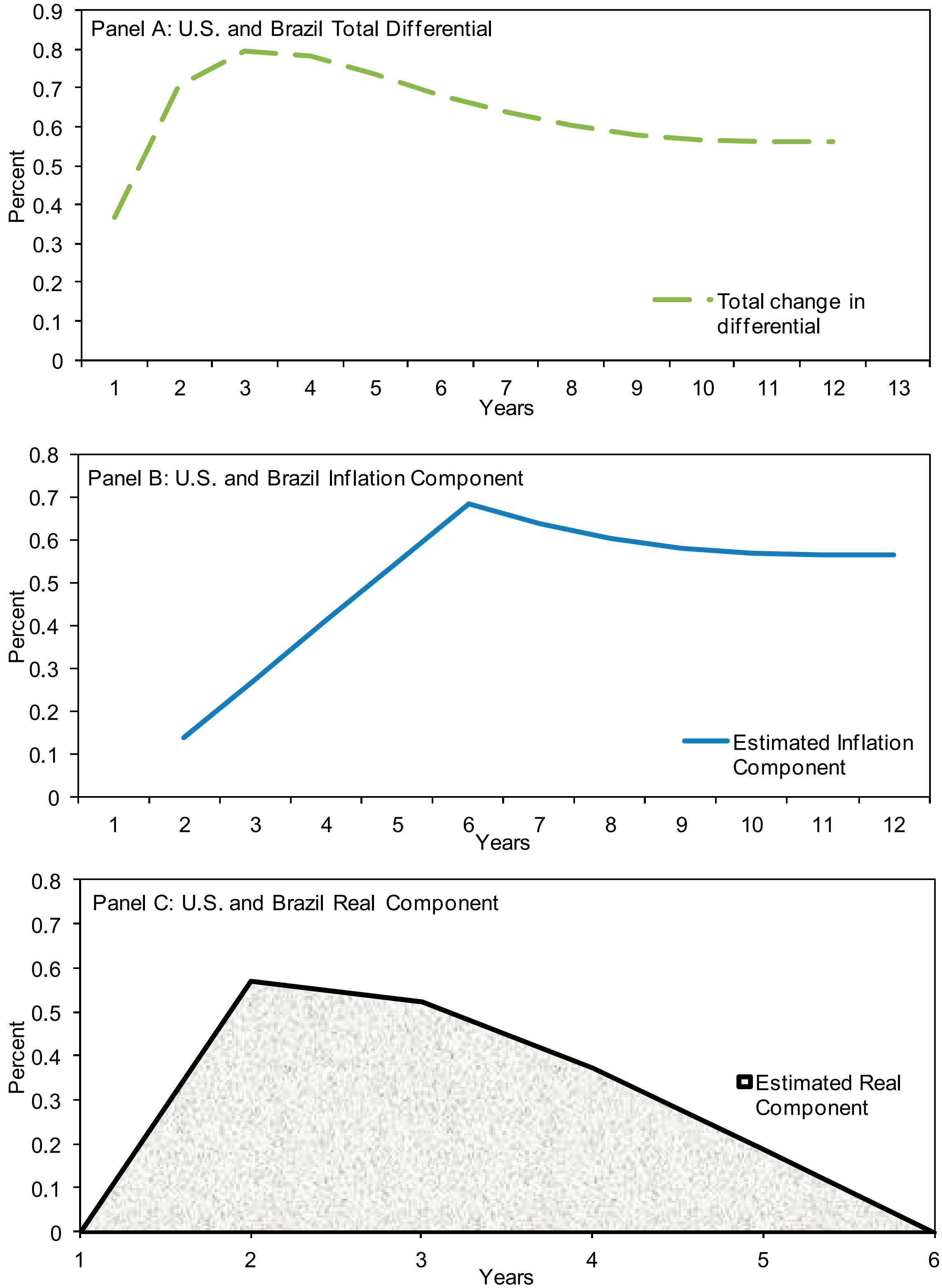
		10/22/2008	10/29/2008
Actual change against:		2.67	-2.92
of which			
Expected		0.00	0.00
"News"		2.67	-2.92
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-0.26	-0.45
	12 years	0.09	-0.87
of which			
Estimated real component		-0.66	-0.34
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-0.56	-0.24
	8 years	-0.62	-0.26
Residual		3.33	-2.58
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	3.23	-2.68
	8 years	3.29	-2.66

Figure 6. Brazil UIP Analysis 10/6/2008



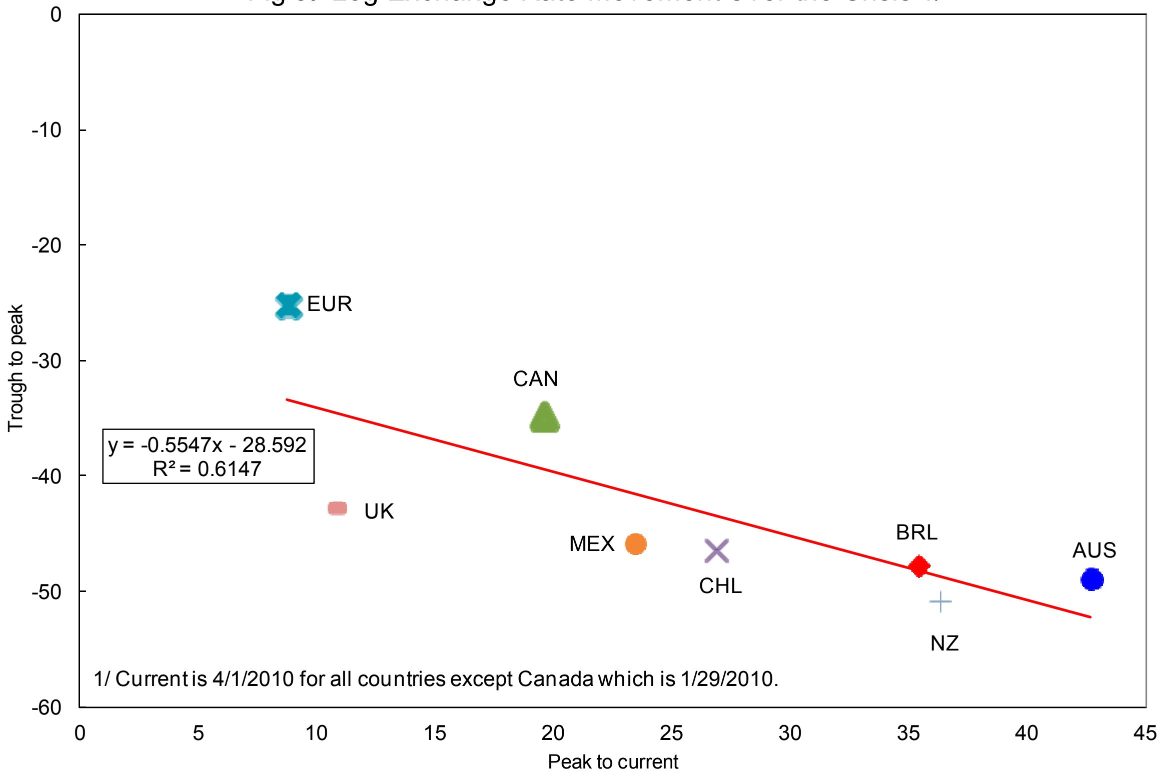
Sources: Bloomberg LLC., Haver Analytics, and authors' calculations.

Figure 7. Brazil UIP Decomposition Into Components, 10/6/2008



Sources: Bloomberg LLC., Haver Analytics, and authors' calculations.

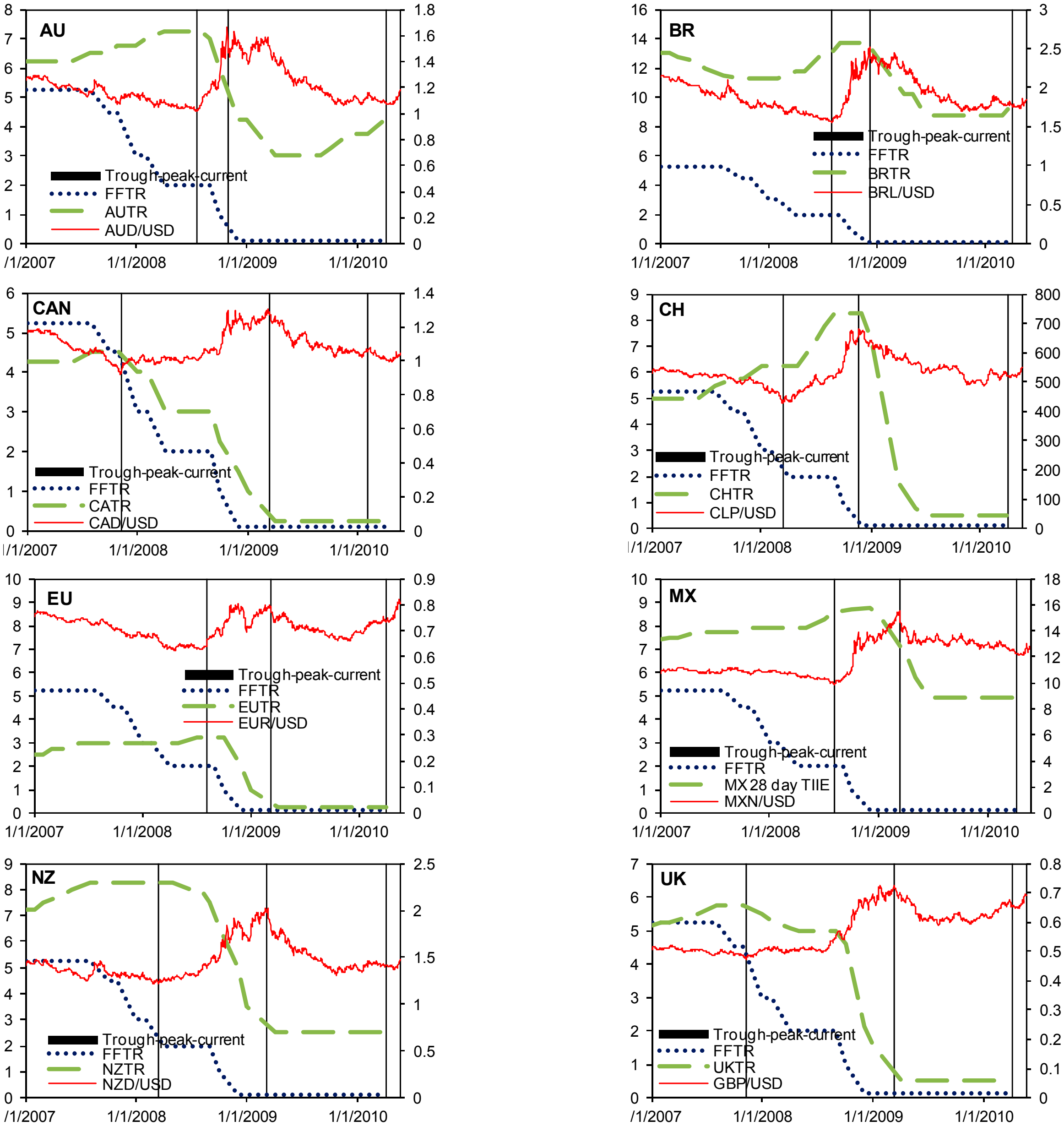
Fig 8. Log Exchange Rate Movement Over the Crisis 1/



Sources: Bloomberg LLC and authors' calculations.

Figure 9. Trough To Peak To Current Exchange Rates and Policy Rates

Policy rates in percent (left), exchange rates (right)



Sources: Haver Analytics, Bloomberg LLC., and authors' calculations.
Note: For Mexico we used the 28 day TIIE rate since Banxico did not use overnight rates as a policy tool until 2008.

Table 3. Decomposition Tables for Trough-Peak-Current Dates

Australia

		Peak	Current
	Trough 7/15/2008	10/27/2008	4/1/2010
Actual change against:		62.86	-34.72
of which			
Expected		0.00	0.00
"News"		62.86	-34.72
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-17.36	8.13
	12 years	-24.01	11.62
of which			
Estimated real component		-4.17	1.04
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-2.79	0.86
	8 years	-7.30	2.41
Residual		67.04	-35.76
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	65.66	-35.58
	8 years	70.17	-37.13

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

Brazil

	Trough 8/1/2008	Peak 12/8/2008	Current 4/1/2010
Actual change against:		61.07	-29.77
of which			
Expected		0.00	0.00
"News"		61.07	-29.77
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	10.47	-25.00
	12 years	19.98	-38.39
of which			
Estimated real component		5.01	-9.68
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	3.07	-6.01
	8 years	5.35	-12.94
Residual		56.06	-20.10
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	58.00	-23.76
	8 years	55.72	-16.83

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

Canada

	Trough 11/6/2007	Peak 3/9/2009	Current 4/1/2010
Actual change against:		41.37	-22.49
of which			
Expected		0.00	0.00
"News"		41.37	-22.49
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-11.54	1.48
	12 years	-16.41	1.86
of which			
Estimated real component		-2.90	0.16
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-1.64	0.39
	8 years	-4.84	0.16
Residual		44.27	-22.64
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	43.01	-22.87
	8 years	46.22	-22.64

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

Chile

		Peak	Current
	Trough 3/11/2008	11/21/2008	4/1/2010
Actual change against:		58.95	-23.54
of which			
Expected		0.00	0.00
"News"		58.95	-23.54
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	1.10	-16.85
	12 years	1.42	-15.73
of which			
Estimated real component		3.55	-15.68
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	2.91	-11.65
	8 years	2.94	-17.79
Residual		55.39	-7.87
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	56.03	-11.90
	8 years	56.01	-5.76

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

European Monetary Union

		Peak	Current
	Trough 4/22/2008	11/20/2008	4/1/2010
Actual change against:		28.42	-8.36
of which			
Expected		0.00	0.00
"News"		28.42	-8.36
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-0.73	-9.42
	12 years	-0.50	-9.43
of which			
Estimated real component		1.28	-8.80
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	0.31	-5.15
	8 years	0.97	-10.52
Residual		27.14	0.45
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	28.11	-3.21
	8 years	27.45	2.17

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

Mexico

	Trough 8/4/2008	Peak 3/9/2009	Current 4/1/2010
Actual change against:		57.91	-20.84
of which			
Expected		0.00	0.00
"News"		57.91	-20.84
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	2.10	-19.63
	12 years	4.13	-26.40
of which			
Estimated real component		1.01	-7.99
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	0.44	-4.60
	8 years	1.21	-11.65
Residual		56.90	-12.85
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	57.47	-16.24
	8 years	56.70	-9.19

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

New Zealand

		Peak	Current
	Trough 3/13/2008	3/2/2009	4/1/2010
Actual change against:		66.12	-30.42
of which			
Expected		0.00	0.00
"News"		66.12	-30.42
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-12.60	5.01
	12 years	-15.34	9.64
of which			
Estimated real component		-8.02	0.59
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-6.46	0.68
	8 years	-9.04	0.59
Residual		74.14	-31.01
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	72.58	-31.10
	8 years	75.16	-31.02

Table 3 (cont.) Decomposition Tables for Trough-Peak-Current Dates

United Kingdom

		10/22/2008	10/29/2008
Actual change against:		2.67	-2.92
of which			
Expected		0.00	0.00
"News"		2.67	-2.92
Cumulative revision to nominal forward interest differentials			
range as terminal horizon varies from 8 to 12 years	8 years	-0.26	-0.45
	12 years	0.09	-0.87
of which			
Estimated real component		-0.66	-0.34
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	-0.56	-0.24
	8 years	-0.62	-0.26
Residual		3.33	-2.58
Sensitivity band			
estimated range as p-horizon varies from 4 to 8 years	4 years	3.23	-2.68
	8 years	3.29	-2.66