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MONETARY POLICY AND EXCHANGE RATE RETURNS:
TIME-VARYING RISK REGIMES

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Monetary Policy and Exchange Rate Returns: Time-Varying Risk Regimes
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ABSTRACT

We develop an empirical model of exchange rate returns, applied separately to samples of developed and developing economies' currencies against the dollar. We incorporate into this model natural-language-based measures of the monetary policy stances of the large global central banks, and show that these become increasingly important in the post-crisis era. We find an important spillover effect from the monetary policy of the Bank of England, the Bank of Japan and the ECB to the exchange rate returns of other currencies against the dollar. Furthermore, we find that the relation between a developed country's interest rate differential relative to the dollar (carry) and the future returns from investing in its currency switches sign from the pre- to the post-crisis subperiod, while for emerging markets the carry variable is never a significant predictor of returns. The high profit from the carry trade for emerging market currencies reflects persistent country characteristics likely reflective of risk rather than the interest differential per se. While measures of global monetary policy stance forecast exchange rate returns against the dollar, they do not predict exchange rate returns against other base currencies. Results regarding returns from carry, however, are insensitive to the choice of the base currency. We construct a no-arbitrage pricing model which reconciles many of our empirical findings.

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An Online Appendix is available at https://sites.google.com/view/hmamaysky

1. Introduction

How do central bank actions, and other changes in the economic environment, forecast exchange rates, and through what channels? There is a huge literature in monetary economics that posits a close connection between monetary policy and exchange rates because the exchange rate is the foreign currency price of money, and central banks control the supply process that creates money. In the 1970s, as part of the rational expectations revolution in macroeconomics, economists developed models of exchange rate determination that saw exchange rates as forward-looking asset prices affected by news, including news about monetary policy.[1]

Along with the conceptual changes in exchange rate modeling in the 1970s, the demise of the Bretton Woods System of fixed exchange rates gave rise to a vast empirical literature attempting to explain exchange rate changes. It proved to be very challenging to capture monetary policy news or translate it or other macroeconomic news into predictions about contemporaneous exchange rate changes.[2] At the same time, other approaches to studying exchange rates arose, including market microstructure models,[3] models that relate global capital flow shocks to exchange rates, and empirical models that study deviations from uncovered interest rate parity and the time variation in exchange rate risk premia.[4]

If the exchange rate market is efficient, then relevant news (e.g., changes in the stance of monetary policy) should be incorporated immediately into the exchange rate, and future

[1] Some important contributions to the early theoretical literature include Dornbusch (1976, 1980, 1987), Mussa (1982), and models that examined the forecasting of fixed exchange rate collapses, such as Flood and Marion (1982), Flood and Garber (1984), and Flood and Hodrick (1986), to name only a few.
[2] Meese and Rogoff (1983), Ito and Roley (1988), Evans and Lyons (2002), Gholampour and van Wincoop (2018).
[3] For example, Dominguez and Frankel (1993), Lyons (2001).
[4] One approach to connecting capital market changes and exchange rates relates changes in the global demand for dollar-denominated debt to exchange rate changes (Jiang, Krishnamurthy, and Lustig 2018a, 2018b).

exchange rate returns should only be forecastable by variables that capture compensation for risk.[5] Empirical models often focus on factor models that identify patterns of association that capture risks that should be relevant for expected exchange rate returns.[6] Factors identified in the literature include the "dollar factor" – which captures changes in many exchange rates relative to the dollar – and the "carry factor" – which exploits currency return variation related to interest rate differences across countries. A carry factor trading strategy buys currencies with the highest nominal interest rates and shorts currencies with the lowest nominal rates. Several other factors have been identified in the literature, including the "dollar carry factor," which considers the returns to a contingent strategy that goes long (short) the dollar against a basket of all other currencies when the dollar has the higher (lower) interest rate.

Despite the promising patterns of association that have been identified between exchange rate factors and exchange rate returns, factor models do not identify the underlying economic shocks that account for the importance of these factors. Specifically, they do not ask whether the importance of factors reflects monetary policy risk. With few exceptions (see Rey 2015, and Taylor 2018 for a review), the recent finance and economics literatures on exchange rates have not focused on measuring monetary policy's influence on future exchange rate returns. The absence of attention is striking, given the apparent importance of recent monetary policy shocks for exchange rate changes, which has been captured by analyses of low-frequency association between exchange rate movements and quantitative easing (QE) policy actions (Taylor 2018)

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[5] We use the term *efficient* to refer to both information efficiency, as well as to the absence of market frictions, such as microstructure effects, slow moving capital, or barriers to arbitrage. Similarly, we use the term *inefficient* to refer to both informational inefficiency, as well as to the presence of market frictions.

[6] Chernov (2007), Brunnermeier, Nagel and Pederson (2009), Caballero and Doyle (2012), Jurek (2014), Barroso and Santa-Clara (2015), Della Corte, Riddiough and Sarno (2016), Della Corte, Kozhan and Neuberger (2016), Della Corte, Ramadorai and Sarno (2016), Menkhoff, Sarno, Schmeling and Schrimpf (2016), Daniel, Hodrick and Lu (2017), Du, Tepper and Verdelhan (2018), Lustig and Richmond (2018), Lustig, Roussanov and Verdelhan (2011 and 2014), Verdelhan (2018), Aloosh and Bekaert (2019).

and the exchange rate announcement effects of quantitative easing policy (Chari, Stedman, and Lundblad 2018).

Part of the challenge of modeling the effects of monetary policy on future exchange rates is identifying a way of measuring policy consistently across countries and over time. Another part of the challenge is disentangling the effects of monetary policy from other influences that are relevant for exchange rates, which also may affect or be affected by monetary policy. In the literature on modeling equity returns, researchers have converged on a list of several robust forecasting variables that can be said to comprise a baseline model, which is taken into account when identifying new forecasting variables (Calomiris and Mamaysky 2018). But in the exchange rate literature, despite progress in identifying forecasters of returns by numerous researchers, there is no apparent consensus regarding a comprehensive baseline model for forecasting exchange rate returns. Any attempt to capture monetary policy influences must account for and control for other influences on exchange rates that may be correlated with monetary policy actions. Other sources of risk include influences on the real exchange rate, which may vary over time in response to differences in productivity growth among countries (the Balassa-Samuelson effect). Risks related to capital flows may also be relevant.

In this paper, we first develop an empirical model, in the form of a panel regression, for exchange rate returns which captures virtually all of the forecasting variables identified in the literature. We then use this model to investigate the importance of monetary policy stance for forecasting exchange rate returns for many developed and emerging countries over the period 1996-2016. We do so for one-year exchange rate returns, using both in-sample and out-of-sample approaches to gauging the predictive importance of changes in monetary policy stance. We find that monetary policy has played an important role in forecasting exchange rate returns, even after controlling for other currency influences identified in the prior literature. We identify important differences over time and between developed and emerging economies. Furthermore, consistent with recent research on the dominance of the dollar in international transactions and capital markets (Rey 2015, Gerko and Rey 2017, Gopinath and Stein 2018a, 2018b, Jiang, Krishnamurthy and Lustig 2018a, 2018b), we show that the effect of monetary policy on exchange rates is only present when the US dollar is used as the base currency, suggesting that the US dollar plays a unique role in the global financial system.

One important new finding is a spillover effect in monetary policy. We find that a tightening posture of the major non-US central banks (the European Central Bank (ECB), the Bank of England (BOE), and the Bank of Japan (BOJ)) forecasts an appreciation of the dollar relative to the currencies of countries other than those in the Eurozone, the UK, and Japan. The magnitude of the spillover effect is large. Furthermore, we find that this spillover does not reflect market inefficiencies in reacting to news about predictable Fed tightening in the future. As part of this analysis, we also estimate the extent to which central banks' actions have influenced each other, and how this has changed over time. We consider whether this monetary policy spillover may reflect predictable reactions of the Fed to other central banks' actions (an explanation that would be inconsistent with the efficient market view of exchange rate return predictability), and we are able to reject this explanation. We interpret the role of monetary policy spillovers in forecasting exchange rates relative to the dollar as capturing risk factors related to the global economy and financial system, rather than the risks associated with the monetary policy actions of the major non-US central banks.[7]

[7] This interpretation is consistent with Gerko and Rey's (2017) finding that interest rate changes attributable to US monetary policy affect the UK economy, but that interest rate changes attributable to BOE monetary policy do not affect the US economy. Therefore our own finding that BOE monetary policy affects currency returns against the

We make use of a new indicator of monetary policy that is based on textual analysis of monetary authority statements by the data provider Prattle.[8] This approach enables us to employ a common indicator of policy stance across countries and across monetary policy regimes. For example, our measure combines, in one variable, changes that show up in some regimes as interest rate movements and in other regimes as quantitative easing policy. The Prattle measure of monetary policy, based on central bank policy statements, minutes, governor speeches and press releases, is much broader than just a country's short-term rate, and reflects a given central bank's assessment of the economic and market conditions in its sphere of influence. [9]

We begin by connecting the Prattle measures of monetary policy to other variables, partly to validate their usefulness, and partly as a way of understanding the likely connections between monetary news and exchange rates. Interestingly, we find that Prattle not only is useful as a forecaster of future interest rate changes, but is closely related to financial risk.[10] This analysis informs our interpretation of the changing relationships we observe among measures of risk, monetary policy, and exchange rates. Financial traders often refer to changes in their taste for risk in foreign exchange and other assets pre- and post-2007 as moving from a "risk-on" to a "risk-off" posture. The idea seems to be that in the earlier period concerns about managing risk were not as important. We find that measures of risk (exchange rate volatility and the VIX) are

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dollar is due to either (1) the possibility that BOE policy affects economic activity in *all* other countries, which seems implausible, or (2) the fact that BOE monetary policy proxies for some unobservable risk factors.

[8] We thank Prattle for sharing their Central Bank Analytics data with us. See www.prattle.co for more information.

[9] We also note that many papers use proprietary text-derived series obtained from third party data providers. To name but a few: Heston and Sinha (2017) use Thomson-Reuters News Analytics proprietary sentiment measures; Asness et al. (2017) use Ravenpack's proprietary news sentiment measures; Nechio and Regan (2016) and Nechio and Wilson (2016) use the same Prattle measures that we do.

[10] Dossani (2018) uses a simpler measure of central bank tone to forecast currency volatility risk premia (the difference between implied volatility for currency options and lagged realized volatility) and finds that hawkish tone is associated with higher volatility risk premia. This is consistent with our findings if higher currency volatility risk premia are associated with higher precautionary savings demands of other countries relative to the US, as discussed in Section 7.

more important in the post-crisis period for developed economies' exchange rates. We also find that monetary policy posture is more important in forecasting exchange rate returns in the post-2007 period, which may reflect greater monetary policy activism in the post-2007 period, as well as the fact that monetary policy responds more to risk (measured by the VIX) in that period.

We explore the relationship between exchange rate return forecasters, including monetary policy indicators, and various previously identified return factors, including the dollar factor and the carry factor. We decompose each predictive variable's role into channels of influence related to the dollar factor, the carry factor, or the idiosyncratic component of currency returns. Doing so yields some surprising insights. In particular, we find that the impact of monetary policy news of major central banks other than the Fed operates primarily through the dollar factor.

We also consider the empirical puzzle of the recent reversal of the role of the interest rate differential as a positive predictor of the exchange rate, as documented in Hodrick and Tomunen (2018). We find that this reversal reflects changes in the risk environment over time. Our finding is similar to theirs – the early pattern of a positive association between a country's current interest rate (relative to others) and its future currency return is reversed after 2007. We find, however, that this reversal is only evident among developed economies, and we provide evidence indicating that the reversal could have reflected temporary savings differences among developed countries during the recent crises in the U.S. and Europe.

As part of this analysis, we produce new evidence that the interest rate differential sort for EM countries is largely a sort on country characteristics. Once we control for those characteristics, we find little evidence that the *carry* variable, the difference between a foreign and domestic short-term rate, forecasts currency returns in our panel analysis, even though the

EM carry trade has been consistently profitable. On the other hand, the *carry* variable for DM countries works both as a sorting variable and as a predictor in a panel regression. This suggests that the EM and DM currency carry trades may reflect different underlying mechanisms, and sheds light on why the DM, but not the EM, carry trade stopped "working" after the financial crisis.

We construct a theoretical model along the lines of Bekaert (1996), Bansal (1997), and Backus et al. (2001) that links exchange rate returns and risks to interpret the empirical patterns we identify. Our model shows how country-specific and global variation in the risk environment can explain changes in the coefficients we observe in our forecasting model. Furthermore, we show that the different empirical patterns we observe for the carry trade can be seen as reflecting three alternative risk regimes, which can be understood from the perspective of our no-arbitrage pricing model.

Section 2 describes our empirical model and defines the variables we include in our study. We also estimate rolling elastic net regressions to investigate whether all the forecasting variables which we include in our model are justified on statistical grounds, and we find that none of the variables can be excluded. Section 3 discusses the Prattle data on central bank policy in detail, and analyzes its usefulness as a gauge of monetary policy The Prattle measures are not just useful for forecasting future interest rates. They also reflect and predict changes in financial risk (as measured by the VIX), which suggests that their influence on exchange rates may contain both news about policy actions and news about the state of the economy. Our other data sources are described in the Online Appendix.

Section 4 reports in-sample estimates for our main endogenous variable, twelve-month-ahead returns, which are presented separately for developed and emerging economies (which differ in some important respects). Our model explains a large percentage of the variation in future returns, and many variables' coefficient estimates are highly statistically significant. The Prattle measures of central bank policies work well as forecasters of currency returns, especially in the post-crisis period.

Section 5 discusses the puzzle of the reversal of the carry variable (foreign vs US interest rate differential) as an exchange rate predictor in DMs, and shows that there is substantial heterogeneity among DM countries in the extent of this reversal, which is related to risk. In Section 7, we interpret the carry reversal as reflecting the difference between asynchronous and synchronous global economic cycles. Specifically, we posit that when foreign countries and the US have asynchronous economic cycles, low interest rate differentials are associated with low expected returns on the foreign currency. This leads to the usual positive correlation between interest rate differentials and currency returns. This pattern is robustly found for emerging market countries (EMs) and for developed countries (DMs) in the early subperiod of our sample. In the later subperiod, the result flips for DMs, and we speculate that this flip reflects a newly synchronous global economic cycle. When the foreign country and the US are both in a recession, their interest rate differential can move in the opposite direction of the currency expected return if their marginal utilities of consumption have different elasticities to the economic cycle than do their savings demands.

Section 6 relates the results of Section 4 to the literature on exchange rate factors. Here we decompose currency predictability into two parts: factor-related and idiosyncratic predictions, making use of the recent work on currency factor models (e.g., Aloosh and Bekaert 2019 and Verdelhan 2018).

Section 7 develops a simple, and quite general, no-arbitrage pricing model which is able to reconcile several of the important features of time-varying risk pricing, as well as the differences in the currency carry trade identified in our empirical work. In particular, we show that the model leads to a linear empirical specification in which returns depend on domestic, foreign, and global factors, thus justifying our main empirical setup, and providing interpretations of our results. Section 8 concludes.

2. Model Specification

Table 1 lists the regressors used in our exchange rate forecasting model, and data sources are discussed in the Online Appendix. Table 4 reports summary statistics. Section 4's discussion of the results explains the economic interpretations we attach to each of the variables included in the forecasting model, and we avoid repetition of that discussion here. The theoretical and empirical literatures on exchange rate determination indicate that monetary policy is only one of many influences that must be captured in any empirical model of exchange rate returns. Our vector of characteristics reflects a variety of factors, including monetary policy, variables that measure influences on real exchange rates and the mean reversion in the latter over time, capital account influences, time variation in volatility of exchange rate returns and the volatility of other asset returns, and momentum of exchange rate returns. We discuss in Section 2.1 our methodology for determining that all of our forecasting variables are indeed statistically relevant.

The dependent variable in our model is returns to investing in a foreign currency. In theory, forecasters of returns should capture risks that are priced by the market, as we explain more fully in Section 7. Our interpretation of our regression model, therefore, is that the regressors we include are state variables that capture risks that are priced by the market. Although we interpret our results from the perspective of an equilibrium model under efficient markets, we also consider alternative interpretations of some of our findings that may reflect market inefficiencies that result in predictable changes in exchange rates that reflect delayed market adjustment to news rather than compensation for risk.[11]

We measure exchange rates as the US dollar price of a foreign currency. Let S_t be the dollar price of a unit of foreign currency, and let y_t and y_t^* be the US and foreign short-term rates quoted in monthly terms. The return to a dollar investor of buying a unit of foreign currency and holding it for one month is $S_{t+1}e^{y_t^*}/S_t$. In continuously compounded terms this is $s_{t+1} - s_t + y_t^*$, where we denote logs with lower case letters. The excess return of this strategy above the US short-term rate is $rx_{t+1}^{(A)} = s_{t+1} - s_t + y_t^* - y_t$. Now consider committing S_t dollars of capital to buy one unit of foreign currency one month forward and then sell it immediately at S_{t+1}. The return from this strategy is $(S_{t+1} - F_t)/S_t$ where F_t is the one-month ahead forward price at time *t*. The first order approximation of this return is given by[12]

$$rx_{t+1} \approx s_{t+1} - f_t. \tag{1}$$

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[11] As several studies note, it may be that exchange rates do not fully adjust to news immediately, as a result of limits to market efficiency (see Duffie 2010, Gromb and Vayanos 2010, and Greenwood, Hanson and Liao 2018). In that case, some of forecasted returns can reflect slow responses to information. We recognize this possibility, but we found that the forecastability of exchange rate returns is much greater for the one-year period we analyze than for shorter time periods (e.g., a one-month period). We believe our long-term forecasts are unlikely to be driven by lagged responses to news, and are more likely to reflect expected returns due to risk exposures. Nevertheless, in our empirical discussion we note how some of our results could be interpreted from this alternative perspective.

[12] This follows from a first-order Taylor series expansion of $\exp(s_{t+1} - s_t) - \exp(f_t - s_t)$.

Covered interest parity is a no-arbitrage condition that requires the returns from these two strategies to be equal,[13] i.e. $rx = rx^{(A)}$, which occurs when $f_t - s_t = y_t - y_t^*$. The higher the foreign rate relative to the domestic rate, the lower the forward price of the foreign currency relative to the spot price.

Our one month return measure *ret1m* is rx_{t+1} from (1). Assuming CIP holds, this equals the return of a one-month investment into the foreign currency, financed by borrowing at the US one-month rate. The twelve-month lagged return is defined as $ret12m_t = \prod_{i=0}^{11}(1 + rx_{t-i}) - 1$. The regressions we estimate take the general form:

$$ret12m_{t+12}^{(i)} = a_i + \boldsymbol{\beta}'\boldsymbol{X}_t + \epsilon_{i,t+h}, \tag{2}$$

where α_i is the country fixed effect, and $\boldsymbol{X}_t$ is the set of time *t* forecasting variables. Among the elements of $\boldsymbol{X}_t$, two receive particular attention in our analysis. First, we study how the Prattle measures of central bank communications helps to forecast returns. We discuss the Prattle measure in detail below. Second, we focus on the forecasting ability of the short-term interest rate differential, *carry*, between the foreign market and the US. Our *carry* variable is defined as

$$carry_t \equiv -\log\frac{F_t}{S_t} \approx y_t^* - y_t, \tag{3}$$

where the second equality follows from CIP.

2.1 Model Selection

Because the extant literature on currency forecasting has identified many potential predictors of currency returns, our list of potential right-hand side variables is rather long.[14] Our

[13] We discuss later how the failure of CIP, documented in Du, Tepper, and Verdelhan (2018), Jiang, Krishnamurthy, and Lustig (2018a, 2018b), and Andersen, Duffie and Song (2019), affects our results.
[14] We have 21 explanatory variables, though some variables, such as our lagged returns variables, are simply the same variable measured over multiple horizons.

approach to model selection is able to remove variables that are redundant. Only variables that capture influences that are not spanned by the other variables are retained. Because the variables we include in our initial model all have justifications on economic grounds, we hesitate to remove any explanatory variable (for fear of an omitted variable bias) unless that variable can be shown to be not useful statistically.

When over-fitting is a concern, the typical solution is to penalize coefficient estimates by shrinking their absolute value based on an objective function that weighs each coefficient's contribution to explanatory power (which receives a positive weight) against the magnitude of that coefficient (which receives a negative weight). We use the elastic net estimator (implemented in the *glmnet* package of Hastie and Qian 2016), which combines the least absolute shrinkage and selection operator (lasso) regression, introduced by Tibshirani (1996), with a ridge regression, to ameliorate this over-fitting problem.

In our panel setting, we estimate rolling five-year regressions using the elastic net objective function, which is given by

$$\min_{\beta} \frac{1}{2N} \sum_{i,t} \left(z_{i,t} - x'_{i,t-1}\beta\right)^2 + \lambda(\alpha\|\beta\|_1 + (1-\alpha)\|\beta\|_2^2/2)$$

where N is the total number of observations in the regression, $z_{i,t}$ is the response variable (12-month forward returns in our case), $x_{i,t-1}$ is a vector of the predictors, $\|\beta\|_1$ is the L1-norm of the coefficients (the sum of the absolute values of the β vector) and $\|\beta\|_2^2$ is the L2-norm squared (the sum of the squares of the β coefficients).[15] We include country fixed effects by constructing demeaned z's and *x*'s within each country grouping – so a constant in the above regression is not

[15] One important subtlety in the out-of-sample estimation for 12-month ahead returns is to truncate the measured 12-month ahead outcomes in the pre time-(*t+1*) estimation window to ensure that they do not overlap with the *t+1* through *t+12* outcome that we are trying to forecast out-of-sample. This is needed in our root mean-squared error analysis, which is discussed in the Online Appendix.

necessary. The choice of λ determines the penalty applied to the blended L1- and L2-norms of the coefficients. This parameter is selected in each 60-month window to minimize the cross-validation error. We set $\alpha = 1$, i.e., the lasso objective, though other choices of α have little effect on the qualitative behavior of the model. Section 4.4 summarizes our empirical estimates of the elastic net model.

3. Prattle as a Measure of Central Banks' Policy Stance

In theory, under efficient markets, exchange rate returns should react to the (lagged) policy stance of monetary authorities only if it informs the market about risks that should be compensated for through higher expected returns. The stance of monetary policy contains information about risk either because the monetary authority's actions reflects risks that are exogenous to its actions, or because the monetary authority creates or mitigates risks through its actions. Statements or actions related to monetary policy by central banks potentially contain both elements. Using changes in interest rates to measure monetary policy actions has become common in macroeconomics, but there is more to monetary policy than interest rate changes. Monetary policy at the zero interest rate lower bound entails other actions: quantitative easing policy that grows the central bank's balance sheet, forward guidance that attempts to commit to a path of interest rate changes beyond the present, or other attempts to provide commitments that affect markets, such as the "Greenspan put" (an implicit commitment to try to prevent large stock market downturns, or Mario Draghi's commitment to do "whatever it takes" to stabilize the euro zone. A major challenge of mapping from monetary policy stance to exchange rate returns is measuring ex ante monetary policy stance, as distinct from observed ex post changes in the instruments of policy themselves.

This is particularly challenging when the instruments of policy change over time. Even if changes in the policy stance could be quantified by modeling expected changes in the instruments of policy, what is one to do when the monetary authority changes from using an interest rate as its policy instrument to using the growth of its liabilities? How can one construct a comparable measure over time that captures consistently the variety of changes in various instruments over time?

The Prattle measure of a central banks' policy stance addresses both of these challenges. It uses the statements of central bankers – including press releases, speeches of policy makers, minutes of their meetings, and other communications – to capture the ex ante stance of policy, which is expressed in a single variable that is centered at zero with a standard deviation of one in the training window. High values are "hawkish," meaning that they imply future changes in policy that are contractionary, while low values are "dovish," meaning that they imply future changes in policy that are accommodative. Prattle identifies combinations of words (linguistic patterns) that elicit market responses in its training period, and then uses those combinations in the out-of-sample period as real-time measures of monetary policy stance.[16]

Word combinations are not selected by Prattle based on any a priori views, but are entirely dictated by observed market reactions during the training period. Prattle finds that it is useful to take account of the relative frequency of the use of linguistic patterns, the context in

[16] According to the company: The training period for the Fed is 1998-2005, for the ECB it is 2004-2012, for the Bank of England it is from 2000-2008, and for the Bank of Japan it is from 2006-2013. Our post-crisis results for the Fed are both stronger than in the earlier subperiod and are completely out-of-sample. For the other banks, our pre- and post-crisis windows overlap with the training window. The models are trained to identify central bank language with market outcomes, where the latter are measured using a short- and long-dated bond, the trade weighted currency and the domestic stock index. In our forecasting regressions we forecast exchange rates against the dollar, which were not included in the security training set for the ex-Fed currencies. Furthermore, in results where we use the euro, pound or yen as the base currency (which do reflect the security training set), the forecasting power of the Prattle measure becomes much weaker. Hence, we do not believe in-sample bias is a major cause for concern.

which the pattern appears, and the novelty of that context, not just the presence or absence of word combinations. After the training window for each central bank, Prattle updates its linguistic mapping to take into account new words and phrases that enter the vernacular. However, the company has told us that the historical Prattle scores we have are the ones that were available at the time, and do not reflect model updates that took place afterwards. For more details on the Prattle text measure, including comparisons to other Fed sentiment measures, see Prattle (2016), Nechio and Regan (2016), and Nechio and Wilson (2016).[17]

Thus, Prattle offers a single measure of monetary policy stance that can be used across countries and across different monetary policy regimes where different monetary policy instruments are employed. We find that the Prattle score is best seen as a forward-looking measure of changes in central bank policy. As Table 2 shows, Prattle makes use of six categories of communications: monetary policy communications, an unlabeled category, speeches, other publications, minutes, and official press statements. We exclude from our Prattle measure the unlabeled category and the other publications category, as these consist of idiosyncratic research papers and other publications that we believe are not news and whose coverage is spotty.

The Prattle series for seventeen central banks are displayed in Figure A1 in the Online Appendix, along with one series we constructed for use in our empirical work, *CBexFed*, which combines information about more than one central bank (it is an average of the monthly Prattle scores for the ECB, BOE and BOJ). As Figure A1 shows, the coverage of Prattle has grown over time and now includes ten developed economies (Australia, Canada, Eurozone, Japan, New Zealand, Norway, Sweden, Switzerland, the U.K, the U.S.) and seven emerging economies

[17] In particular, Nechio and Regan (2016) show that the median Prattle score of speeches made by FOMC participants is positively correlated with the median medium-term interest rate forecast made by the same FOMC participants.

(Brazil, India, Israel, Mexico, South Korea, Taiwan, and Turkey). As Figure A2 shows, coverage improved markedly after 2000. Online Appendix Figure A3 maps the full-sample correlations across the various central bank Prattle scores using an ordered correlation matrix which locates central banks according to the similarity in the correlations.

In our empirical work, we show that Prattle measures are useful for forecasting exchange rate returns, but before turning to that analysis, we report evidence examining the Prattle measures of the four major central banks, the Fed, ECB, BOE and BOJ, from three other perspectives, which validate Prattle as a measure of monetary policy. First, to validate Prattle's information content as a measure of important monetary policy news (based on a priori identification of times of significant changes in the stance of policy), we examine whether Prattle scores track changes around quantitative easing announcements, and whether those announcements coincide with changes in 10-year bond yields. Second, we examine the dynamic relationship between Prattle scores and short-term interest rates using simple bivariate VARs, and trivariate VARs that also include the VIX. Third, we examine whether Prattle and short-term interest rates display similar medium-term responses to changes in certain macroeconomic variables. In panel regressions and VARs, we divide our sample into two subperiods, which are split at the end of 2006.

The results for the quantitative easing announcements are reported in Table 3. We use the QE events identified by Fawley and Neeley (2013), which cover announcements by the Bank of England, the Bank of Japan, the European Central Bank, and the Federal Reserve. There are a total of 63 events. The events are associated with negative Prattle scores, as one would expect, except for the ECB announcements which display Prattle scores that are neutral on average. Interest rate changes for 10-year bonds are negative, again with the exception of bund responses to the ECB, which averages about positive 3 basis points. One interpretation of the different reactions to the ECB is that its quantitative easing policy was targeted at alleviating market crisis concerns by supporting bond yields of the peripheral Eurozone countries, rather than achieving a monetary policy objective per se. That interpretation is consistent with other research that has found that ECB announcements affected markets with very long lags (often months), and those effects were not uniform in their incidence within the Eurozone, reflecting differences in country circumstances that mattered for the impact of the announcements (Mamaysky 2018, Fendel and Neugebauer 2018, Gholampour and van Wincoop 2017). From that perspective it is not surprising that the ECB is an outlier in Table 3.

With regard to exchange rate changes, we see that for the Fed and the Bank of England, QE announcements were associated with a large same-day currency depreciation. The Bank of Japan did not yet engage in meaningful QE, while the ECB's policy goals were different as has already been argued. Therefore, the lack of depreciation for these currencies is not surprising. We discuss the effect of monetary policy on exchange rates in much greater detail in Section 4. Though anecdotal, the results of Table 3 support the idea that Prattle scores for the big four central banks convey relevant information about their monetary policy.

We graph the relationship between Prattle and short-term interest rates in Figure 1.[18] Because Prattle is a measure of prospective change, we cumulate Prattle changes in the figure and show cumulative change in Prattle against the short-term interest rate. It is clear visually that Prattle sometimes moves ahead of changes in interest rates, but it is also clear that the two series are not extremely highly correlated. Many of the intentions reflected in Prattle are not clearly realized in short-term interest rates at some fixed lag, and similarly many of the realizations in

[18] The average monthly Prattle score for the Bank of England is positive, and therefore we detrend the cumulative Prattle series for the Bank of England. All other series are not detrended.

short-term interest rates are not anticipated by Prattle. Those patterns are apparent prior to the zero-lower-bound periods depicted in the figure, which begins in Japan in the late 1990s, and in the other three areas after the 2008 crisis.

To examine these relationships more formally, we begin with bivariate VARs, reported in Online Appendix Figures A12 through A15. In most cases, Prattle and the short-term interest rate are not statistically significant forecasters of one another (the short-term interest rate does forecast Prattle positively for the Bank of Japan in the early subperiod, as shown in Figure A15).

We now turn to examine the relationships among Prattle, short-term interest rates and financial risk in trivariate VARs that include the VIX as the measure of risk (Figures 2 and 3 and Online Appendix Figures A17-A18).[19] As Figure A16 shows, the VIX is an important proxy for risk in all the relevant regions, as it is highly correlated with local measures of implied volatility in Europe, the UK and Japan. Those local measures are only available late in the sample period, so to improve coverage, we employ the VIX as the measure of financial risk in all four sets of trivariate VARs.[20]

Including VIX in the model strengthens the magnitude and significance of the impulse response functions of Prattle on the short-term rate and vice versa. For the Fed, in the early subperiod, Prattle is now a significant forecaster of the short-term rate (Figure 2). For the Fed, the ECB, and the Bank of England, in the late subperiod, the short-term rate forecasts Prattle.

The clearest and most consistent pattern visible in Figures 2 and 3, and A17-A18, however, is the late period mutual importance of Prattle and VIX as negative forecasters of each

[19] See also Bekaert, Hoerova, and Lo Duca (2013) and Rey (2015) for investigations of the relationship of the risk-premium and expected volatility components of the VIX and their relationship to monetary policy.
[20] In results not reported here, we also included the ratio of local stock index market-to-book value in place of VIX. Results were similar, although opposite in sign (i.e., shocks and responses associated with VIX are opposite to those observed for market-to-book value).

other for the Fed, the ECB and the BOE. Interestingly, that pattern is also visible for the Fed in the early period, but not for the ECB or the BOE. For the ECB in the early period, Prattle is a positive forecaster of VIX, and VIX shocks have a weakly positive effect on Prattle. For the BOE in the early period, the two series do not forecast one another.

We interpret the early period connections between Fed Prattle and VIX as indicative of a so-called "Greenspan put" in Fed monetary policy during the early period: Rising risk (shocks to VIX) led the Fed to take a more accommodative stance. Similarly, assuming that the Fed had private information about risk, a Greenspan put policy would also imply that hawkish shocks to Fed Prattle may have signaled lower future risk. Interestingly, the other major central banks' monetary policy stances display no such Greenspan-put connection in the early period. Indeed, the fact that tightening by the ECB predicts a rise in the VIX suggests what one would expect if monetary policy was not responding to the VIX: Exogenous tightening should have a negative effect on the market. But in the late period, as central banks' main focus shifted to crisis-management, the ECB and BOE became converts to the Greenspan-put and the relationship between their Prattle scores and the VIX became similar to that of the Fed.

This analysis illustrates two points that are of general importance for our modeling of exchange rate returns. First, Prattle measures the thinking of central bankers, and is not just (or even mainly) a forecaster of short-term interest rate changes. Second, if market pricing was less reflective of risk in the early "risk-on" period, that may imply that measures that capture risk (including Fed Prattle) may differ in importance as forecasters of exchange rates across subperiods. Indeed, as we will show, that is the case; the Fed Prattle measure is much more important for forecasting exchange rate returns in the later period than in the early one, as also are the VIX and exchange rate volatility measures (in the developed economy exchange rate regressions). Time variation in risk, and variation in the way that risk affects exchange rate pricing, are important themes to which we will return.

We complete our validation analysis of Prattle by comparing how macroeconomic variables forecast annual changes in Prattle with how those same variables forecast annual changes in short-term interest rates. Table A1 (Panel A) in the Online Appendix reports time series results for each of the four regions, showing how the short-term interest rate responds to past change in GDP growth and inflation. Panel B of Table A1 expands the list of macroeconomic forecasting variables to include the VIX, net foreign assets as a fraction of GDP (*nfa*), and foreign reserves as a fraction of GDP (*res_GDP*). Panels A and B of Table A2 produce similar regressions, but with the Prattle scores of each central bank as the dependent variable. In all four panels of Tables A1 and A2, we divide the sample into early and late subperiods.

We emphasize two points from Tables A1 and A2. First, Prattle and the change in the short-term rate display similar R-squareds and are both predicted by measures of prior macroeconomic and financial conditions, which validates Prattle as a forward-looking measure of monetary policy change. Second, it is interesting to note from a comparison of the R-squareds in Panels A and B of the two tables that both Prattle and the change in the short-term rate are influenced more by measures of international capital and reserve positions and VIX than by domestic GDP growth and inflation. This is consistent with Taylor's (2018) view that during both the early and late sample subperiods central banks were responding to variables outside the narrow confines of the Taylor Rule.

Our overarching conclusion from this analysis of Prattle is that Prattle scores are a valid measure of monetary policy stance, and not just a forecast of the short-term interest rate. Furthermore, Prattle scores have differing import for central bank actions across central banks and over time. Prattle scores respond to variables that central banks have been known to target, and predict changes in variables that monetary policy should be relevant for, but changes in Prattle are not closely related to changes in short-term interest rates. Prattle scores have broader meaning as measures of policy stance, capturing central bankers' views of the state of the economy and especially the risk of the financial system, and they do so in ways that vary across subperiods and across central banks. We make use of these insights in our interpretations of the role of Prattle as an exchange rate return forecaster below.

4. Regression Results

We report regression results forecasting twelve month-ahead exchange rate returns (12-month returns) separately for our sample of 10 DM countries and our sample of 25 EM countries in Tables 5 and 6. The list of countries used in our analysis appears in Table 11. We report results for the entire 1996-2015 period, as well as for the two subperiods divided at November 2006. We refer to these subperiods as the pre-crisis and post-crisis periods.

Table 5 reports results for 12-month returns for DM countries, which are reported for three versions of our model. Similar regressions are reported in Table 6 for EMs. Columns (1)-(3) present what we term the Base model, for the whole period and each subperiod. It excludes any information about the Prattle scores of the major global central banks, which are captured in Columns (4)-(5), which report results for subperiods only (given that we reject stability of coefficients across subperiods). In the Column (1)-(3) results, of course, monetary policy's influence still is present in the model through the way monetary policy affects each of the forecasting variables, most obviously the interest rate variables: *carry*, *exFedRate*, and *T-bill.* Of course, these interest rate variables reflect a combination of real economic conditions and endogenous monetary policy actions and cannot be interpreted as entirely or even mainly reflecting monetary policy, despite the presence of the many control variables that capture real growth and other aspects of the economic environment.

It is useful to categorize our regressors into four groups of variables. First, we include measures that capture dynamic adjustment and changes in measures of financial risk: lagged one-month and twelve-month returns, lagged one-month and twelve-month exchange rate returns volatility, *VIX*, and the two variables that capture long-run real exchange rate mean reversion – *logRSpotPos* and *logRSpotNeg*.[21] Second, we include capital account and reserve balance variables (*nfa* and *res_GDP*). Third, we include variables that capture influences related to real exchange rate changes, including recent GDP growth and price inflation in the subject county, the US, and the average of the geographic areas related to the big three non-US central banks (*cpiYOY, gdprYOY, exFedCpiYOY, cpiYOYUS, exFedGdprYOY,* and *gdprYOYUS*). Finally, we include variables related to monetary policy stance and interest rates, where we employ alternative specifications that include different variables capturing monetary policy (*carry, exFedRate, T-bill, treas_basis, Fed, and CBexFed*).

In the baseline model of columns (1)-(3), monetary policy's influence is captured through various interest rate measures and the carry interest differential. In columns (4)-(5), we add the Prattle measures, *Fed* and *CBexFed*.[22]

[21] Menkhoff et al. (2016) find that a five-year change in the real exchange rate forecasts currency returns. Our *logRSpotPos* captures the change when it is positive, and *logRSpotNeg* captures the change when it is negative. We therefore allow for an asymmetric response of exchange rates to log real exchange rate changes.

[22] In results not reported here, we also include *ownCB* (the Prattle score of the subject country's central bank) in the model. Given the limited coverage of Prattle, however, this results in a severely diminished sample. For EMs, the sample is only 10 percent of the panel in Table 6 for the early period, and about 20 percent for the later subperiod. For DMs, the coverage is better, but we still lose about 20 percent of our observations. For DMs, ownCB displays a positive and highly statistically significant effect, with a coefficient of 1.14. For EMs, the coefficient is 0.122 and not statistically significant.

A few of the coefficient results are stable across the various estimation periods and across the two samples of countries. The coefficient on *gdprYOY* is consistently positive and sometimes statistically significant (mainly for EMs). Under efficient markets, as we discuss further in Section 7, we interpret this as reflecting information about country-specific risks that varies with lagged GDP growth. Alternatively, under inefficient markets, slow adjustment to news could explain this coefficient. To the extent that real growth reflects news about productivity growth, according to the Balassa-Samuelson effect, real growth news should be associated with real exchange rate appreciation. The coefficient on *cpiYOY* is consistently positive and often statistically significant in both DMs and EMs, and the coefficients on *cpiYOYUS* and *gdprYOYUS* are generally negative and when they are negative, they are often statistically significant. Again, under inefficient markets, one could interpret these coefficients as indicating that exchange rates adjust alongside prices with considerable lags to news about real exchange rates, and that some of the change in real exchange rates is apparent first in price indexes, which is why they forecast future appreciation. Note that these patterns are *not* consistent with an inefficient markets view that also posits real exchange rate constancy (so-called Purchasing Power Parity). If real exchange rates were constant and if nominal exchange rates reacted with a lag to news contained in price indexes, then increases in domestic prices in the subject country would forecast nominal exchange rate depreciation (i.e., the dollar price of subject country currency should fall), and increases in foreign (i.e. dollar) prices would forecast nominal exchange rate appreciation of the subject country; but the opposite is true in our regressions.

We interpret the role of *exFedCpiYOY* in our model as a proxy for global, non-US inflation, which may capture some relevant variation in global risk. The coefficient on *exFedCpiYOY* is positive when it is significant for DMs, but it is less significant and less consistent in sign when it is significant for EMs.[23] The coefficient on *exFedGdprYOY* is generally positive when it is significant for both DMs and EMs.

We find evidence of long-term mean reversion in real exchange rates for both DMs and EMs. The coefficients on *logRSpotNeg* and *logRSpotPos* are negative when they are significant for both DMs and EMs.

The coefficient on *nfa* in DMs switches from positive significant to statistically zero across subperiods. In EMs, it is statistically zero consistently. In DMs, the coefficient on *res_GDP* is negative and significant in the early subperiod, but small and statistically insignificant in the later subperiod. In EMs, it is statistically zero in the early subperiod, and positive and somewhat significant in the later subperiod.

For both DMs and EMs, the coefficient on *treas_basis* flips from positive to negative in the two subperiods. Its inclusion adds slightly to the adjusted R-squared (often improving it by one or two percentage points) and generally does not affect the other variables in the regression, with the exception of *T-bill*. The coefficient on *T-bill* switches from insignificant in the first subperiod to positive significant in the second subperiod, and that is true for both DMs and EMs. In results that omit *treas_basis*, which is negatively correlated with *T-bill* (correlation of -37%), the coefficient on T-bill is negative significant in the early period for both DMs and EMs. One interpretation of that result is that in the early subperiod variation in the US interest rate reflects monetary policy actions, while during much of the second subperiod the interest rate was essentially zero, and small upticks in the interest rate mainly may have reflected other factors that were positive influences on aggregate demand. In Section 7, we discuss why sources of variation in aggregate demand may contain relevant information about exchange rate risk.

[23] In our out-of-sample lasso estimates, *exFedCpiYOY* is not an important contributor to the model.

The coefficient changes reported above across subperiods are also present in the specifications reported in Columns (4)-(5). In other words, coefficient changes are not simply the result of taking account of the existence of a monetary policy regime change (as in Columns (4)-(5)) or of the stance of monetary policy. This indicates that there is a fundamental shift in economic structure across subperiods that is relevant for exchange rates.

The differences in estimates across time and across groups of countries leads us to conclude that EMs and DMs should be modeled separately, and that subperiods should be modeled separately. We provide additional evidence supporting this conclusion in the rolling coefficients estimates from our elastic net model, discussed in Section 4.4.

The models that take account of monetary policy stance (in Columns (4)-(5)) improve the fit of the model in the second subperiod. For DMs, the R-squared for the second subperiod is 0.54 in Column (5) of Table 5, compared to 0.49 in Column (3). For EMs, in Table 6, the comparable change is R-squared is from 0.41 to 0.44. For both DMs and EMs, the coefficients on *Fed* and *CBexFed* are both negative and statistically significant in the later subperiod. In the early subperiod, coefficients on those two variables are smaller and insignificant for DMs, and only *CBexFed* (not *Fed*) is significant (and negative) for EMs.

4.1 Lagged Reaction to News or Risk Premium?

As we discussed in Section 2, we interpret the coefficients in the forecasting model as risk indicators, as we discuss further below. An alternative view is that the exchange rate market is inefficient and these forecasting variables reflect lagging responses of exchange rates to news. We performed an informal investigation of this alternative, inefficient-markets interpretation by using the same regressors to predict contemporaneous returns, and also one month-ahead returns, rather than twelve month-ahead returns. If our model captured news with a lag, we would expect the coefficients for the twelve month horizon to reflect effects that were visible early on, either in contemporaneous covariation[24] or one month-ahead covariation. We find that is not the case.

For the four full regression specifications for DMs and EMs for early and late periods, which are reported in columns 4 and 5 of Tables 5 and 6, there are a total of 43 coefficients that are statistically significant. Of those 43 coefficients, in the contemporaneous exchange rate return regressions (reported in Online Appendix Tables A5 and A6), 27 of those coefficients are statistically zero, eight of them are statistically significant but opposite in sign, and 8 of them are statistically significant and of the same sign but typically much smaller than the coefficient estimates in Tables 5 and 6. In the one-month ahead regressions (reported in Online Appendix Tables A7 and A8), we find similar results. Of the 43 coefficients that are significant in columns 4 and 5 of Tables 5 and 6, 24 are statistically zero, two are significant but opposite in sign, and 17 are significant, of similar sign, but smaller. We conclude that it would be implausible to interpret our model as reflecting inefficient, lagging responses to news.

4.2 Variation in the Signs of Coefficients

The R-squared of the Column (1) regression in Table 5, which spans the entire period, 1996-2016, is 0.29, in contrast the much higher R-squareds if the two periods are treated separately (0.66 for the 1996-2006 subperiod and 0.49 for the 2006-2016 subperiod). In Table 6, the R-squareds for the two subperiods are similarly much higher than for the whole period, though the lower than the DM ones in Table 5. This is a clear indicator that forcing the model to maintain stable parameter estimates across subperiods produces inferior overall fit.

Although some coefficient values are consistent across time (e.g., the three risk measures – *vol1m*, *vol2m* and *VIX* – consistently have a positive sign when they are significant), the

[24] Obviously, we do not interpret the contemporaneous regression as providing causal evidence, but rather as indicative of correlations.

instability of some of the model parameters across the two subperiods is striking in both Tables 5 and 6. Consistent with the findings reported in Hodrick and Tomunen (2018), for DMs, the coefficient on *carry* switches from positive significant to negative insignificant (in our out-of-sample results, we will show that it is negative and significant for the early part of the second subperiod). We return to focus on understanding this reversal in Section 5. In EMs, *carry* is positive but statistically insignificant in Table 6.

How should one interpret the fact that the coefficient on *carry* for EMs is insignificant despite the fact that trading EM currencies using the carry factor is so profitable, as we will discuss below, and as is shown in Figure 4?[25] Note that the regression coefficient on *carry* indicates the returns forecast of carry after controlling for other country fixed and varying characteristics (i.e., the other regressors in the model), while the carry factor is a trading strategy that identifies countries' currencies to buy or sell on the basis of their interest rate differentials, and does not control for other country fixed and varying characteristics. In other words, it appears that the profitability of the carry factor reflects the correlation between interest rate differentials and country characteristics, not the differential per se. The fact that the *carry* coefficient is significant for DMs, but the carry factor is less important as a DM trading strategy illustrates the opposite interpretation: in DMs, *carry* is not a very useful proxy for a country risk characteristic, but rather an important forecasting variable after controlling for fixed and varying country characteristics. In other words, the profitability of the carry trade in EMs reflects other factors (e.g., persistent country risk, captured by *vol1m* or *vol12m* or *VIX*) rather than the interest rate difference, per se.

[25] Compare the cumulative return of the *HMLFX* factor using the full set of countries in our paper (from Table 11) in the upper right-hand portion of Figure 4 to the cumulative return of the *HMLFX* factor constructed using only the DM country sample in the upper right-hand portion of Figure A4 in the Online Appendix. The factor construction methodology is discussed in Section 6.

4.3 Global Monetary Policy Influences

Despite differences in the EM and DM models, the patterns that relate to the influence of monetary policy changes of the major central banks on exchange rates remain present and similar in EMs and DMs. As already noted, the coefficient on *T-bill* flips from insignificant to positive significant across the two subperiods for both EMs and DMs, and this occurs in all versions of the model when *treas_basis* is included in the model (*T-bill* is negative significant in the early period without the inclusion of *treas_basis*). The coefficients on *Fed* and *CBexFed* in Columns (4) and (5) of Tables 5 and 6 are large, negative and statistically significant in both EMs and DMs for the later subperiod. The same variables have smaller and less significant effects in the earlier subperiod (as Table 7 shows, the coefficient of -2.097 is significant at the 27 percent level), though *CBexFed* is still highly significant and negative for EMs in the early subperiod.

What do these results say about global monetary policy influences on 12-month returns? As we have already noted, the sign flipping of *T-bill* may indicate that in much of the later period (when rates were near the zero-lower bound in the U.S.), variation in the three-month Treasury bill rate is no longer driven mainly by monetary policy. Its small upticks (downticks) likely reflect real influences that happen to be associated with dollar depreciation (appreciation).

Monetary policy stance, as captured by the two Prattle measures (*Fed* and *CBexFed*), is a much more important predictor in the second subperiod, during which both measures become strong negative predictors of currency returns against the dollar. Low Prattle scores forecast the appreciation of currencies against the dollar. Interestingly, *CBexFed* has a similar effect to *Fed*, and its magnitude is much larger (more than twice the size of the coefficient on *Fed*). That suggests that each of the three non-Fed major central banks had almost as much importance for predicting, say, the appreciation of the dollar value of the Brazilian real, as the Fed did.

It is important to note that the negative coefficients on *CBexFed* and *exFedRate* in Table 5 do *not* imply that tightening by a country's own central bank would predict that *its* own currency would depreciate relative to the dollar (e.g., we are not saying tightening by the Bank of Japan would cause a yen depreciation). *CBexFed* and *exFedRate* are averaged for the major non-US countries, and the dominant influence in the average will generally be countries other than the subject DM country in the panel regression (furthermore the majority of countries in the DM panel do not have their central banks in *CBexFed* or *exFedRate*). In results not reported here (due to the limited country coverage by Prattle), we separate own-country Prattle effects from the responses to *CBexFed* and *exFedRate* for DMs. The coefficient on the own-country Prattle score is generally positive, although it is only statistically significant in the early period for DMs. Thus, when a DM country's central bank tightens, that predicts that its own currency will appreciate against the dollar, but tightening by any of the big four central banks predicts that EM currencies and other DM currencies will depreciate against the dollar.

In Table 7, we decompose *CBexFed* to explore possible differences in the contributions of the ECB, the BOE and the BOJ to the predictive power of *CBexFed*. As before, we report results for DMs (Panel A) separately from EMs (Panel B) and we divide the data into the same two subperiods. For DMs, the ECB drives *CBexFed* in the early subperiod. Including it along in the place of *CBexFed* increases the magnitude and significance of the coefficient. In the later subperiod for DMs, both the ECB and the BOE are important and coefficients are much larger than before. For EMs, the ECB's coefficient magnitude is large in both periods but only significant in the early period (though the p-value in the later subperiod is 0.13). The BOE displays a comparable effect on EM exchange rate returns in the early subperiod and a much larger one in the later subperiod. Interestingly, the BOJ has a relatively small and insignificant influence on EMs in the early period, but a larger and statistically significant influence on EMs in the later period. The fact that the BOJ and BOE exert relatively greater roles than the ECB on EMs is interesting and suggests the potential regional importance of Japan for Asian EMs and perhaps the role of London as the most important of the three global financial centers for EMs.

In summary, there are several important facts that the analysis of Tables 5-7 brings to light about monetary policy and exchange rate returns. First, a monetary tightening posture by the major non-Fed central banks in the later subperiod, whether captured by non-Fed interest rate increases or by higher Prattle scores, tends to be associated with the future appreciation of the dollar relative to other currencies. This pattern is visible for both DMs and EMs. The magnitude of the effect is more than twice the size of the dollar appreciation that results from Fed tightening. Second, any forecasting model of exchange rate returns must take account of structural instability that produces changes in coefficient values over time (as we do more systematically in the rolling coefficient estimate results reported below). Out-of-sample modeling and structural instability turn out to be particularly important for interpreting the cause, timing, and duration of the carry reversal for DMs. Third, the reversal of the predictive role of *carry*, from a positive to a negative (or zero) predictor of exchange rate returns, is limited to DM countries. In EMs, *carry* is not a significant predictor of exchange rate returns in either subperiod. We address these findings and interpret them from the perspective of the asset pricing literature in Section 7.

4.4 Model Selection: Elastic Net Estimates

We now discuss the statistical evidence supporting inclusion of all our explanatory variables in our panel regressions. Figure 5 shows significant changes over time in the elastic net coefficient estimates for all variables in our model, including the text measures describing central bank policy, labeled *Fed* and *CBexFed*. Coefficient magnitudes, when non-zero, are large and similar to the statistically significant coefficients identified in our panel regression results (reported in Tables 5 and 6), and have similar temporal patterns. It is interesting to note the variation in EM and DM coefficients is often similar, although the two models are estimated independently. For example, the DM and EM coefficients for both *logRSpotNeg* and *logRSpotPos* (which proxy for long-term deviations away from a fixed real exchange rate) move substantially and together over time. Even more striking is the similarity between EM and DM loadings on *Fed* and *CBexFed* for the 12-month return rolling elastic net estimates, suggesting that global central bank policy news plays a similar role in exchange rate determination across DM and EM contexts.

The elastic net regressions address concerns about multicollinearity of our regressors. If one forecasting variable dominated another one in every rolling five-year window over the data, then the latter forecasting variable would always show up as zero in our elastic nets (which with $\alpha = 0$ are lassos). However, for our DM regressions this never happens. Every one of our 21 forecasting variables enters positively in multiple windows suggesting that all these variables capture some aspect of currency expected returns. We therefore conclude that each of our forecasting variables is justified on statistical grounds, and including them in our regressions provides a good baseline model against which to assess the usefulness of our central bank variables, *Fed* and *CBexFed*.

Finally, while there is some evidence that several of our forecasting variables are not useful for forecasting EM currency returns against the dollar (for example, the reserves to GDP ratio, *res_GDP*, and net foreign assets, *nfa*, don't seem to enter the EM forecasting elastic nets), we include them in our EM panels to maintain model consistency with the DM specification.

4.5 Monetary Policy Spillovers

How do we think about the finding that *CBexFed* forecasts currency returns against the US dollar? Under the inefficient-markets (lagging reaction to news) interpretation of the negative coefficient of *CBexFed*, one possible aspect of the news to which exchange rates might be presumed to react slowly is news that *CBexFed* might contain about future Fed policy. As Taylor (2018) shows, measuring policy using interest rates or central bank balance sheet size, the major central banks respond to each other's policies. It is possible that non-U.S. big three central bank Prattle scores predict dollar appreciation because they predict future actions by the Fed, which controls the supply of dollars.

One piece of evidence against this view is the finding by Gerko and Rey (2017) that Bank of England policy, as measured by changes in a short sterling futures contract, has no effect on U.S. interest rates or other economic variables. If the Fed's policy predictably responded to Bank of England actions, then that response should be reflected in U.S. interest rates changes, but it is not. We investigate the question of dynamic interactions among central banks more directly with a VAR analysis where we ask whether the predictive power of *CBexFed* and *exFedRate* are reflecting the roles of those variables as news about future Fed tightening.

We analyze the dynamic predictability of each other's Prattle scores and each other's interest rates across central banks, and the relationship between Prattle scores, on the one hand, and own-country or other-countries' interest rates. In Figure 6, Panel A, we report Granger causality tests for Prattle scores among the major central banks, which are reported separately for the two subperiods. In neither of the two subperiods do we find that the Fed's Prattle score is predicted by the Prattle scores of other central banks.

It is possible, however, that Fed monetary policy changes reflected in the short-term interest rate react to other central bank actions, even if the Fed's Prattle score does not. This view finds some support in In Panel B of Figure 6. There we report Granger causality results for one-month changes in short-term interest rates across countries. We find that the Fed's actions (measured through interest rate changes) are indeed predicted by interest rate changes of other central banks in the second half of the sample, even though Fed Prattle scores are not predicted by the Prattle scores of other central banks. This indicates that *exFedRate* may be predicting dollar appreciation at least in part through its role as a forecaster of *T-bill*.

The causality tests in Panels A and B of Figure 6 suggest that central bank policies, either as measured through Prattle or their domestic short-rates, became more interrelated following the financial crisis. This is supportive of Taylor's (2018) argument that in the quantitative easing era – without the constraints of traditional monetary policy – central banks engaged in de-facto currency devaluations by more actively responding to one another's policies.

However, these observed connections among interest rate changes do not explain the power of *CBexFed* in our model. If *CBexFed* matters in our model mainly because it is forecasting *Fed* or Fed interest rate changes, then we would expect it to forecast the *T-bill* (because as shown in Panel A of Figure 6, *CBexFed* does not predict *Fed*). In Online Appendix Figure A19 we construct a bivariate VAR of *CBexFed* and *T-bill* and we find that *CBexFed* does not significantly predict *T-bill* changes in either subperiod.[26] We conclude that *CBexFed* does not matter for dollar exchange rate returns because of inefficiently lagging responses to the news contained in *CBexFed* about future Fed policy reactions.

[26] Similarly, Figure A20 shows that changes in *exFedRate* do not forecast changes in *Fed* Prattle in either subperiod, despite the role of *exFedRate* in forecasting *T-bill*.

A different, inefficient-markets interpretation of the impact of *CBexFed* is also conceivable. It may be that the underlying mechanism for why *CBexFed* is able to forecast exchange rates against the dollar is a substitutability among the major developed market currencies, as posited by McKinnon (1982), McKinnon and Tan (1983), and McKinnon et al. (1984). For example, if tighter Bank of Japan policy makes the yen less readily available, then global investors may switch to holding dollars, thus causing a dollar appreciation in response to tightening by the Bank of Japan. As we show in Section 4.5, however, this currency substitutability effect does not appear to be present. If currency substitutability were driving the forecasting power of *CBexFed*, then we would expect to find symmetric results when we alter the base currency for our regressions. But we find no such symmetry.

We interpret the forecasting importance of *Fed* and *CBexFed* as reflecting global risk factors that influence monetary policy. This interpretation follows from the perspective of the risk-pricing model we develop in Section 7. Monetary policy in the second period is a more powerful indicator of global risk than it had been in the early period because monetary policy reacts more to risk than it had done previously. As we showed in Section 3, risk became more important for influencing non-U.S. central banks' monetary policy stances in the second period. For example, the result in the VAR analysis of Figures 2, 3, A17, and A18, that hawkish policy shocks forecast *lower* levels of the VIX in the later subperiod, indicate that monetary policy makers were keenly aware of their potential market impact.

4.6 Results with Non-Dollar Base Currencies

Thus far our analysis has modeled exchange rate returns against the US dollar. In Tables 8, 9 and 10 we explore how our *Fed*, *CBexFed*, and *carry* results change when the base currency used is the euro, the British pound or the yen, respectively.

We find that the estimation results for the *carry* coefficient are highly consistent regardless of the base currency chosen. For DMs, the *carry* coefficient goes from positive in the early subperiod to negative in the later subperiod. And for EMs, the *carry* coefficient is always positive, although of a smaller magnitude that the DM *carry* coefficient. From this we conclude that the carry results we obtain are invariant to the base currency.

However, we see that the *Fed* and *CBexFed* coefficients have much lower magnitudes in the regressions in Panels B, C, and D, where the dollar is not the base currency, compared to the ones with the dollar as the base currency in Panel A. In fact, neither central bank variable has a significant negative coefficient in either the DM or the EM regressions in either subperiod (except for the pound for DMs in the late subperiod). In fact, the *CBexFed* coefficient for the euro as the base currency (Panel B) is positive in the second subperiod for both DMs and EMs. This suggests that tighter monetary policy by the central banks other than the Fed causes a euro *depreciation* relative to other currencies (since the other currencies tend to appreciate relative to the euro), exactly the opposite effect that we saw for the dollar.

These results show that monetary policy influences among the major central banks are not symmetric, which is inconsistent with the currency substitution interpretation of the importance of *CBexFed* as a dollar exchange rate forecaster. The influences of the global monetary policy postures of the major central banks for forecasting exchange rate returns operate through the dollar, and *not* through the other major global currencies.[27] We explore this result

[27] These results also provide further reassurance regarding potential in-sample bias with respect to the construction of the Prattle measures. In Prattle's training window, the security set included the central bank's own (e.g. euro for the ECB) currency against a trade-weighted basket. If in-sample bias were a problem, one would expect the results of Tables 8, 9 and 10 to be stronger, not weaker, than those in Panel A (which is out-of-sample for the Fed in the second subperiod and uses a different base currency than the training security set for the non-Fed central banks).

further in Section 6 using a factor model for currency returns to decompose our coefficient estimates into channels.

4.7 Increasing Uncertainty about Central Bank Policy

Finally, we explore how changes in monetary policy regimes (pre- and post-global crisis) have affected market uncertainty about exchange rate modeling. Obstfeld and Rogoff (2002) provide a model of exchange rates in which the adoption of flexible inflation rate targeting rules by central banks limits the exchange rate uncertainty that can arise from ad hoc interventions in the exchange market, which can also give rise to competitive devaluations. Taylor (2018) shows that a commitment to flexible inflation targeting has been particularly absent in recent years. He and the literature he surveys find that, especially after the global financial crisis, central banks frequently departed from rule-based behavior, and often varied monetary policy in an effort to influence the exchange rate, and this became a major source of competitive devaluation during the post-crisis era.

In our analysis, we consider whether the activist and novel policy regime of recent years produced greater uncertainty about exchange rates, as implied by Obstfeld and Rogoff (2002) and Taylor (2018). Using out elastic net model described in Section 2, we find no evidence of a significant persistent increase in the root mean-squared error for exchange rate return forecasts after the crisis. This result suggests that, although central bank policy became more novel in its approach and became a more important source of news, central banks were able to convey their thinking to the market sufficiently well (as our Prattle measure captures) to mitigate any resulting increase in forecasting uncertainty related to reduced reliance on prior implicit or explicit monetary rules.   Further details about this analysis are in the Online Appendix.

5. Further Evidence Related to the Selective Carry Variable Reversal

Here we consider the reversal in the second subperiod of the first subperiod's positive predictive role of *carry* for exchange rate returns in DMs. Why should this effect be selective (i.e., confined to DMs), and why does the late subperiod reverse the pattern from the early subperiod?

The selective reversal, which was apparent in our panel regression analysis in Tables 5 and 6, is also visible in simple country-level association between twelve-month exchange rate returns and the country's interest differential against the dollar (*carry*). In Table 11, we report the slope coefficients from regressing twelve-month ahead currency returns against the subject country's interest rate differential to the US for each of the ten DM countries.[28] In all ten cases, the positive association, which we refer to as the *return-carry beta*, is visible for the early subperiod, and changes to a negative slope in the late subperiod (scatter plots for each country are presented in Online Appendix Figures A9-A11). For EMs, no such pattern is visible, with the exception of a few cases, such as Israel and Chile (see the scatter plots in Online Appendix Figures A9-A11).

The pre-crisis global economy was characterized by less synchronous economic cycles across countries than in the post-crisis era. In Sections 7.2 and 7.3 below, we explain how this difference between the two subperiods can result in different patterns of association between interest differentials and exchange rate returns. The intuition is as follows. In the early (relatively asynchronous) period, cyclical changes produce episodes where a country's marginal utility of consumption and precautionary savings rise or fall together relative to those of other countries. That positive comovement results in interest rate differentials and expected returns on

[28] This is the classic return versus carry differential test of uncovered interest rate parity from Fama (1984).

currencies that change in the same direction. However, during the post-crisis (relatively synchronous global economic cycle) period, countries that differ with respect to the cyclical sensitivities of their marginal utilities of consumption and their precautionary savings demands can see their marginal utilities of consumption and their precautionary savings moving in opposite directions relative to one another. Those differences can cause interest rate differentials and expected currency returns to move in opposite directions.

In Section 7.3, we show that this model implies that in the pre-crisis period, the variance of a country's *carry* against the dollar generally should be weakly negatively correlated with its return-carry beta. But in the post-crisis period our model implies that the variance of *carry* and return-carry betas should be positively correlated for DMs.

We provide evidence consistent with this implication in Figure 7. First, in the left-hand side of Panel A of Figure 7, for each of the two subperiods, we estimate each currency's return-carry beta by running a time series regression for each of the DM countries of its twelve-month currency returns vs the dollar against lagged *carry*. The return-carry betas for those twenty regressions (for the ten DM countries and two subperiods) are then plotted against the variance of *carry* in each of the country-subperiods. The early subperiod points and regression line through them are shown in blue, and the post-crisis ones in red. First we note that high variances tend to occur in the early subperiod, and low variances tend to occur in the late subperiod. Second, in the pre-crisis period *carry* variance and return-carry betas are weakly negatively correlated, whereas in the post-crisis period they are strongly positively correlated.

A similar analysis of EM country-subperiods, provided in the left-hand side of Panel B of Figure 7, shows a different pattern. In EMs, there is no association between the *carry* coefficient and the variance of *carry*. Furthermore, the *carry* variance is much higher in EM countries:

almost all of the DM country-subperiod observations for the standard deviation of *carry* are less than 0.04, while in EMs, the vast majority are greater than 0.04.

We also considered how changes in the *carry* effect in DMs may have coincided with changes in the patterns of capital inflows. The predictions of the risk-pricing model we discuss in Section 7 are not clear cut, but it is possible that relative decreases in savings among countries could be a source of capital inflows. Under that interpretation, DMs with the strongest carry reversal should also experience greater capital inflows. An association between capital inflows and exchange rate returns may also reflect slow adjustment under inefficient markets. If slow adjustment of exchange rates to capital flows exerted upward pressure on expected exchange rate returns in the second period, then it should also be true that the change in the value of a country's *carry* beta from the early to the late subperiod should be negatively related to the change in the capital inflows that it experienced – i.e., countries that experienced heavy capital inflows in the later subperiod should have exhibited lower *carry* betas in the later period relative to the earlier period. It is also conceivable that capital inflow differences across countries reflected influences not captured in section 7, such as differences in the riskiness of financial systems that gave rise to flight-to-quality to low-risk destinations. However, models of flight-to-quality to low-risk destinations during a severe global financial shock have opposite implications for capital inflow changes than those reported in Figure 7. Specifically, safe havens should experience increased capital outflows during such episodes.[29]

We examine the relation between *carry* beta changes and capital inflows, separately for DMs and EMs, on the right-hand side of Panels A and B of Figure 7, respectively. We find that

[29] See Gourinchas, Rey and Govillot (2018) and Maggiori (2017), which build on the thinking of Gourinchas and Rey (2007) and Caballero, Farhi, and Gourinchas (2008).

carry beta change is negatively related to the change in capital inflows[30] for DMs (with a t statistic of 1.87), but they are not significantly negatively related in EMs. For DMs, higher post-crisis capital inflows are associated with more negative *carry* betas.[31]

6. Decomposing Regression Results into Idiosyncratic vs. Factor Channels

As noted in the introduction, the literature has identified a few factors that capture substantial exchange rate return variation. The two most important factors are the dollar factor *RX* and the carry factor *HMLFX* (not to be confused with the *carry* regressor used above). The dollar factor is an equal weighted index of a select set of currencies, and captures the common variation of all other currencies against the dollar. The carry factor captures the exchange rate returns differences between high-interest rate and low-interest rate countries. Investing in the dollar factor implies going long all other currencies against the dollar. Investing in the carry factor implies going long the currencies of the countries with the highest interest rates and going short the currencies with the lowest interest rates. We also considered a third factor, known as the dollar carry (*DC*) factor, which selectively takes a long (short) dollar position when the average of all other countries' short-term rates is lower (higher) than the dollar rate.

[30] Our capital flows measure is the net inflows to the private sector coming from the three portfolio investment series (debt to banks, debt to other sectors, and equity), as reported in Lane and Milesi-Ferretti (2017).

[31] We also considered additional regression specifications in which we interacted *Fed* and *CBexFed* with carry, to see whether the role of carry varied with the directional stance of monetary policy. In the Online Appendix, in Tables A9 and A10, we report those results. We find that, in both DMs and EMs, there is some evidence that *carry*'s ability to forecast returns depends on the state of monetary policy, though these results are not always statistically significant. The negative coefficient on the *carry*CBexFed* variable in Tables A9 and A10 implies that carry reversal occurs in the second subperiod for EMs only when *CBexFed* is sufficiently positive (making the interacted term sufficiently negative to offset the positive insignificant coefficient on *carry*). Note also that the negative DM *carry* coefficient is made even more negative when *CBexFed* is positive.

6.1 Factor Construction

Our analysis follows the factor analysis of Lustig, Roussanov and Verdelhan (LRV, 2011, 2014), Verdelhan (2018), and Aloosh and Bekaert (2019). These studies identify factors that represent common components of currency returns against the dollar across different countries. The dollar factor, *RX*, found by Verdelhan (2018) to explain the majority of time-series variation in currency returns, is simply an equal weighted average of currency returns against the dollar for a given basket of countries. For the carry factor, *HMLFX*, we use the LRV methodology to define the factor: in a given month *t* this factor is the return from going long 1/6 of the highest yielding countries relative to the dollar in month *t-1* (those with the lowest $f_{t-1} - s_{t-1} = y_{t-1} - y_{t-1}^{*}$) and going short the 1/6 of countries with the lowest interest rate differential to the dollar. Again, this factor is calculated using a given basket of currencies. Finally, we look at the dollar carry factor, *DC*, from LRV (2014) which goes long a basket of currencies against the dollar when their average interest rate differential to the dollar from the prior month is positive, and goes short this basket of currencies, i.e. goes long the dollar, when their average interest rate differential in the prior month is negative. This factor's returns in a given month is equal to $\pm RX_t$ depending on whether *DC* is long or short the dollar.

Figure A4 shows the cumulative returns of *RX*, *HMLFX*, and *DC* for the DM currencies (which are the same in our paper as in LRV). All cumulative return series in Figures 4, A4, and A5 have been normalized to equal one in January of 1999. Superimposed on the charts are the cumulative returns of *RX* and *HMLFX* obtained from Lustig and Verdelhan's websites (their factor time-series ends sooner than ours). As can be seen from Figure A4, our *RX* and *HMLFX* and those of LRV are virtually identical. The lower left-hand figure shows the dollar factor, with our *RX* and *HMLFX*, superimposed for comparison. The lower right-hand figure shows the average interest rate differential of the currency basket against the dollar, i.e. $1/N \sum_i (y_t^{(i)} - y_t)$, which tends to fluctuate over time. Also shown are the annualized factor returns, volatilities and Sharpe ratios.

Figure A5 shows the same factors as Figure A4, but using the basket of currencies corresponding to the full currency set of LRV (not restricted to DM countries). Here our dollar factor is almost identical to theirs, though there is a slight difference in *HMLFX* though our two series still track each other very closely.[32] The *DC* factor is almost identical to *RX* for this currency basket because the average interest rate differential to the dollar is almost always positive (lower right-hand chart). Notably, the Sharpe ratio of the carry factor is close to one, and is twice as high at the Sharpe ratio of the DM carry factor. Furthermore, while the DM carry factor in Figure A4 has had a poor post-crisis performance, no such performance degradation is visible in the carry factor for the larger currency set.

Finally, in Figure 4 we plot the same factors but for the set of countries used in the current paper (making it not directly comparable to the LRV factors). Notably the Sharpe ratio of the carry trade now jumps to almost 1.5 – though it is likely several of the currencies in our data set are very illiquid, something we do not control for in our analysis. Otherwise the factors from this larger set are qualitatively similar to the ones in Figure A5.

In our factor decompositions in Section 6.2, we use the LRV-set of countries (the factors from Figure A5) for *RX* and *HMLFX*, and we use the *DC* factor from the DM countries (Figure A4) because the other *DC* factors are almost identical to their respective *RX* factors.

[32] The calculation of the *RX* factor only relies on currency returns. The calculation of *HMLFX* also relies on forward differentials to the dollar, which are much noisier. The discrepancy is attributable to our having slightly different currency forwards data.

6.2 Analysis of Factors

According to Figure A4, a trading strategy for DM countries based on the dollar factor produces a portfolio value that rises by only about ten percent cumulatively from 1999 to 2016 (all cumulative return series are normalized to one in January 1999). The carry factor trading strategy for DMs over the same period produces roughly a doubling of value, although there is a steep drop in 2008-2009, and flat returns thereafter. This parallels our prior discussion of the reversal of the role of the *carry* variable for DMs in the later subperiod.

When we include EMs in the trading strategy to construct global versions of the factor trading strategies, as shown in Figures 4 and A5 (where Figure A5 uses the LRV sample, and Figure 4 uses our sample of countries), the pattern for the dollar factor trading strategy is similar to that seen for only DMs, but the carry factor trading strategy results in much higher cumulative returns (a 2016 portfolio value 3.5 times its 1999 value for the LRV sample of countries), although there is also a severe dip in 2008-2009.

The dollar carry factor trading strategy *DC* in DMs substantially outperforms the dollar factor trading strategy, as indicated by the lower left panel in Figure A4. But when the dollar carry factor strategy is applied to all countries, whether using the LRV sample or our sample, it does not improve upon the simple dollar factor because the interest rate differential relative to the dollar is almost always positive, as can be seen in the lower right-hand chart in the figures.

Table A3 computes country betas for the 1996-2016 period for the ten DM countries for the *RX* and *HMLFX* factors obtained from the LRV set of countries. For DMs, coefficients for the dollar factor are large and positive (averaging 1.27), while they are negative or small positive for the carry factor (averaging -0.22). For EMs, reported in Table A4, the patterns are different.

The average coefficient on the dollar factor is smaller (0.86), and for the carry factor the average coefficient is positive (0.14).

How do our panel regression results relate to the dollar and carry factors?[33] To what extent is the forecasting power of the variables in Tables 5 and 6 explicable in terms of factor loadings on the dollar and carry factors? In particular, through which factors do monetary policy influences matter most? In Tables 9 and 10 we decompose the coefficient loadings from columns (6) and (7) of Tables 5 and 6 into their factor exposures. For each country *i*, we decompose its returns against the dollar by running the following regression[34]

$$r_t^{(i)} = a^{(i)} + \underbrace{b^{(i)} \times RX_t}_{Dollar} + \underbrace{c^{(i)} \times HMLFX_t}_{Carry} + \underbrace{\epsilon_t^{(i)}}_{Residual} . \quad (4)$$

We then run the panel regression in (2) separately for each of the three components in the above decomposition (where the expressions referred to here as *Dollar*, *Carry*, and *Residual* are the dependent variables in the three regressions). For any explanatory variable from Tables 5 and 6, these three panel regressions produce a decomposition of the forecasting power of that variable into the portion due to its ability to forecast through currencies' dollar factor, carry factor and residual exposures.

For example, for the late-sample DM regression in column (5) of Table 5, we see that the *Fed* coefficient is -5.131. The "Late period" panel of Table 12 reproduces this coefficient in the "Full" column, and then shows that -4.083 of this loading is attributable to *Fed*'s ability to forecast the dollar component of returns ("Dollar" column), 0.152 is due to the *Fed*'s ability to

[33] We also considered adding the dollar carry factor to this analysis, but we found that this factor was not an important channel for any of the variation explained by our regression model, so we did not include it in the results discussed here. Tables A3 and A4 show the *DC* contributed a negligible amount of explanatory power in most cases.
[34] We experimented with the MSCI All Country Index as an additional factor, but it explains a very small proportion of residual variation for both DMs and EMs, after including *RX* and *HMLFX*, and so we omit it from this analysis.

forecast the carry component of returns ("HMLFX" column), and -1.2 is due to *Fed*'s ability to forecast the residual currency return ("Resid" column). By linearity of the regression, the three coefficients sum to -5.131. The "Early period" panel shows this decomposition for the early subperiod.

Several interesting patterns emerge in Table 12 (DM) and Table 13 (EM) with regard to non-monetary-policy variables. For DMs, several macro variables, *cpiYOYUS, exFedGdprYOY* and *gdprYOYUS*, forecast returns largely through currencies' dollar exposures in the early subperiod. In the late subperiod for DMs, most of the macro variables, c*piYOY*, *gdprYOY*, *exFedCpiYOY,* in addition to the three already mentioned, now operate through the *HMLFX* factor. No such pattern with regard to the macro variables is apparent for EMs. Of our market variables for DMs, *vol12m* and *VIX* positively forecast returns in the later subperiod, and operate through the dollar factor channel. For EMs, in the early subperiod, *vol1m* and *vol12m* positively forecast the residual component of returns; and in the later subperiod for EMs *vol12m* and *VIX* positively forecast returns through the dollar channel. For both DMs (both subperiods) and EMs (late subperiod), *logRSpotNeg* is a negative forecaster of returns, and operates through the residual channel.

With regard to our monetary policy predictors, most are better, or at least equally strong, forecasters of the dollar component of returns than of the *HMLFX* component or of the residual. For DMs, that is true for *carry* in the early subperiod, and for *T-bill*, *exFedRate*, *CBexFed*, and for *Fed* in the late subperiod. In EMs, *T-bill*, *exFedRate*, *Fed*, and *CBexFed* are better forecasters of the dollar component of returns in the later subperiod.

One general finding is that for DMs, in the early subperiod, many of the forecasting variables operated through the dollar channel, whereas in the later subperiod many more forecasting variables operate through either the *HMLFX* or the residual channel. For EMs, there is generally predictability through the dollar channel in both subperiods. We investigate these finding in the context of a no-arbitrage pricing model in Section 7.

Another finding across DMs and EMs noted above is that when non-U.S. DM central banks, on average, adopt a tightening posture of monetary policy, as evidenced either through their interest rate or their Prattle score, this causes DM and EM currencies to depreciate against the dollar through a common dollar channel.

7. Conceptual Framework

Our general perspective follows the finance literature's view that predictable variation in expected returns reflects time-varying risk (Cochrane 2011). We start with a nominal version of a currency model in the spirit of Bekaert (1996), Bansal (1997) and Backus et al. (2001). As before, we let S_t be the dollar price of a unit of foreign currency, and let M_t and $M_t^{(i)}$ be the US and foreign stochastic discount factor (SDF) for country *i*, respectively. We think of this model as applying to all bilateral exchange rates against the dollar, though for notational simplicity we suppress the *i* superscript for *s* and the excess return of the foreign currency against the dollar, *rx*. No-arbitrage, and complete markets, imply that[35]

$$s_{t+1} - s_t = m_{t+1}^{(i)} - m_{t+1}, \tag{5}$$

[35] The two Euler equations are $1 = E_t[M_{t+1}R_{t+1}]$ and $1 = E_t[M_{t+1}^{(i)}R_{t+1}^{(i)}]$ where the *'s indicate foreign quantities. The Euler equation for a US dollar investor who converts dollars into foreign currency, invests in a foreign asset for one period, and then converts the resulting positive back into dollars is $1 = E_t\left[M_{t+1}R_{t+1}^{(i)}/S_t \times S_{t+1}\right]$. Assuming complete markets implies $M_{t+1}^{(i)} = M_{t+1}S_{t+1}/S_t$. Lustig and Verdelhan (2019) study the effect of incompleteness.

where lowercase letters indicate logs. Using this and assuming lognormality of the SDFs, the expected excess return from owning the foreign currency is[36]

$$E_t[rx_{t+1}] = E_t s_{t+1} - f_t = \frac{1}{2}\left[var_t(m_{t+1}) - var_t(m_{t+1}^{(i)})\right]. \tag{6}$$

The $var_t(m_{t+1})$ and $var_t(m_{t+1}^{(i)})$ terms measure the uncertainty of next period's log SDF. The country with the higher uncertainty expects risk compensation for owning the other country's currency. If the variances in (6) are equal, then the forward rate is the time *t* expectation of the *t+1* exchange rate and uncovered interest rate parity holds. Using (6), we can write the excess return rx_{t+1}, defined in equation (1) in Section 2, of a security as

$$s_{t+1} - f_t = E_t[rx_{t+1}] + \epsilon_{t+1}, \tag{7}$$

where ϵ_{t+1} is orthogonal to $E_t[rx_{t+1}]$, the time-*t* forecast of the excess return.

The recent literature on exchange rates models the reduced form log SDF's as having time-varying loadings on identically and independently distributed innovations (for example, Lustig et al. 2014 equation 9, or Verdelhan 2018 equation 1). Such specifications result in conditional variances of the log SDF's that are linear in the model factors. If we assume a country-specific factor $z_t^{(i)}$ and a global factor $z_t^{(g)}$, then we can write country *i*'s conditional variance as

$$var_t(m_{t+1}^{(i)}) = 2\, l^{(i)} z_t^{(i)} + 2 g^{(i)} z_t^{(g)}$$

[36] Noting that entering at time *t* into a one-period forward contract costs nothing, we have that $E_t[M_{t+1}(S_{t+1} - F_t)] = 0$, which implies that $F_t/S_t\, E_t[M_{t+1}] = E_t[M_{t+1}S_{t+1}/S_t] = E_t[M_{t+1}^{(i)}]$. Therefore $f_t - s_t = \log E_t\left[M_{t+1}^{(i)}\right] - \log E_t[M_{t+1}]$. Assuming lognormality of the SDFs, we have $f_t - s_t = E_t\left[m_{t+1}^{(i)}\right] + 0.5\, var_t\left(m_{t+1}^{(i)}\right) - E_t[m_{t+1}] - 0.5\, var_t(m_{t+1})$. Using the time *t* expectation of (5) in the right-hand side yields (6).

for constants $l^{(i)}$ and $g^{(i)}$ (the 2 is a normalization). Suppressing the superscript for US variables, we can therefore write a country's excess return from (7) as

$$s_{t+1} - f_t = l\, z_t - l^{(i)} z_t^{(i)} + \left(g - g^{(i)}\right) z_t^{(g)} + \epsilon_{t+1}. \tag{8}$$

7.1 Interpreting the Panel Regressions

Under the assumptions of the theoretical model, equation (8) represents the structure of the panel regressions in Tables 5 and 6, if we assume a simplified setting with a single subject country forecasting variable $z_t^{(i)}$, a single US forecasting variable z_t (which is unrelated to the log SDF volatility of the subject country), and a single global forecasting variable $z_t^{(g)}$ common to the US and subject country. Via equation (6), country-specific variables forecast returns via their effect on the precautionary savings demand of their home country. The global factor $z^{(g)}$ affects both countries' precautionary savings demand, and will only forecast returns to the extent that this effect is asymmetric (i.e. $g \neq g^{(i)}$).

For example, we can interpret the forecasting power of *cpiYOY* (positive) and *cpiYOYUS* (negative) in light of equation (8) if each inflation measure is associated with a lower precautionary savings demand in its own country, i.e., $l^{(i)}, l < 0$. Perhaps in our sample, which excludes high inflationary episodes and especially for DMs, higher inflation is associated with strong economic conditions and therefore lower precautionary savings. As we already mentioned, these signs are the opposite of the prediction under Purchasing Power Parity.

When forecasting power of a global variable goes from zero to negative significant, as is the case for *exFedRate* and *CBexFed* from the early to the late subperiod in DMs, we can interpret this as a change from $g = g^{(i)}$ in the early subperiod to $g < g^{(i)}$ suggesting that non-

US countries became more sensitive to the monetary policy of the ECB, BOE and BOJ in the later subperiod assuming that $g^{(i)}, g > 0$ (tighter policy leads to higher precautionary savings).

Furthermore, equation (8) provides justification for our result that *Fed* and *CBexFed* both do not forecast exchange rate returns against non-dollar base currencies. When looking at the return of currency *i* against currency *j* (as opposed to the dollar) the g coefficient in (8) becomes $g^{(j)}$. If these loadings are similar across non-dollar countries, i.e. if for all *i* and *j* $g^{(i)} \approx g^{(j)}$ then $z_t^{(g)}$ will not forecast returns against non-dollar base currencies, but it *will* forecast returns against the dollar as long as $g^{(i)} \neq g$. This is the fact pattern we document in Section 4.4.

7.2 Interpreting Different Carry Regimes

As can be seen from Table 5 (DMs) and Table 6 (EMs), with respect to changes in the *carry* variable, we identify three different currency return regimes in our data:

1. For DMs in the early part of the sample, *carry* positively forecasts currency returns.
2. For DMs in the late part of the sample, *carry* becomes negative though not significant.
3. For EMs, the *carry* coefficient is positive, but small in magnitude and not significant.

This is despite the fact that the carry trade is profitable for EMs (see Figures 4 and A5).

We analyze these findings in the context of equations (6) and (7) . The domestic one-period interest rate is given by $y_t = -E_t[m_{t+1}] - \frac{1}{2}var_t(m_{t+1})$ and the foreign interest rate is $y_t^{(i)} = -E_t[m_{t+1}^{(i)}] - \frac{1}{2}var_t(m_{t+1}^{(i)})$.[37] In the standard power utility model with risk aversion γ and identically and independently distributed consumption growth Δc_t,

[37] These follow from $\exp(-y_t) = E_t[M_{t+1}] = E_t[\exp(m_{t+1})]$ and the lognormality of the SDF.

$$var_t(m_{t+1}) = \gamma^2 \times var_t(\Delta c_{t+1}),$$

and therefore $var_t(m_{t+1})$ determines the precautionary savings component (which is negative and serves to lower the interest rate) of the short rate.[38]

The interest rate differential, our $carry_t$ variable, can therefore be written as

$$\underbrace{y_t^{(i)} - y_t}_{carry_t} = E_t[m_{t+1} - m_{t+1}^{(i)}] + E_t[rx_{t+1}], \tag{9}$$

where we have used the result in (6). Assuming that *carry* captures some of the elements of the factors in equation (8), and simplifying to exclude other variables for the moment, a version of the regression in (8) where *carry* is the sole regressor takes the form:

$$s_{t+1} - f_t = a + b(y_t^{(i)} - y_t) + \eta_{t+1}. \tag{10}$$

This regression generates Figures A9-A11 (and the results in Table 11). Using (7), the *carry* coefficient *b* is given by

$$b = \frac{cov(E_t[m_{t+1} - m_{t+1}^{(i)}], E_t[rx_{t+1}]) + var(E_t[rx_{t+1}])}{var(carry_t)}. \tag{11}$$

where from (6) we have that $E_t[rx_{t+1}] = {}^1/_2 \left[var_t(m_{t+1}) - var_t(m_{t+1}^{(i)})\right]$. The *b* coefficient in (11) can be positive or negative depending on the covariance term in the numerator. To gain intuition for the sign of this term, note that $E_t[m_{t+1}]$ proxies for expectations about next period's log marginal utility of consumption (relative to the current period's). We can therefore think of a high (low) value of $E_t[m_{t+1}]$ as indicating a weak (strong) domestic economy. Under the

[38] Note that $var_t(m_{t+1})$ can also be driven by heteroscedasticity in the return of the total wealth portfolio under the Epstein-Zin (1991) SDF, or by changing local risk-aversion in a habit model. We will use the "precautionary savings" terminology throughout because it is succinct, but there can be other effects in $var_t(m_{t+1})$.

interpretation that $var_t(m_{t+1})$ proxies for precautionary savings demand, we expect this term to be countercyclical as well, since investors choose to save more during bad times. We can now interpret the three possible carry regimes in light of the model.

Regime 1. For DMs, in non-stressed (pre-2007) times, we interpret recessions as being largely idiosyncratic in nature, i.e., affecting only the US or the foreign economy but not both. In this case, both $E_t[m_{t+1} - m_{t+1}^{(i)}]$ and $var_t(m_{t+1}) - var_t(m_{t+1}^{(i)})$ (recall that the latter equals $2E_t[rx_{t+1}]$) should reflect the relative economic conditions of the US versus the foreign economy. If the US is doing worse than the subject country, and if doing worse results in both a higher marginal utility of consumption in the US, and higher precautionary savings in the US, then the *carry* variable against the subject country will be positive, then $E_t[m_{t+1} - m_{t+1}^{(i)}]$ and $E_t[rx_{t+1}]$ will be positively correlated, and b in (11) will be positive.

Regime 2. For DMs, in the post-crisis period, we found the *carry* coefficient to be negative. This implies that the numerator of b in (11) is negative, or[39]

$$cov\left(E_t[m_{t+1} - m_{t+1}^{(i)}], E_t[rx_{t+1}]\right) < -var(E_t[rx_{t+1}]).$$

The relationship between expected relative marginal utilities and relative precautionary savings demands (i.e., the $E\_t\ [rx\_(t+1)\ ] = 1/2[var_t\ (m_{t+1}) - var_t\ (m_{t+1}^{(i)}\ )]$ term) must become strongly negative in the second subperiod. As opposed to an idiosyncratic recession, in a global recession we are looking at the covariance of the difference of two terms, and if for one country the elasticities of $E_t\ [m_{t+1}^{(i)}\ ]$ and $var_t(m_{t+1}^{(i)})$ with regard to the state of its economy are not the

[39] Since the absolute value of the correlation is under one, a necessary condition for this is $var\big(E_t[m_{t+1} - m_{t+1}^{(i)}]\big) > var(E_t[rx_{t+1}])$. Of the two components of carry in (9), under Regime 2, the expected difference in marginal utilities must be the more volatile one.

same, we can have a negative correlation between $E_t[m_{t+1} - m_{t+1}^{(i)}]$ and $E_t[rx_{t+1}]$. For Regime 2 to hold, it is necessary that relatively high marginal utility be associated with relatively *low* precautionary savings. We may expect that countries that are doing relatively better in growth will have lower marginal utility. Under Regime 2, it is also true that they will have higher precautionary savings demands.[40]

Regime 3. For the EM results, one must reconcile the fact that the carry trade is profitable with the fact that the *carry* coefficient in Table 6 is of much smaller positive magnitude that the DM early subperiod coefficient in Table 5, which is true for EMs in both subperiods. From equation (6), the unconditional risk-premium of a currency against the dollar depends on the average difference in precautionary savings demands, i.e., $E[var_t(m_{t+1}) - var_t(m_{t+1}^{(i)})]$, between the US and the foreign economy. From (9), we see that the average interest rate differential between the US and the foreign country depends on the average difference of precautionary savings demands through the $E_t[rx_{t+1}]$ term, but also on the average difference between log marginal utilities. If the average value of $E_t[m_{t+1} - m_{t+1}^{(i)}]$ is similar across countries, then cross-sectional variation in carry differentials will be driven by the average value of $E_t[rx_{t+1}]$, and high interest rate differential countries will have high expected returns (a country risk characteristic) while low interest rate differential countries will have low expected returns.

But how can the b coefficient in (10) be close to zero? For this to happen, we need the unconditional variance of $E_t[m_{t+1} - m_{t+1}^{(i)}]$ to be high relative to the unconditional variance of $E_t[rx_{t+1}]$ because the former shows up in the denominator of b in equation (11) but it appears in the numerator only through the correlation term, which needs to be small. Effectively, to explain

[40] For a related discussion of the sign of the carry coefficient in a general equilibrium setting, see Backus et al. (2010) and Benigno, Benigno and Nistico (2012).

the close-to-zero value of *b* one needs the currency risk premium relative to the dollar for EM countries $E_t[rx_{t+1}]$ to be a constant country risk characteristic, and not a conditioning variable having to do with relative economic conditions, as it is for DMs.

7.3 A Simple Empirical Test of the Model

Note that the variance of $carry_t$ in equation (9) is given by

$$var(carry_t) = var(E_t[m_{t+1} - m_{t+1}^{(i)}]) + var(E_t[rx_{t+1}]) + 2cov\left(E_t[m_{t+1} - m_{t+1}^{(i)}], E_t[rx_{t+1}]\right) \tag{12}$$

While the *b* coefficient in (11) and the variance of $carry_t$ in (12) can be thought of as an average over the population of countries, we can also think of each of these quantities at the country level. The cross-section of *b*'s and $var(carry_t)$'s, shown for DMs in the left chart of Panel A of Figure 7, gives a simple empirical test of the model as we now discuss.

Regime 1. If in idiosyncratic recessions the covariance term in (11) and (12) is indeed positive, then this implies a large-cross sectional variation in $var(carry_t)$ because the cross-sectional variation in $var(E_t[m_{t+1} - m_{t+1}^{(i)}])$ and $var(E_t[rx_{t+1}])$ gets amplified in the carry variance. In this case, we expect the *b*'s and $var(carry_t)$'s to be weakly negatively correlated (since $var(carry_t)$ shows up in the denominator of *b*). This is exactly what we see in the early part of the sample in the top left chart of Figure 7.

Regime 2. If the covariance term in (11) and (12) is on average negative in periods of global recession, then the cross-sectional variation in in $var(E_t[m_{t+1} - m_{t+1}^{(i)}])$ and $var(E_t[rx_{t+1}])$, i.e., the cross-country differences in these time series variances, gets dampened in $var(carry_t)$ and we expect the variance of carry to have relatively little cross-sectional variation. In this case the numerator of (11) is the dominant driver of cross-sectional variation in the b's, which renders the b's positively correlated with $var(carry_t)$ because the numerator of b is contained in the variance of carry in (12). Both of these predictions, i.e., the small cross-sectional variation in $var(carry_t)$ and the positive correlation between this and the b's, are evident for the later subperiod in the top-left chart of Figure 7.

Regime 3. Since we have argued that for EMs the b coefficient in (10) is close to zero, we don't expect to see much cross-sectional variation between the b's and $var(varry_t)$. Indeed from the left chart in Panel B of Figure 7 this is what we see.

7.4 Explaining Factor Decompositions: Future Research Directions

As shown by Lustig et al. (2011, 2014) and Verdelhan (2018) currency models of the form in equation (5) imply a specific process for the dollar *RX* and carry *HMLFX* factors. Using these, the currency return in equation (8) can be restated in term of a factor model with *RX*, *HMLFX* and an appropriately defined residual term, i.e., our empirical specification in (4). Our results in Tables 9 and 10 on decomposing variable predictability into factor and idiosyncratic channels can then be analyzed in the context of that model. In future research, we plan to employ this approach to shed light on the findings of Tables 9 and 10.

In particular such an analysis could shed light on the facts about coefficient changes and their relationship to factors that we learn in Tables 9 and 10. There are important differences between DMs and EMs in the role of the dollar factor in driving the regression results. We find that in DMs in both subperiods predictors of exchange rate returns operate mainly through the dollar factor. That is not true for EMs in the first subperiod, but then, in the second subperiod, coefficients for EMs work mainly through the dollar factor, as is true for DMs.

More generally, what is called for is a structural economic model that can endogenously generate the currency risk premium dynamics that we have laid out in this discussion. Which of the workhorse asset pricing models, and which elements of those models (long-run risks, habits, or time-varying disaster probability) works best to reconcile the model to the data?

8. Conclusion

We construct a forecasting model of exchange rate returns for separate samples of developed and emerging economies. Our model includes text-based measures of monetary policy stance, as well as a wide range of variables that capture other influences, which draw from the evidence previously reported in a wide range of studies.

To summarize, we make several contributions to the literature. (1) Our forecasting model integrates measures of monetary policy change with real exchange rate influences, and other relevant influences. (2) We measure monetary policy using a text-based measure, obtained from Prattle, and find that this has much more important predictive value for exchange rate returns in the post-2007 period. (3) Monetary policy by the major non-US central banks becomes much more responsive to risk in the post-2007 period. (4) We show that there are important spillovers from central bank policies for currencies other than their own, especially in the post-2007 period. (5) We connect the predictive power of forecasting variables, including monetary policy, to dollar and carry factors, and show that monetary policy spillovers operate mainly through the dollar factor. This spillover, however, effect does not reflect the predictive role of non-US central banks for forecasting US monetary policy. (6) We show that the predictive power of monetary policy for future exchange rates is only present when the US dollar is used as the base currency, suggesting a unique role for the dollar in the transmission of global monetary policy shocks. (7) We show that carry trade profitability in emerging and developed economies is driven by different influences; in emerging economies interest rate differences reflect persistent country risk characteristics, while in developed economies they reflect interest rate differences produced largely by influences that boost foreign demand for capital (e.g., an economic expansion in the high carry country prior to 2007, and by different influences later). (8) We find that the carry reversal after 2007 that has been documented in prior work was confined to developed economies, and that it potentially reflected savings differences in the years after the global financial crisis. (9) We show that our main findings, including monetary policy spillover effects and differences across countries and across time in the relation between interest differentials and exchange rate changes, can be understood as reflecting changes in risk pricing from the perspective of a no-arbitrage asset pricing model. (10) We examine whether the activist and novel monetary policy after 2007 increased forecasting uncertainty, and find no evidence that it did, suggesting that central banks pursuing discretionary policy were able to communicate their intentions reasonably well to the market despite the absence of adherence to rules.

We emphasize two overarching conclusions from our various findings. First, changes in risk and the pricing of risk are central to monetary policy stances of the major central banks, to modeling exchange rate changes, and to understanding the persistent profitability of the carry trade in EMs and the carry trade reversal in DMs. Second, one cannot properly model the exchange rate of one currency without modeling all currencies. In particular, when considering how cross-border influences affect currency values it is important to take into account the influence of dominant developed countries' central banks on exchange rates not directly related to their own currency. Finally, the majority of global monetary policy influence on exchange rates operates through the US dollar.

Online Appendix

The Online Appendix can be found at https://sites.google.com/view/hmamaysky.

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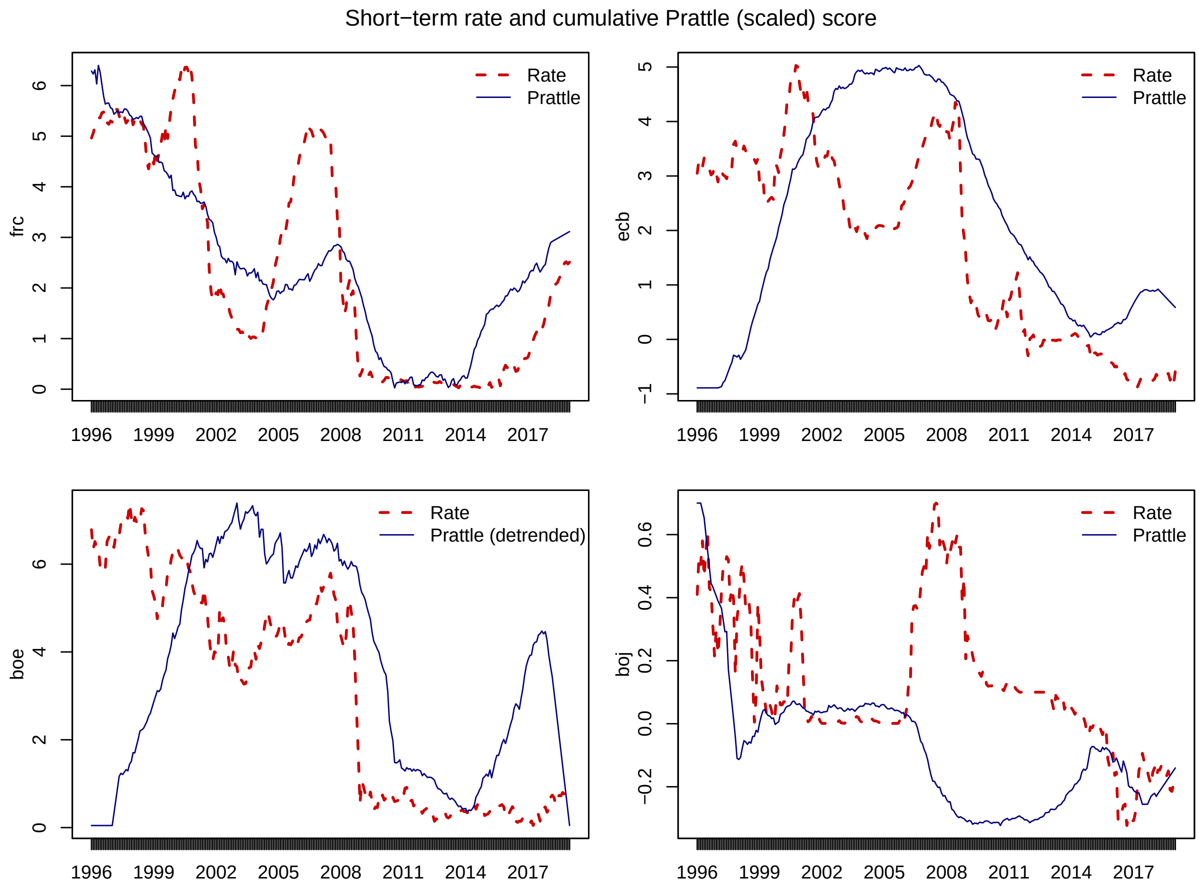
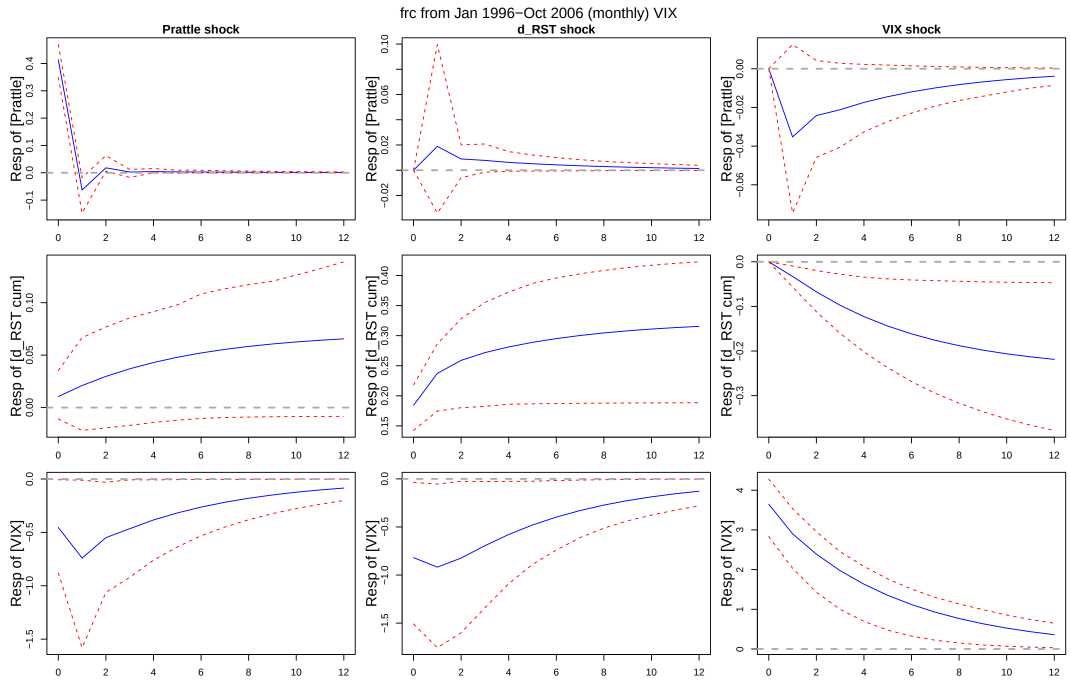


Figure 1: The short-rate ranges from a 6-month to a 2-year yield on government bonds (Bunds are used for the ECB). The Prattle series is shown as a cumulative sum of monthly Prattle scores, scaled to have the same range of values as the short-rate. In the case of the Bank of England, the average monthly Prattle score was strongly positive, and so the cumulative Prattle series has been detrended.

Fed: VARs of Prattle, Short-Rate and VIX – Early Subperiod



Fed: VARs of Prattle, Short-Rate and VIX – Late Subperiod

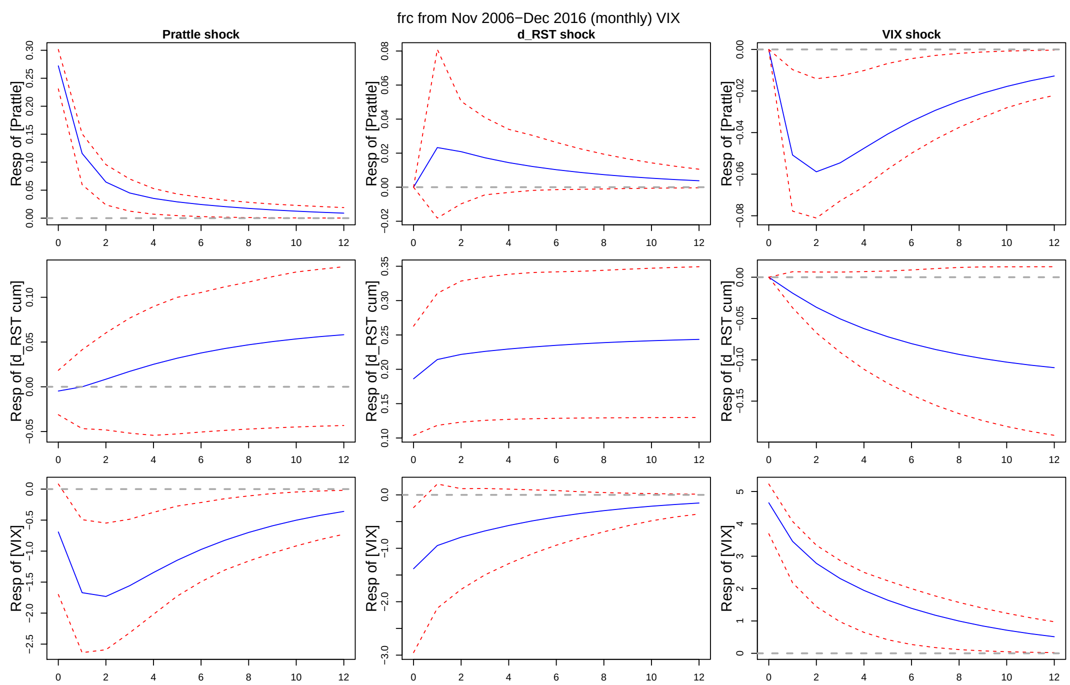
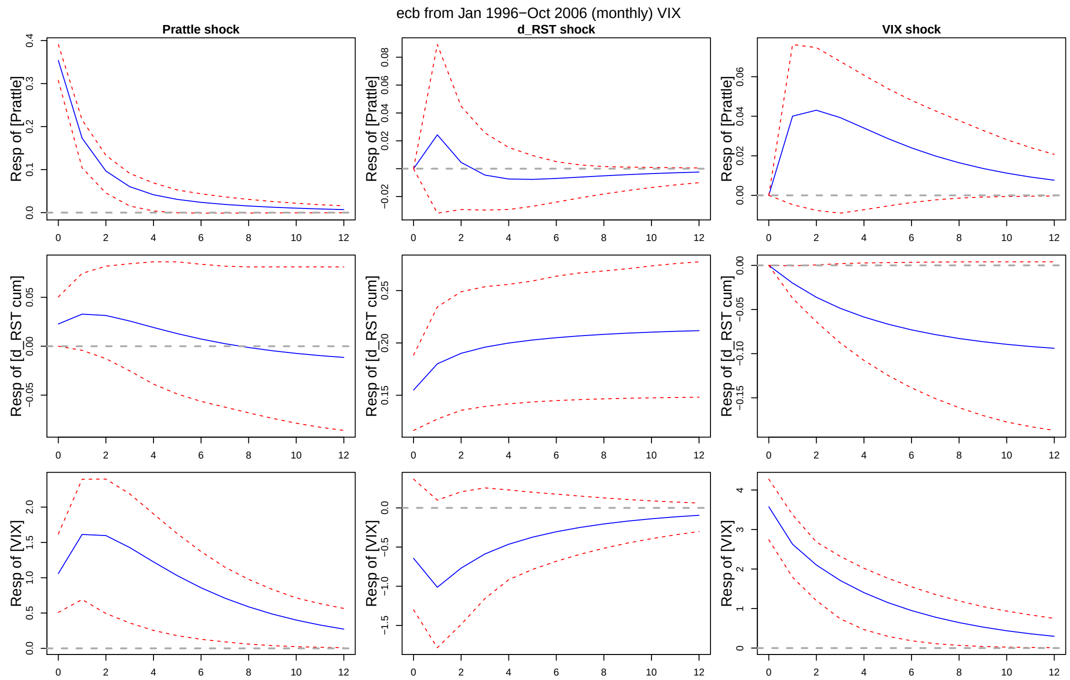


Figure 2: The VAR contains the Prattle score, the difference in the short-rate and the VIX, in that order. Impulse responses are calculated using a Cholesky decomposition of the residual covariance matrix. Impulse responses for the change in the short-rate are cumulative. Other impulse responses are non-cumulative. Each time step is one month.

ECB: VARs of Prattle, Short-Rate and VIX – Early Subperiod



ECB: VARs of Prattle, Short-Rate and VIX – Late Subperiod

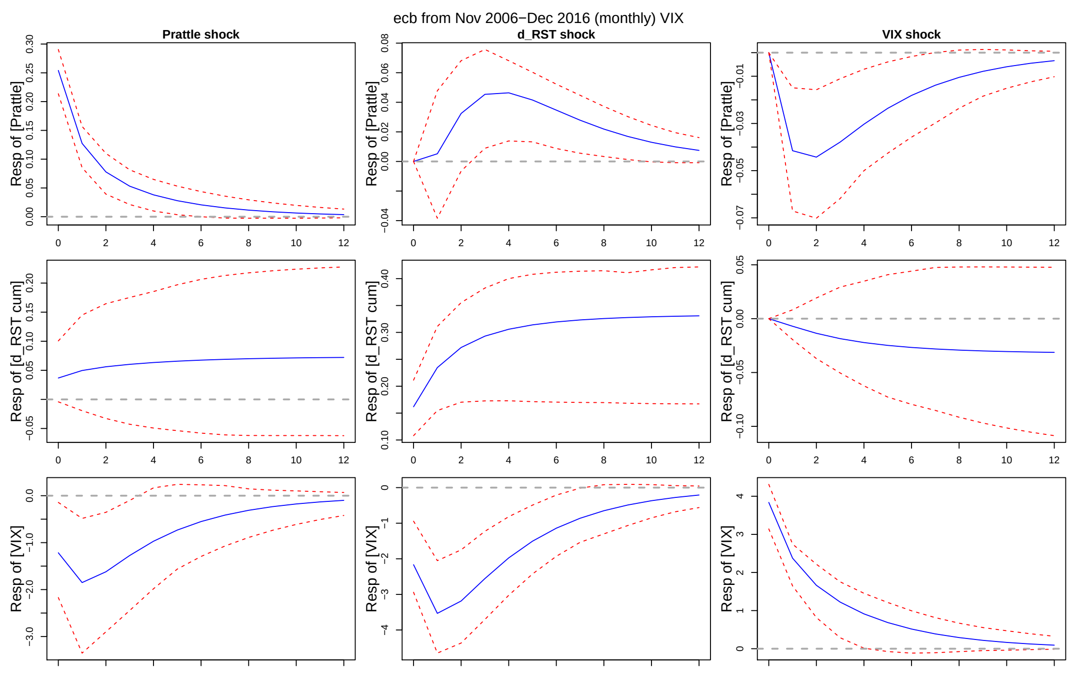


Figure 3: The VAR contains the Prattle score, the difference in the short-rate and the VIX, in that order. Impulse responses are calculated using a Cholesky decomposition of the residual covariance matrix. Impulse responses for the change in the short-rate are cumulative. Other impulse responses are non-cumulative. Each time step is one month.

The full sample of countries

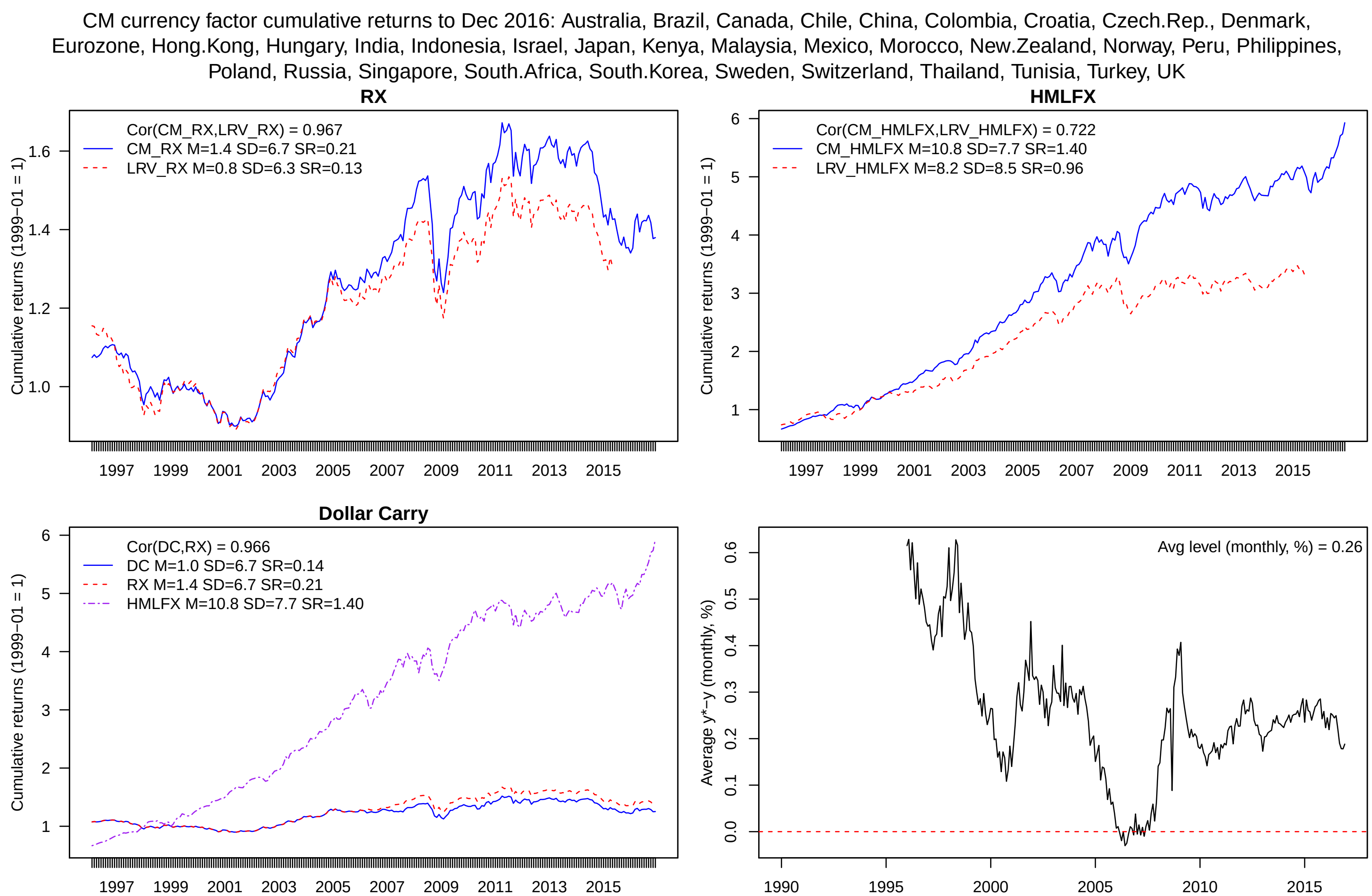


Figure 4: This figure shows cumulative returns for the dollar factor RX, the currency carry factor $HMLFX$ and the dollar carry factor $Dollar\ Carry$. The factors are constructed for the full sample of countries. The top two charts show our version of the RX and $HMLFX$ factors (in blue, labeled CM), versus the same two factors as downloaded from Lustig and Verdelhan's websites (in red, labeled LRV). The lower right hand chart shows the average rate differential between foreign currencies and the dollar, i.e. $y^* - y$ where y^* (y) is the foreign (dollar) monthly nominal yield (not annualized).

Elastic net rolling coefficient estimates for 12-month returns

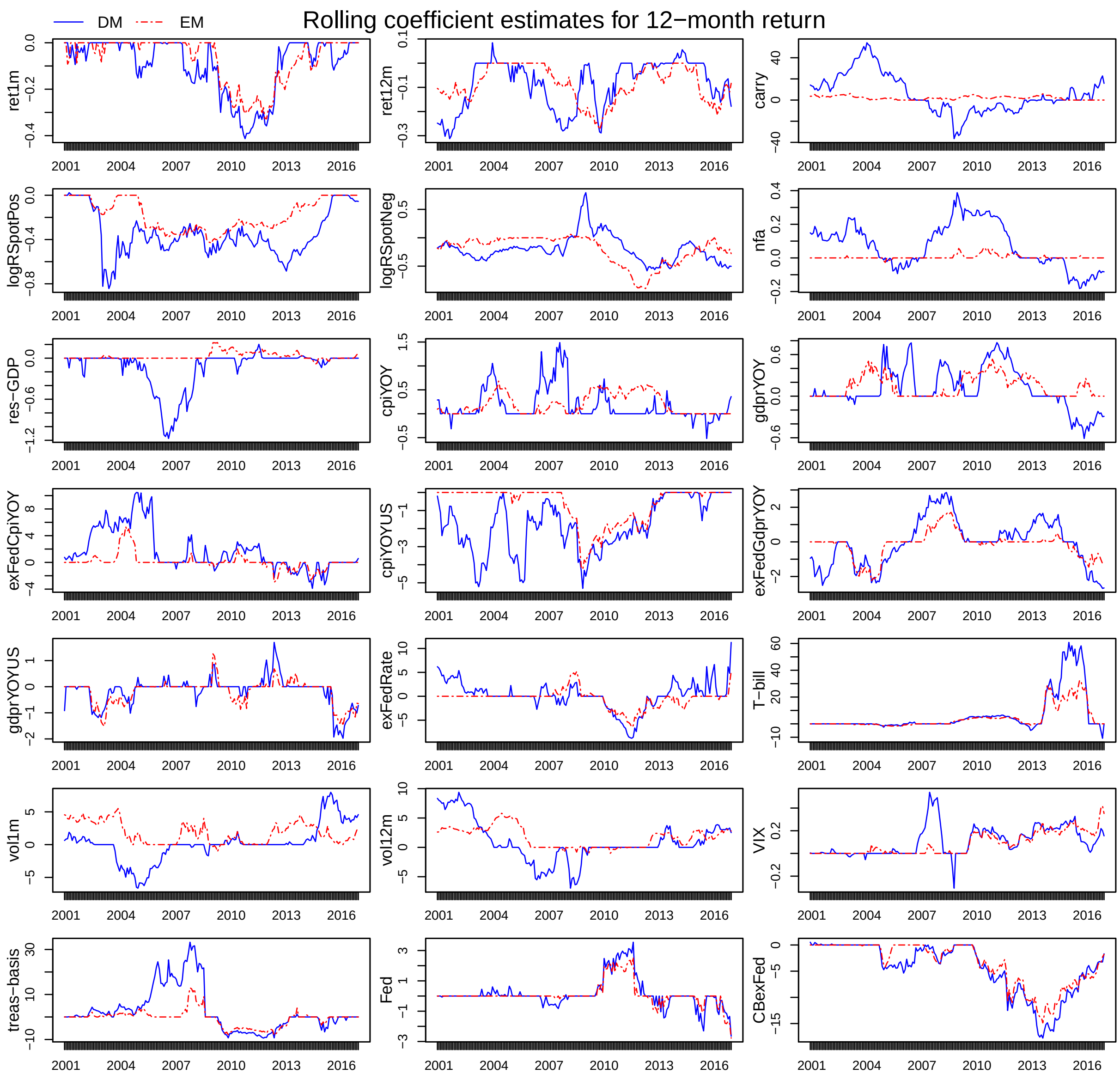
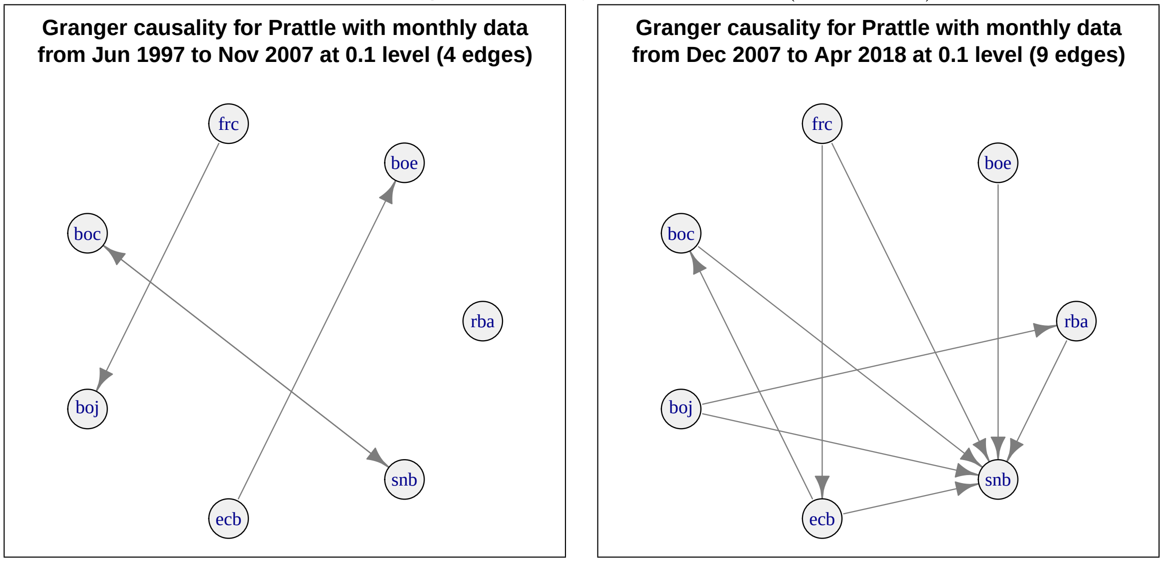


Figure 5: Rolling coefficients for forecasting regressions for 12-month returns. The model is estimated in rolling 60 month windows using truncated 12-month returns data. Data are demeaned at the country level in each 60 month window prior to running the elastic net. Coefficients are estimated using an elastic net model implemented in the glmnet package in R. We use cross-validation with 10 folds and the lambda.1se (maximally regularized) version of the λ calculation.

Panel A: Granger causality with Prattle (10% level)



Panel B: Granger causality with changes in short-rates (2.5% level)

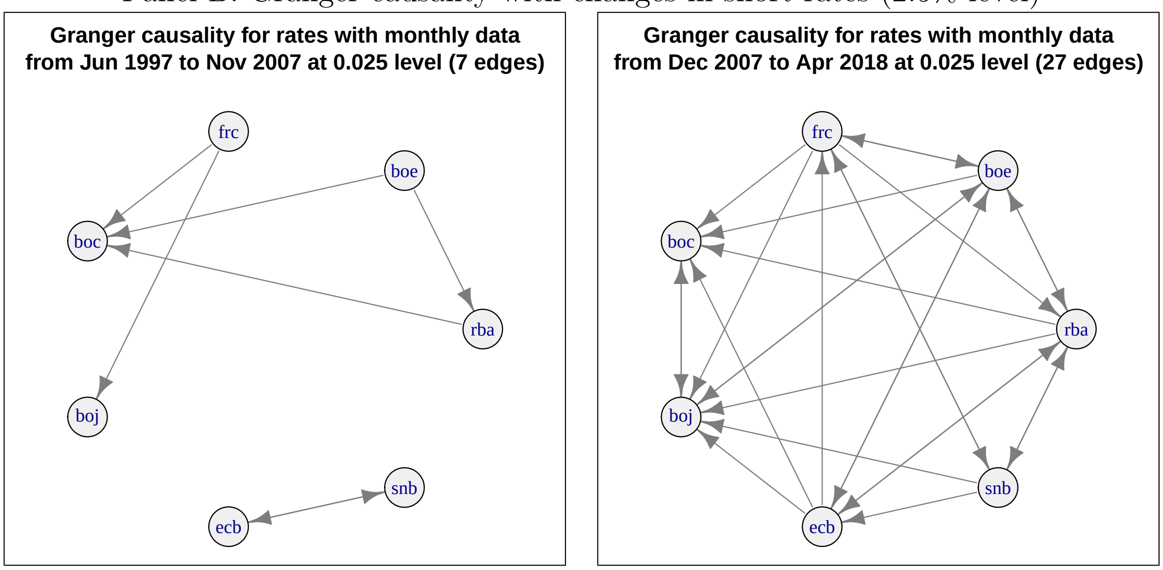
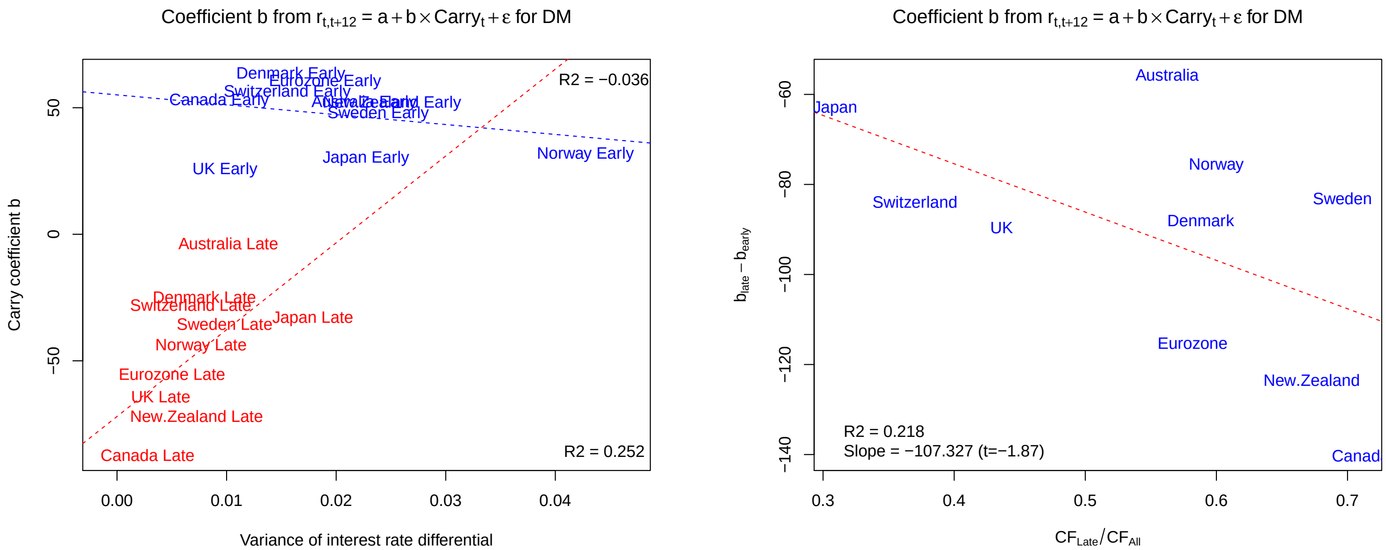


Figure 6: Panel A tests Granger causality of Prattle scores, in levels. Panel B tests Granger causality of one-month changes in short rates (with maturity between 6 months and 2 years, depending on data availability). Tests use 3 lags. An arrow from A to B indicates that A Granger causes B at the indicated significance level. Central banks codes: rba–Australia; mex–Mexico; boe–UK; frc–US; boc–Canada; rnz–New.Zealand; swe–Sweden; boj–Japan; tur–Turkey; nor–Norway; ecb–Eurozone; bra–Brazil; snb–Switzerland; tai–Taiwan; isr–Israel; rbi–India; kor–South.Korea.

Panel A: Developed markets



Panel B: Emerging markets

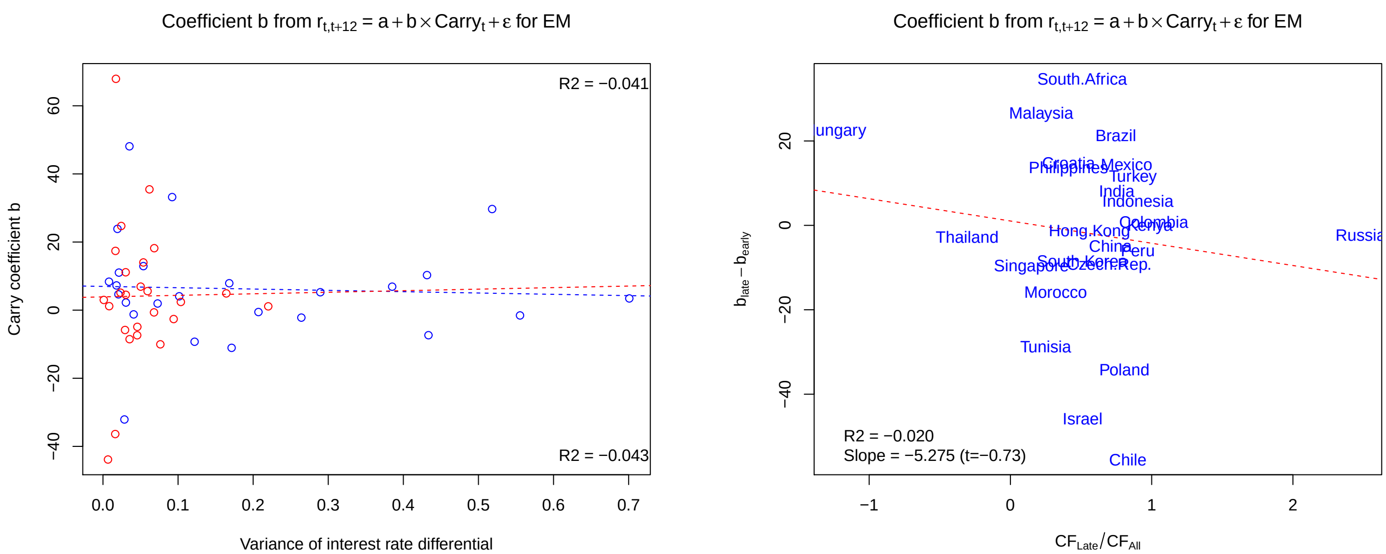


Figure 7: The left charts show the forecasting carry coefficient b versus variance of interest rate differential. The early subperiod is in blue (R^2 shown at top), and the late is in red (R^2 shown at bottom). The right charts show the difference in carry coefficients across samples ($b_{late} - b_{early}$) plotted against the ratio of second half to total capital inflows, CF_{late}/CF_{all}. The t-statistics use OLS standard errors. The early period runs from January 1996 to October 2006, and the late subperiod starts in November 2006 and runs to December 2016.

Table 1: Data definitions summary. More detailed descriptions are in the appendix.

Variable	Definition
	Market variables
ret1m	One month return of local currency (LCY) in US dollars (positive means LCY appreciation)
ret12m	Twelve month return of LCY against the US dollar (positive means LCY appreciation)
drawdown	The maximum negative return experienced by LCY against the US dollar over twelve months
exFedRate	Short-term interest rate averaged across Germany, UK and Japan, annualized in percent
T-bill	US 3-month T-bill rate, annualized in percent
R10y	Local 10-year bond yield
Slope	Difference between local 10-year yield and the local short-rate (6 months – 2 years)
vol1m	Monhtly volatility (not annualized) of daily % currency changes against the US dollar
vol12m	Twelve month average of vol1m; missing if 7 or more months of data are not available
VIX	An index of the n average short-dated implied volatility of S&P500 options, in percent
carry	LCY vs dollar interest rate differential in % implied in one-month forward (continuously compounded, not annualized; higher means LCY has higher interest rate than the dollar)
treas_basis	The Treasury dollar basis from Jiang et al. (2018) defined as the US T-bill yield minus the synthetic T-bill yield implied from currency forwards: $x_t^{Treas} = y_t - (y_t^{(i)} + f_t - s_t)$
	Macro variables
RSpot	the real exchange rate $S_t P_t^* / P_t$ for P_t (P_t^*) the US (foreign) price levels
logRSpotPos	$logRSpot \times \mathbb{1}[logRSpot > 0]$ for $logRSpot \equiv RSpot_t / \overline{Rspot}_{t-60}$ and $RSpot_t$ the current real exchange rate in month t and $\overline{Rspot}_{t-60}$ the average real exchange rate in $[t-55, t+66]$
logRSpotNeg	This is $logRSpot \times \mathbb{1}[logRSpot < 0]$
cpiYOY	The year-over-year local currency inflation rate, in percent
cpiYOYUS	Year-over-year CPI inflation for the US, in percent
exFedCpiYOY	cpiYOY averaged across the Eurozone, UK and Japan
gdprYOY	Year-over-year growth in real GDP, in continuously compounded percent
gdprYOYUS	Year-over-year growth in real GDP for the US, in continuously compounded percent
exFedGdprYOY	gdprYOY averaged across the Eurozone, UK, and Japan
res_GDP	Foreign reserves excluding gold as a percent of nominal GDP
nfa	Net foreign assets as % of GDP, 1970-2015 data from Lane and Milesi-Ferretti (2017)
capital flows	Gross portfolio inflows to debt to banks, debt to other sectors, and equity
	Cental bank variables
QE	For month t: $QE(t) \equiv \mathbb{1}[\text{Mar } 2008 \leq t \leq \text{Dec } 2012]$
postQE	For month t: $postQE(t) \equiv \mathbb{1}[\text{Jan } 2013 \leq t]$
Fed	The Prattle Fed (named *frc* by Prattle) series, averaged first within a day and then averaged within a month; we exclude all Prattle releases labeled "[blank]" or "Other Publication"
CBexFed	The average Prattle monthly score for the ECB (*ecb*), Bank of Japan (*boj*) and the Bank of England (*boe*), using same calculation as for Fed
ownCB	A country's own central bank Prattle score, using same calculation as for Fed

Table 2: Summary of Prattle data. Communication type “” (blank) is labeled this way by Prattle, and consists of academic working papers published by the Bank of Mexico. Our version of the Prattle measure excludes the unlabeled and the “Other Publication” categories.

Prattle data summary

Communication	Count	Mean Score	SD Score
Monetary Policy	2134	0.116	1.075
	240	0.437	0.753
Speech	11353	0.036	0.913
Other Publication	3054	-0.135	1.021
Minutes	1628	-0.316	1.316
Official Press	11109	0.043	0.957
Total	29518	0.011	0.984

Table 3: Summary of Prattle scores around the quantitative easing (QE) events documents in Fawley and Neeley (2013). The *#Prattle* column shows the number of Prattle events that occurred on the QE days identified by Fawley and Neeley (2013). The next three columns shows the mean, maximum and minimum Prattle scores across these events. *Chg10yr* shows the change in the local nominal 10-year government rate on the day of the announcements (we use Bund yields for the ECB). *ChgCCY* shows the percent change in the currency's dollar price on the day of the announcement, and the return of the *DXY* index for the Fed.

Summary of Prattle scores on quantitative easing announcements

bank	#Events	#Prattle	Mean	Max	Min	Chg10yr (bp)	ChgCCY (%)
boe	11	8	-0.80	-0.23	-1.27	-3.70	-0.57
boj	23	23	-0.69	0.32	-1.46	-1.06	0.08
ecb	9	6	0.05	0.54	-0.51	3.23	0.03
frc	20	20	-0.99	-0.34	-2.43	-5.05	-0.41

Table 4: For each currency we calculate the time-series values of the variables (mean, sd, percentiles and AR(1) coefficient) reported in the table. The table shows the mean across countries of these variables. The $cpiYOY$, $vol1m$ and $vol12m$ series reported here have been winsorized at the 1% level.

Panel data summary

DM

	mean	sd	5%	95%	AR(1)
ret1m	0.02	3.07	-4.77	4.97	0.01
ret12m	0.56	11.63	-17.61	20.80	0.92
dd_n12m	6.80	6.73	0.00	20.09	0.91
vol1m	0.62	0.25	0.32	1.05	0.65
vol12m	2.23	0.67	1.38	3.60	0.98
VIX	20.84	7.77	12.01	34.79	0.83
logRSpotPos	8.01	10.83	0.00	30.91	0.98
logRSpotNeg	-9.45	12.49	-37.14	0.00	0.98
nfa	2.85	15.38	-18.31	29.30	0.97
res-GDP	10.35	5.21	5.12	19.83	0.98
gdebt-GDP	62.39	13.07	43.98	83.26	1.00
LDC	52.78	6.37	42.85	61.28	0.98
cpiYOY	1.56	1.05	-0.01	3.39	0.94
gdprYOY	2.05	2.08	-1.43	4.71	0.93
exFedCpiYOY	1.26	0.68	0.13	2.38	0.96
cpiYOYUS	2.19	1.24	-0.03	4.05	0.94
exFedGdprYOY	1.45	2.35	-3.88	3.52	0.96
gdprYOYUS	2.35	1.81	-0.31	4.57	0.97
carry	0.01	0.13	-0.20	0.20	0.93
exFedRate	1.82	1.38	-0.04	3.61	1.00
T-bill	2.28	2.20	0.01	5.34	1.00
treas-basis	-0.23	0.21	-0.55	0.01	0.89
QE	0.23	0.42	0.00	1.00	0.98
postQE	0.19	0.39	0.00	1.00	0.99
ownCB	0.08	0.59	-0.87	0.93	0.38
CBexFed	0.12	0.30	-0.33	0.69	0.59
Fed	-0.07	0.38	-0.70	0.45	0.12
ECB	0.03	0.47	-0.59	0.91	0.72
BOE	0.38	0.36	-0.24	0.82	0.31
BOJ	-0.12	0.79	-1.20	0.92	0.40

EM

	mean	sd	5%	95%	AR(1)
ret1m	0.15	3.00	-4.38	4.39	0.10
ret12m	2.02	11.07	-16.48	19.80	0.93
dd_n12m	5.65	6.98	0.00	19.91	0.92
vol1m	0.48	0.29	0.16	1.07	0.66
vol12m	1.82	0.89	0.75	3.75	0.98
VIX	20.84	7.77	12.01	34.79	0.83
logRSpotPos	12.22	15.94	0.00	47.89	0.98
logRSpotNeg	-9.04	13.01	-36.12	0.00	0.98
nfa	-12.92	18.22	-42.14	11.20	0.98
res-GDP	23.88	6.45	14.11	33.80	0.98
gdebt-GDP	42.26	9.56	29.56	58.35	0.98
LDC	48.61	11.78	29.34	62.05	0.99
cpiYOY	5.84	4.67	0.93	15.69	0.96
gdprYOY	4.02	3.15	-1.47	8.30	0.93
exFedCpiYOY	1.26	0.68	0.13	2.38	0.96
cpiYOYUS	2.19	1.24	-0.03	4.05	0.94
exFedGdprYOY	1.45	2.35	-3.88	3.52	0.96
gdprYOYUS	2.35	1.81	-0.31	4.57	0.97
carry	0.36	0.36	-0.05	1.04	0.85
exFedRate	1.82	1.38	-0.04	3.61	1.00
T-bill	2.28	2.20	0.01	5.34	1.00
treas-basis	-0.23	0.21	-0.55	0.01	0.89
QE	0.23	0.42	0.00	1.00	0.98
postQE	0.19	0.39	0.00	1.00	0.99
ownCB	0.09	0.57	-0.84	0.88	0.47
CBexFed	0.12	0.30	-0.33	0.69	0.59
Fed	-0.07	0.38	-0.70	0.45	0.12
ECB	0.03	0.47	-0.59	0.91	0.72
BOE	0.38	0.36	-0.24	0.82	0.31
BOJ	-0.12	0.79	-1.20	0.92	0.40

Table 5: Panel regressions for 12-month forward returns for the DM sample across different time periods. Columns (1-3) show the baseline model in all time periods. Columns (4-5) show the baseline model augmented with QE indicators in the two subsamples. Columns (6-7) show the baseline model augmented with central bank sentiment measures in the two subsamples. The $cpiYOY$, $vol1m$ and $vol12$ series have been winsorized at the 1% level when they appear as right hand side variables. The $vol1m$ and $vol12m$ variables are not winsorized when they appear on the left hand side. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively.

12-month forward returns forecasts for DM across time periods

	12-month return				
		Base		Central bank	
	(1)	(2)	(3)	(4)	(5)
ret1m	−0.286**	−0.035	−0.212*	−0.020	−0.283***
ret12m	0.071	−0.066	0.207***	−0.054	0.177**
vol1m	5.701**	1.388	4.680**	1.076	3.151
vol12m	2.993***	3.883**	5.023***	1.645	3.758**
VIX	0.139	0.123	0.344***	0.075	0.222**
logRSpotPos	−0.088	0.099	−0.300***	0.025	−0.298***
logRSpotNeg	−0.107*	−0.226***	−0.209*	−0.202***	−0.245***
nfa	−0.020	0.172***	−0.105	0.196***	−0.093
res_GDP	0.002	−0.390**	−0.121**	−0.707***	−0.079
cpiYOY	1.362	1.604***	0.886	1.510***	0.656
gdprYOY	0.502**	0.465	0.043	0.418	0.136
exFedCpiYOY	−0.319	3.631**	3.369	4.582**	3.763*
cpiYOYUS	−2.153***	−4.059***	−2.171*	−3.982***	−2.420**
exFedGdprYOY	1.314**	1.760*	−0.189	1.632*	0.295
gdprYOYUS	−2.357***	−2.341***	1.545	−2.151***	1.000
carry	11.178**	12.776***	−9.402	16.268***	−11.178
exFedRate	1.999	−1.955	−9.018***	−1.827	−9.281***
T-bill	0.141	−0.405	9.926***	0.033	9.107***
treas_basis	15.736***	18.542***	−6.373**	18.694***	−5.825**
Fed				0.214	−5.131**
CBexFed				−2.097	−12.910***
Start	$Oct96$	$Oct96$	$Nov06$	$Feb97$	$Nov06$
End	$Dec15$	$Oct06$	$Dec15$	$Oct06$	$Dec15$
Observations	2,274	1,174	1,100	1,039	1,100
Adjusted R^2	0.292	0.656	0.487	0.652	0.542

Note: *p<0.1; **p<0.05; ***p<0.01
Std. errors clustered by both.

Table 6: Panel regressions for 12-month forward returns for the EM sample across different time periods. Columns (1-3) show the baseline model in all time periods. Columns (4-5) show the baseline model augmented with QE indicators in the two subsamples. Columns (6-7) show the baseline model augmented with central bank sentiment measures in the two subsamples. The $cpiYOY$, $vol1m$ and $vol12$ series have been winsorized at the 1% level when they appear as right hand side variables. The $vol1m$ and $vol12m$ variables are not winsorized when they appear on the left hand side. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively.

12-month forward returns forecasts for EM across time periods

	12-month return				
	Base			Central bank	
	(1)	(2)	(3)	(4)	(5)
ret1m	−0.167*	−0.165	−0.162	−0.192	−0.229**
ret12m	0.026	−0.013	0.059	−0.016	0.032
vol1m	4.655***	5.999***	1.204	6.704***	1.045
vol12m	2.645***	4.154***	2.997***	3.959***	2.560***
VIX	0.129*	−0.056	0.419***	−0.056	0.294***
logRSpotPos	−0.026	−0.043	0.010	−0.128**	0.003
logRSpotNeg	−0.003	0.014	−0.158**	0.056	−0.168***
nfa	0.050*	−0.034	−0.011	−0.043	−0.013
res_GDP	−0.066	0.221	0.144*	0.037	0.146*
cpiYOY	0.461***	0.453***	0.494**	0.657***	0.454*
gdprYOY	0.532***	0.309*	0.544***	0.442**	0.409**
exFedCpiYOY	−2.526**	0.672	1.583	−0.471	1.591
cpiYOYUS	−0.254	−0.313	−1.173	−0.168	−1.245
exFedGdprYOY	0.551	1.381*	−0.445	1.119	−0.051
gdprYOYUS	−1.497**	−1.482**	−0.164	−1.223*	−0.278
carry	3.349**	3.343	1.403	2.834	2.354
exFedRate	1.124	−0.773	−9.484***	−0.349	−9.667***
T-bill	−0.048	−1.053	9.347***	−0.667	8.936***
treas_basis	8.839***	9.507***	−5.672**	13.797***	−5.738**
Fed				1.060	−3.065*
CBexFed				−3.876***	−9.292***
Start	$Oct96$	$Oct96$	$Nov06$	$Feb97$	$Nov06$
End	$Dec15$	$Oct06$	$Dec15$	$Oct06$	$Dec15$
Observations	5,046	2,377	2,669	2,101	2,669
Adjusted R^2	0.183	0.318	0.406	0.331	0.437
Note:					*p<0.1; **p<0.05; ***p<0.01 Std. errors clustered by both.

Table 7: This table shows a summary of the central bank Prattle coefficients in forecasting regressions for twelve-month returns for the DM and EM samples, with the dollar as the base country. The "Core" column summarizes the results from Tables 5 and 6. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively. T-statistics are shown in square brackets.

Panel A: DM Central Bank Coefficients, dollar as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	16.268***	15.469***	-11.178	-10.786
	[4.02]	[3.87]	[-1.31]	[-1.24]
Fed	0.214	0.019	-5.131**	-5.018***
	[0.21]	[0.02]	[-2.46]	[-2.61]
CBexFed	-2.097		-12.910***	
	[-1.11]		[-3.93]	
ECB		-2.672**		-5.908***
		[-2.04]		[-2.90]
BOE		-1.452		-6.814***
		[-1.38]		[-2.83]
BOJ		0.393		-2.183
		[0.58]		[-1.58]
Start	Feb97		Nov06	
End	Oct06		Dec15	

Panel B: EM Central Bank Coefficients, dollar as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	2.834	2.825	2.354	2.467
	[1.11]	[1.10]	[1.05]	[1.09]
Fed	1.060	1.010	-3.065*	-2.942*
	[1.59]	[1.47]	[-1.74]	[-1.70]
CBexFed	-3.876***		-9.292***	
	[-3.17]		[-3.85]	
ECB		-1.605*		-2.927
		[-1.93]		[-1.52]
BOE		-1.866***		-4.297**
		[-3.94]		[-2.34]
BOJ		-0.895		-2.460**
		[-1.50]		[-2.15]
Start	Feb97		Nov06	
End	Oct06		Dec15	

Table 8: This table shows a summary of the central bank Prattle coefficients in forecasting regressions for twelve-month returns for the DM and EM samples, with the euro as the base country. The "Core" column summarizes the results from Tables 5 and 6. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively. T-statistics are shown in square brackets.

Panel A: DM Central Bank Coefficients, euro as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	35.544***	35.096***	-21.604**	-21.678**
	[5.25]	[5.40]	[-2.22]	[-2.26]
Fed	-0.175	-0.238	0.438	0.429
	[-0.41]	[-0.58]	[0.30]	[0.30]
CBexFed	-1.077		4.005**	
	[-0.79]		[1.99]	
ECB		1.491***		1.055
		[2.66]		[0.84]
BOE		-0.177		1.198
		[-0.54]		[0.95]
BOJ		-2.202**		1.511***
		[-2.15]		[2.96]
Start	Oct99		Nov06	
End	Oct06		Mar16	

Panel B: EM Central Bank Coefficients, euro as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	6.777**	6.631**	3.002	3.032
	[2.52]	[2.52]	[1.24]	[1.26]
Fed	0.292	0.150	2.306	2.388
	[0.27]	[0.15]	[1.30]	[1.34]
CBexFed	-1.241		4.644**	
	[-0.42]		[2.56]	
ECB		3.022**		2.237
		[2.40]		[1.55]
BOE		-0.043		1.329
		[-0.04]		[1.30]
BOJ		-3.847**		1.441*
		[-2.20]		[1.87]
Start	Oct99		Nov06	
End	Oct06		Mar16	

Table 9: This table shows a summary of the central bank Prattle coefficients in forecasting regressions for twelve-month returns for the DM and EM samples, with the pound as the base country. The “Core” column summarizes the results from Tables 5 and 6. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively. T-statistics are shown in square brackets.

Panel A: DM Central Bank Coefficients, pound as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	21.445***	21.344***	-20.189*	-18.890
	[3.50]	[3.48]	[-1.69]	[-1.59]
Fed	0.163	0.122	-3.573**	-3.258**
	[0.39]	[0.27]	[-2.51]	[-2.19]
CBexFed	-0.764		-4.731*	
	[-0.84]		[-1.83]	
ECB		-0.304		1.590
		[-0.33]		[1.18]
BOE		-0.837*		-1.526
		[-1.69]		[-0.70]
BOJ		0.013		-2.672***
		[0.04]		[-2.60]
Start	Feb97		Nov06	
End	Oct06		Mar16	

Panel B: EM Central Bank Coefficients, pound as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	4.391*	4.275*	4.827*	4.853**
	[1.77]	[1.72]	[1.92]	[1.99]
Fed	1.458*	1.526*	-1.054	-0.532
	[1.69]	[1.74]	[-0.65]	[-0.33]
CBexFed	-2.250		-1.006	
	[-1.45]		[-0.38]	
ECB		0.678		5.133***
		[0.57]		[3.61]
BOE		-1.284		0.764
		[-1.53]		[0.35]
BOJ		-1.073		-2.619**
		[-1.64]		[-2.45]
Start	Feb97		Nov06	
End	Oct06		Mar16	

Table 10: This table shows a summary of the central bank Prattle coefficients in forecasting regressions for twelve-month returns for the DM and EM samples, with the yen as the base country. The "Core" column summarizes the results from Tables 5 and 6. Standard errors are clustered by month and country. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively. T-statistics are shown in square brackets.

Panel A: DM Central Bank Coefficients, yen as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	36.554***	36.492***	-13.811*	-13.958*
	[6.34]	[6.35]	[-1.68]	[-1.67]
Fed	0.564	0.478	0.799	0.621
	[0.80]	[0.66]	[0.34]	[0.26]
CBexFed	-0.148		-1.208	
	[-0.11]		[-0.34]	
ECB		-1.402		-1.922
		[-1.37]		[-0.63]
BOE		-0.122		0.142
		[-0.17]		[0.06]
BOJ		0.509		-0.218
		[0.83]		[-0.15]
Start	Feb97		Nov06	
End	Oct06		Mar16	

Panel B: EM Central Bank Coefficients, yen as base country

Coeffs	Composite	Disaggregated	Composite	Disaggregated
carry	3.514	3.584	5.122**	5.112**
	[1.14]	[1.15]	[2.23]	[2.22]
Fed	2.884*	2.883*	1.253	1.246
	[1.91]	[1.81]	[0.53]	[0.54]
CBexFed	-3.101		-0.194	
	[-1.44]		[-0.06]	
ECB		-2.116		-0.082
		[-1.32]		[-0.03]
BOE		0.258		0.022
		[0.18]		[0.01]
BOJ		-1.214		-0.107
		[-1.30]		[-0.06]
Start	Feb97		Nov06	
End	Oct06		Mar16	

Table 11: We regress twelve-month forward returns on lagged carry for all countries, over the full, early, and late samples. The table shows the slope coefficients from these regressions. The early period goes from Jan 1996 to Oct 2006 and the late period goes from Nov 2006 to Dec 2016. Standard errors are calculated using Newey-West with auto lag selection. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively.

Carry coefficients from bivariate regressions of 12-month returns on lagged carry

Country	Early.Beta	Late.Beta
Australia	51.897***	-3.694
Canada	52.840***	-87.317***
Denmark	63.110**	-24.872
Eurozone	60.109**	-55.158
Japan	29.864**	-33.259*
New.Zealand	51.689***	-71.769
Norway	31.563	-44.275
Sweden	47.657	-35.414
Switzerland	56.041***	-27.860
UK	25.350	-64.228

Country	Early.Beta	Late.Beta
Brazil	-7.357**	14.007
Chile	48.103***	-7.374
China	2.227	-2.614
Colombia	-1.554	-0.657
Croatia	-9.276***	5.585
Czech.Rep.	-0.557	-10.029
Hong.Kong	4.638***	3.001*
Hungary	-11.069**	11.122
India	-1.250	6.909
Indonesia	29.684***	35.466***
Israel	1.950	-43.854
Kenya	5.257	4.916
Malaysia	-32.103	-5.823
Mexico	10.286***	24.714*
Morocco	7.258	-8.525
Peru	8.358	2.408
Philippines	4.068	17.401
Poland	-2.193	-36.373
Russia	3.436***	1.112
Singapore	11.026**	1.165
South.Africa	33.194**	67.919*
South.Korea	12.927	4.513
Thailand	7.902	5.128
Tunisia	23.865	-4.904
Turkey	6.894	18.189

Table 12: Panel results for twelve month returns using the DM currency set. The *cpiYOY*, *vol1m* and *vol12* series have been winsorized at the 1% level when they appear as right hand side variables. All regressions use only observations for which Prattle data are available to make the samples comparable across specifications. The *Full* column shows the same model specification that appears in Table 5. The *Dollar*, *HMLFX*, and *Resid* columns show the factor loadings of the return decomposition.

Twelve Month Returns for DM

Early period

	Full	Dollar	HMLFX	Resid
ret1m	-0.020	-0.038	-0.005	0.022
ret12m	-0.054	0.009	-0.055**	-0.007
vol1m	1.076	-0.714	-0.836***	2.627**
vol12m	1.645	1.386	-0.790**	1.050
VIX	0.075	0.075	-0.044	0.044
logRSpotPos	0.025	0.044	-0.034	0.015
logRSpotNeg	-0.202***	0.011	0.005	-0.218***
nfa	0.196***	0.151***	0.018	0.027
res-GDP	-0.707***	-0.070	-0.002	-0.634***
cpiYOY	1.510***	0.825**	0.229*	0.456
gdprYOY	0.418	0.137	-0.046	0.327
exFedCpiYOY	4.582**	1.293	0.586	2.703*
cpiYOYUS	-3.982***	-3.477***	-0.159	-0.346
exFedGdprYOY	1.632*	2.212***	-0.018	-0.562
gdprYOYUS	-2.151***	-2.678***	0.260*	0.267
carry	16.268***	8.912***	-1.180	8.536**
exFedRate	-1.827	3.458**	-1.106	-4.179***
T-bill	0.033	-1.123*	-0.196	1.352**
treas-basis	18.694***	12.862***	-0.667	6.499***
Fed	0.214	0.113	0.025	0.076
CBexFed	-2.097	-2.411	-0.169	0.483
R2	0.652	0.696	0.143	0.259
Start	Feb 1997	Feb 1997	Feb 1997	Feb 1997
End	Oct 2006	Oct 2006	Oct 2006	Oct 2006
Observations	1039	1039	1039	1039
StdError	both	both	both	both

Late period

	Full	Dollar	HMLFX	Resid
ret1m	-0.283***	-0.275**	0.014	-0.021
ret12m	0.177**	0.112	-0.041***	0.105
vol1m	3.151	1.668	1.214**	0.270
vol12m	3.758**	3.425***	0.216	0.117
VIX	0.222**	0.320***	-0.071***	-0.027
logRSpotPos	-0.298***	-0.130*	0.033	-0.201**
logRSpotNeg	-0.245***	0.038	-0.012	-0.271***
nfa	-0.093	-0.053	-0.001	-0.039
res-GDP	-0.079	-0.077***	0.005	-0.007
cpiYOY	0.656	0.577**	0.311**	-0.232
gdprYOY	0.136	-0.112	0.161**	0.087
exFedCpiYOY	3.763*	1.089	-0.774**	3.448***
cpiYOYUS	-2.420**	-1.868*	0.611**	-1.164**
exFedGdprYOY	0.295	0.456	-0.311**	0.150
gdprYOYUS	1.000	0.660	0.414*	-0.073
carry	-11.178	0.686	-6.420**	-5.444
exFedRate	-9.281***	-11.851***	1.098**	1.472
T-bill	9.107***	10.381***	-0.934**	-0.340
treas-basis	-5.825**	-10.878***	0.900***	4.153***
Fed	-5.131**	-4.083*	0.152	-1.200**
CBexFed	-12.910***	-11.791***	0.440	-1.559
R2	0.542	0.671	0.202	0.161
Start	Nov 2006	Nov 2006	Nov 2006	Nov 2006
End	Dec 2015	Dec 2015	Dec 2015	Dec 2015
Observations	1100	1100	1100	1100
StdError	both	both	both	group

Table 13: Panel results for twelve month returns using the EM currency set. The *cpiYOY*, *vol1m* and *vol12* series have been winsorized at the 1% level when they appear as right hand side variables. All regressions use only observations for which Prattle data are available to make the samples comparable across specifications. The *Full* column shows the same model specification that appears in Table 6. The *Dollar*, *HMLFX*, and *Resid* columns show the factor loadings of the return decomposition.

Twelve Month Returns for EM

Early period

	Full	Dollar	HMLFX	Resid
ret1m	-0.192	-0.083	0.004	-0.136
ret12m	-0.016	0.025	-0.022**	-0.030
vol1m	6.704***	0.879	1.052**	4.866***
vol12m	3.959***	0.919**	-0.292**	3.280***
VIX	-0.056	0.022	0.003	-0.090*
logRSpotPos	-0.128**	-0.004	0.007	-0.129**
logRSpotNeg	0.056	0.016	0.006	0.029
nfa	-0.043	-0.013	0.001	-0.032
res-GDP	0.037	0.066	0.016	-0.052
cpiYOY	0.657***	0.059	0.076*	0.561***
gdprYOY	0.442**	0.111	0.001	0.322**
exFedCpiYOY	-0.471	0.418	-0.648	-0.256
cpiYOYUS	-0.168	-1.728***	0.153	1.420**
exFedGdprYOY	1.119	1.522***	-0.004	-0.394
gdprYOYUS	-1.223*	-2.189***	-0.049	1.036*
carry	2.834	-0.043	0.612	2.307
exFedRate	-0.349	2.712***	-0.021	-3.082*
T-bill	-0.667	-1.155***	-0.002	0.453
treas-basis	13.797***	9.505***	0.298	4.080*
Fed	1.060	0.085	0.017	1.045***
CBexFed	-3.876***	-1.732	0.020	-2.120***
R2	0.331	0.556	0.0376	0.228
Start	Feb 1997	Feb 1997	Feb 1997	Feb 1997
End	Oct 2006	Oct 2006	Oct 2006	Oct 2006
Observations	2101	2122	2122	2101
StdError	both	both	group	both

Late period

	Full	Dollar	HMLFX	Resid
ret1m	-0.229**	-0.168**	-0.002	-0.059*
ret12m	0.032	0.071*	-0.002	-0.037
vol1m	1.045	0.882	0.288	-0.125
vol12m	2.560***	1.688***	0.477*	0.394
VIX	0.294***	0.275***	-0.003	0.022
logRSpotPos	0.003	-0.005	-0.012	0.019
logRSpotNeg	-0.168***	0.082*	0.009	-0.258***
nfa	-0.013	-0.026	0.017**	-0.004
res-GDP	0.146*	0.033	-0.009	0.122*
cpiYOY	0.454*	0.055	0.136**	0.265
gdprYOY	0.409**	0.252***	-0.017	0.176
exFedCpiYOY	1.591	0.311	0.109	1.176**
cpiYOYUS	-1.245	-1.174*	-0.055	-0.021
exFedGdprYOY	-0.051	0.137	0.133	-0.321
gdprYOYUS	-0.278	0.121	-0.178	-0.222
carry	2.354	-1.146	-0.750	4.285**
exFedRate	-9.667***	-8.009***	-0.366	-1.286
T-bill	8.936***	6.512***	0.195	2.231**
treas-basis	-5.738**	-8.458***	0.272	2.463**
Fed	-3.065*	-2.773*	-0.005	-0.294***
CBexFed	-9.292***	-8.645***	-0.001	-0.606
R2	0.437	0.57	0.0455	0.116
Start	Nov 2006	Nov 2006	Nov 2006	Nov 2006
End	Dec 2015	Dec 2015	Dec 2015	Dec 2015
Observations	2669	2672	2672	2669
StdError	both	both	group	both