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## Central bank transparency and the volatility of exchange rates

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## Central Bank Transparency and the Volatility of Exchange Rates

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# Central Bank Transparency and the Volatility of Exchange Rates\*

## Abstract

We analyze the effect of monetary policy transparency on bilateral exchange rate volatility. We test the theoretical predictions of a stylized model using panel data for 62 currencies from 1998 to 2010. We find strong empirical evidence that an increase in the availability of information about monetary policy objectives decreases exchange rate volatility. Using interaction models, we find that this effect is more pronounced for countries with a lower flexibility of goods prices, a lower level of central bank conservatism, and a higher interest rate sensitivity of money demand.

*Keywords: central bank transparency, exchange rate volatility, panel model*

*JEL Classification: E58, F31*

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# 1. Introduction

Volatile exchange rate rates hurt the economy for several reasons. By increasing uncertainty about future consumption and firm revenues, volatile exchange rates reduce welfare (Obstfeld and Rogoff, 1998; Devereux, 2004). Empirical results reveal that higher exchange rate volatility increases the risk of domestic investment (see, e.g., Darby et al., 1999; Servén, 2003; Byrne and Davis, 2005) as well as foreign direct investment (see, e.g., Campa, 1993; Urata and Kawai, 2000), particularly in developing economies. Several studies also find a negative effect of higher exchange rate volatility on exports since more volatile exchange rates make export revenues uncertain (Arize et al., 2008; Byrne et al., 2008). Exchange rate volatility increases the home-bias in portfolio investment (Fidora et al., 2007; Mishra 2011), and thus, presents an obstacle to consumption risk sharing. Exchange rate volatility reduces economic growth, particularly for less developed economies, by exacerbating the adverse effect of credit constraints on domestic investment (Bagella et al., 2006; De Grauwe and Schnabl 2008; Aghion et al., 2009).

Given these negative consequences, a huge literature deals with the determinants of exchange rate volatility. We contribute to the literature by analyzing the impact of central bank transparency on exchange rate volatility. We combine the exchange rate overshooting model of Dornbusch (1976) and Frankel (1979) with a stylized monetary policy model in the spirit of Kydland and Prescott (1977) and Barro and Gordon (1983) to establish the channel how higher levels of central bank transparency can reduce exchange rate volatility. By reducing the public's uncertainty about the central bank's policy objectives (i.e. by increasing central bank transparency), the central bank can reduce the volatility of inflation expectations. Less volatile inflation expectations help agents to estimate the appropriate long run equilibrium value of the exchange rate as suggested by purchasing power parity and to assess the degree of over- or undervaluation of the exchange rate in the short run. In addition to this unconditional effect, we show that the size of the impact of central bank transparency on

exchange rate volatility depends on the price flexibility in the goods market, central bank preferences for price stability and the interest rate sensitivity of money demand.

We test the implications of the model using a panel data approach that exploits disaggregated information of the central bank transparency index of Dincer and Eichengreen (2014), where we distinguish between direct communication (i.e. transparency about the central bank's policy targets) and indirect communication (i.e. transparency about the central bank's economic models and forecasts).<sup>1</sup> We use a panel of bilateral exchange rates for 62 currencies over the period 1998-2010.<sup>2</sup> In line with our main hypothesis, we find that an increase in monetary policy transparency reduces the volatility of historical as well as conditional GARCH-based exchange rate volatility measures. We find for the direct and indirect communication measures that the standardized marginal effects amount for 3.44 percent and 8.46 percent of the standardized average change in exchange rate volatility over the sample period, respectively. The larger effect of indirect communication implies that more detailed information about the central bank's economic models and forecasts provides more valuable and credible information to market participants and is better able to reduce exchange rate volatility than mere numerical information about policy goals, which are only a rough guide for the public. These results survive a large battery of robustness tests.

Consistent with the theoretical model, we additionally provide evidence that the stabilizing effect of central bank transparency on bilateral exchange rates works through the anchoring of inflation rate expectations.

Employing multiplicative interaction models, we further show that – in line with the theoretical model – the effect of monetary policy transparency on exchange rate volatility is more pronounced for countries with a lower flexibility of prices in the goods market, with less

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<sup>1</sup> The general term central bank transparency that used in this paper refers to the transparency about monetary policy objectives. This transparency can be achieved via direct communication or indirect communication about monetary policy targets. Hence, we use the terms direct and indirect communication and central bank transparency interchangeably in this paper.

<sup>2</sup> Table A4 in the appendix records all 62 currencies that are included in the baseline estimation.

conservative central banks and a higher interest rate sensitivity of money demand. First, less flexible goods prices are associated with a larger degree of exchange rate overshooting. Therefore, lower uncertainty about the short run over- and undervaluation of the exchange rate to its PPP implied long run equilibrium value, will lead to a stronger stabilizing effect on the exchange rate than in countries where the degree of exchange rate overshooting is less of an issue. By communicating about its monetary policy objectives, the central bank can reduce the uncertainty about inflation expectations and thereby reduce the uncertainty about the degree of exchange rate overshooting. Second, a more conservative central bank responds more strongly to inflation than to output gap deviations, and thus produces lower uncertainty of inflation expectations. Hence, the stabilizing effect of direct and indirect communication about monetary policy objectives on inflation rate expectations is more amplified for less conservative central banks, where communication about monetary policy objectives alleviates this trade off and leads to a more pronounced stabilizing effect on exchange rate volatility by reducing inflation expectation uncertainty. Third, in countries with a higher interest rate sensitivity of money demand, the exchange rate volatility is more sensitive to changes in interest differentials and, in turn, to central bank transparency.

To the best of our knowledge, we are the first to analyze the impact of central bank transparency on exchange rate volatility and its conditionality on structural country characteristics in a theoretical and empirical context. We contribute to two strands of the literature. First, we add to a broad literature on the determinants of exchange rate volatility.

Several studies focus on the role of monetary policy for exchange rate volatility. Rose (2007) finds that the introduction of inflation targeting reduces exchange rate volatility. Distinguishing between flexible and strict inflation targeting central banks in emerging markets, Berganza and Broto (2012) find that flexible inflation targeting can indeed reduce exchange rate volatility as compared to non-inflation targeting economies. Cady and Gonzales-Garcia (2007) find that the adoption of the IMF's International Reserves and

Foreign Currency Data Template is associated with a decrease in exchange rate volatility. Clare and Courtenay (2001) and Conrad and Lamla (2010) use an event study framework and find that monetary policy shocks significantly affect exchange rate volatility. Bleaney and Francisco (2010) find that real exchange rate volatility of countries with a floating exchange rate is at least 45% than of countries with a peg. Klein and Shambaugh (2008) find that fixed exchange rate regimes reduce nominal exchange rate volatility not only on the bilateral level, but also on the multilateral level.

Several economic and financial factors have been found to determine exchange rate volatility. Bayoumi and Eichengreen (1998) argue that countries that do not form an optimum currency area will have volatile bilateral exchange rates and consequently find that asymmetric economic shocks, low levels of bilateral trade, and large country size are associated with higher bilateral exchange rate volatility. Ganguly and Breuer (2010) confirm that nominal shocks affect exchange rate volatility. Devereux and Lane (2003) find that developing countries with high levels of external debt have low exchange rate volatility. They argue that developing countries are financially constrained and must issue external debt in foreign currency. In order to avoid fluctuations in the value of foreign debt, highly indebted developing countries need to reduce exchange rate volatility by using foreign exchange market intervention. Industrialized countries, on the contrary, can issue domestic currency denominated external debt and exchange rate volatility is therefore independent of foreign debt.

Hausmann et al. (2006) find that the real exchange rate volatility of developing countries is 2.5 times higher than for developed countries. More developed economies adjust quicker to economic shocks and therefore exhibit less persistent exchange rate volatility.

Other studies address the flexibility of goods prices (Hau, 2002; Bravo-Ortega and Di Giovanni, 2006). Hau (2002) finds that in more open economies prices of tradable goods adjust more quickly than the prices of non-tradable goods, which reduces the impact of real or



monetary shocks on the real exchange rate. Bravo-Ortega and Di Giovanni (2006) show that higher trade costs lead to a larger non-tradable goods sector which, in turn, leads to less flexible prices in the aggregate goods market, and thus, more volatile exchange rates.

A second strand of the literature investigates the effects of central bank transparency. Several papers find that better central bank communication helps financial markets to anticipate monetary policy actions (Lange et al., 2003; Nautz and Schmidt, 2009; Swanson, 2006). Other papers find that communication events of central banks indeed convey useful information for financial market participants (see, e.g., Ehrmann and Fratzscher, 2009; Ranaldo and Rossi, 2010; Hansen and McMahon, 2016; or Dräger et al., 2016). Some studies directly analyze the impact of central bank transparency on forecasts. Ehrmann et al. (2012) reveal that central bank transparency reduces the forecast dispersion among professional forecasters, confirming previous findings of Crowe and Meade (2008) and Crowe (2010). Hubert (2015) finds that the release of the central bank's inflation forecasts influences private inflation forecasts, whereas central bank forecasts are not affected by private forecasts.

Van der Cruysen and Demertzis (2007) find that the link between current inflation and inflation expectations is less pronounced for countries with higher levels of transparency, which points to an enhanced inflation anchoring due to central bank transparency. Other studies focus more explicitly on the role of central bank transparency in reducing the level of inflation and its volatility as well as its effect on output volatility (see, e.g., Demertzis and Hallett (2007) or Dincer and Eichengreen (2014)). Analyzing cross-border bank claims, Eichler et al. (2017) provide evidence that improvements in central bank transparency attract foreign cross-border bank claims if the corresponding central bank is sufficiently shielded from political influence.

To the best of our knowledge, there is no study that analyzes the effect of central bank transparency on bilateral exchange rate volatility.

While the role of expectations management in money markets as well as the impact on forecasts have been extensively examined in the literature, we reveal new theoretical and empirical results about the effect of central bank transparency on exchange rate volatility, which has not been investigated so far.

The rest of the paper is organized as follows: In section 2, we present a simple theoretical model that is used to derive testable hypotheses. In section 3, we introduce the empirical model, and describe the data. In section 4, we present the results of the baseline model, additional robustness tests, and interaction models. Section 5 concludes.

## 2. Theoretical Reasoning

### 2.1 Exchange Rate Volatility

As the benchmark model of exchange rate volatility we use the exchange rate overshooting model of Dornbusch (1976) and Frankel (1979). Assuming sticky goods prices in the short term, and fully flexible goods prices in the long term, this model allows for short term deviations from purchasing power parity (PPP) but assumes that exchange rates converge to their PPP level in the long run. That is, sticky prices lead to overshooting real and nominal exchange rates beyond their equilibrium PPP implied levels in the short run as jump variables in the model, interest rates and exchange rates, compensate for the stickiness in goods prices.

All variables are used in logs. Asterisks denote foreign variables. All parameters are positive. In the long run, prices are fully flexible and the long run equilibrium value of the nominal exchange rate is given by PPP,  $\bar{s} = \bar{p} - \bar{p}^*$ , where the equilibrium value of the log exchange rate,  $\bar{s}$  (direct quote), is governed by the relative price levels in the domestic economy,  $\bar{p}$ , and foreign economy,  $\bar{p}^*$ . Money demand is given by  $m = p + \phi y - \lambda i$ , where  $m$ ,  $y$ , and  $i$  are the logs of domestic money demand, output, and one plus the interest rate on risk-less assets. An analogous money demand equation holds for the foreign economy.

Equilibrated domestic and foreign money markets imply:

$$p - p^* = m - m^* - \phi(y - y^*) + \lambda(i - i^*). \quad (1)$$

In the long run equilibrium, PPP holds and the exchange rate equals:

$$\bar{s} = m - m^* - \phi(y - y^*) + \lambda(i - i^*). \quad (2)$$

In the short run, however, goods prices are sticky, which leads to the fact that – driven by interest rate fluctuations – exchange rates typically overshoot beyond their PPP implied equilibrium level. Assume that capital controls and transaction costs are absent and thus the uncovered interest parity (UIP) holds,  $s^e - s = i - i^*$ , where the expected rate of depreciation,  $s^e - s$  equals the interest rate spread.

UIP suggests that a higher domestic interest rate would cause the domestic currency to appreciate. This short run result seemingly contradicts the PPP hypothesis that the domestic currency depreciates in the long run when the domestic interest rate is increased.

To resolve for this seeming contradiction, Dornbusch (1976) and Frankel (1979) assume that the exchange rate can overshoot beyond its PPP equilibrium level in the short run since prices are sticky and converges only gradually to its long run equilibrium level as implied by PPP:

$$s^e - s = -\theta(s - \bar{s}) + \pi^e - \pi^{e*}. \quad (3)$$

The expected depreciation,  $s^e - s$ , is the higher, the less undervalued the current exchange rate relative to its equilibrium level,  $s - \bar{s}$ . The parameter  $\theta$  measures the speed of exchange rate adjustment to the equilibrium level, which is determined by the flexibility of goods

prices. When the exchange rate reaches its equilibrium level,  $s = \bar{s}$ , PPP suggests that the expected rate of depreciation is determined by the difference between expected inflation rates for the domestic and the foreign economy,  $\pi^e - \pi^{e*}$ . According to UIP this implies that interest rate differential equals the inflation differential and the equilibrium exchange rate (see Eq. (2)) can be written as:

$$\bar{s} = m - m^* - \phi(y - y^*) + \lambda(\pi^e - \pi^{e*}). \quad (2')$$

Using Eq. (2') and UIP in Eq. (3) we can derive the value of the current exchange rate:

$$s = m - m^* - \phi(y - y^*) - 1/\theta(i - i^*) + (1/\theta + \lambda)(\pi^e - \pi^{e*}), \quad (4)$$

where the equilibrium exchange rate,  $s$ , depends on relative money supply,  $m - m^*$ , relative output,  $y - y^*$ , relative interest rates,  $i - i^*$ , and relative inflation expectations,  $\pi^e - \pi^{e*}$ . The parameters  $\phi$ ,  $\theta$ , and  $\lambda$  denote the sensitivity of money demand to output, speed of price adjustment in the goods market and the interest rate sensitivity of money demand, respectively.

In this model, interest rate fluctuations lead to overshooting exchange rates in the short run, where the degree of overshooting is the larger, the stickier the goods prices, i.e. the smaller the adjustment parameter  $\theta$ . In the long run, prices fully adjust, i.e.  $\theta$  becomes infinitely large, and the exchange rate adjusts to its PPP implied long run value. Higher expected inflation rates in the domestic relative to the foreign economy lead to a depreciation of the domestic currency against the foreign currency, where the effect is more pronounced in the short run than in the long run.

Based on Eq. (4), the variance of the exchange rate is given by:

$$\sigma_s^2 = \sigma_m^2 + \sigma_{m^*}^2 + \phi^2 \sigma_y^2 + \phi^2 \sigma_{y^*}^2 + 1/\theta^2 \sigma_i^2 + 1/\theta^2 \sigma_{i^*}^2 + (1/\theta + \lambda)^2 \sigma_{\pi^e}^2 + (1/\theta + \lambda)^2 \sigma_{\pi^{e*}}^2 + \sum \text{COV} \quad (5)$$

Given the volatilities of money supply, output, and interest rates in the domestic and foreign economy, a higher volatility of inflation expectations increases exchange rate volatility.<sup>3</sup> This aspect can be easily demonstrated by rearranging Eq. (4):

$$s = m - m^* - \phi(y - y^*) - 1/\theta[(i - \pi^e) - (i^* - \pi^{e*})] + \lambda(\pi^e - \pi^{e*}) \quad (4')$$

Firstly, a higher volatility of domestic and foreign inflation expectations make the long run equilibrium PPP value of the exchange rate more uncertain, thereby increasing exchange rate volatility today. This long-run effect increases the volatility of the  $\pi^e - \pi^{e*}$  term in Eq. (4'). Secondly, a higher volatility of domestic and foreign inflation expectations makes it more difficult for market participants to estimate the possible under- or overvaluation, i.e. the overshooting of the exchange rate relative to its long run PPP equilibrium value. This short-run effect increases the volatility of the  $[(i - \pi^e) - (i^* - \pi^{e*})]$  term in Eq. (4').

In the next section, we show that a higher degree of central bank transparency reduces the volatility of inflation expectations and, in turn, reduces exchange rate volatility.

## 2.2 Inflation Volatility

In order to show that a higher degree of central bank transparency can reduce the volatility of inflation expectations, we use a stylized monetary policy model in the spirit of Kydland and Prescott (1977) and Barro and Gordon (1983). Suppose the central bank maximizes the objective function:

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<sup>3</sup> For simplicity, we do not present the covariance terms.

$$W = -\frac{1}{2}\alpha(\pi - \tau)^2 - \frac{1}{2}(1 - \alpha)(y - \kappa)^2, \quad (6)$$

where  $\pi$  denotes inflation,  $y$  denotes the output gap,  $\tau$  and  $\kappa$  are the central bank's inflation and output gap targets, and  $0 < \alpha < 1$  the relative weight of inflation in the objective function. The output gap is determined by a simple Phillips equation,  $y^s = \pi - \pi^e + \varepsilon_s$ , where  $\varepsilon_s$  is an output shock. Aggregate demand,  $y^d = -\delta(i - \pi^e) + \varepsilon_d$ , is determined by the real interest rate,  $i - \pi^e$ , and a demand shock  $\varepsilon_d$ . Output and demand shocks are stochastic with zero mean and constant variance, i.e.  $\sigma_{\varepsilon_s}^2$  and  $\sigma_{\varepsilon_d}^2$ . What is more, we assume that the central bank's inflation and output targets are not known to the public, i.e. they are stochastic variables with constant mean and constant variance, i.e.  $\sigma_\tau^2$  and  $\sigma_\kappa^2$ . We assume that the stochastic variables are not correlated with each other.

The model is solved as follows. In the first stage, the private sector forms rational expectations about inflation,  $\pi^e = E(\pi)$ , on which basis nominal wages are contracted. After inflation expectations are formed and wages are negotiated, the central bank anticipates the realization of output and demand shocks,  $\varepsilon_s^a$  and  $\varepsilon_d^a$ , and sets the interest rate so that the objective function (Eq. (6)) is maximized. Using aggregate supply and demand functions in Eq. (6), and maximizing the central bank's objective function with respect to the policy interest rate,  $i$ , yields optimal interest rate given the private sector's inflation expectations,  $\pi^e$ , and the output and demand shocks anticipated by the central bank,  $\varepsilon_s^a$  and  $\varepsilon_d^a$ :

$$i = 1/\delta[(\alpha + \delta)\pi^e - \alpha\tau - (1 - \alpha)\kappa - \alpha\varepsilon_s^a + \varepsilon_d^a]. \quad (7)$$

Using the optimal interest rate in the aggregate supply and demand functions, we can infer the equilibrium inflation rate:

$$\pi = (1 - \alpha)\pi^e + \alpha\tau + (1 - \alpha)(\kappa - \varepsilon_s) - \alpha\varepsilon_s^u + \varepsilon_d^u, \quad (8)$$

where the amount of output and demand shocks, not correctly anticipated by the central bank are denoted as  $\varepsilon_s^u = \varepsilon_s - \varepsilon_s^a$  and  $\varepsilon_d^u = \varepsilon_d - \varepsilon_d^a$ .

Private agents know the shape of the central bank's interest reaction function (Eq. (7)) but they are uncertain about the central bank's inflation and output gap target,  $\tau$  and  $\kappa$ . Based on Eq. (8) we can infer the variance of inflation expectations of the private sector:

$$\sigma_{\pi^e}^2 = \sigma_\tau^2 + \left(\frac{1 - \alpha}{\alpha}\right)^2 \sigma_\kappa^2 + \left(\frac{1 - \alpha}{\alpha}\right)^2 \sigma_{\varepsilon_s}^2 + \sigma_{\varepsilon_s^u}^2 + \left(\frac{1}{\alpha}\right)^2 \sigma_{\varepsilon_d^u}^2. \quad (9)$$

A higher level of central bank transparency, i.e. less uncertainty of the private sector about the central bank's inflation and output target,  $\sigma_\tau^2$  and  $\sigma_\kappa^2$ , leads to a lower volatility in inflation expectations,  $\sigma_{\pi^e}^2$ .

### 2.3 Central Bank Transparency and Exchange Rate Volatility

Using the volatility of inflation expectations (Eq. (9)) for the domestic and the foreign economy in the exchange rate volatility equation (Eq. (5)), we can analyze the impact of central bank transparency on exchange rate volatility:

$$\begin{aligned}
\sigma_s^2 = & \sigma_m^2 + \sigma_{m^*}^2 + \phi^2 \sigma_y^2 + \phi^2 \sigma_{y^*}^2 + 1/\theta^2 \sigma_i^2 + 1/\theta^2 \sigma_{i^*}^2 + \\
& (1/\theta + \lambda)^2 \left[ \sigma_\tau^2 + \left( \frac{1-\alpha}{\alpha} \right)^2 \sigma_\kappa^2 + \left( \frac{1-\alpha}{\alpha} \right)^2 \sigma_{\varepsilon_s}^2 + \sigma_{\varepsilon_s^u}^2 + \left( \frac{1}{\alpha} \right)^2 \sigma_{\varepsilon_d^u}^2 \right] + \\
& (1/\theta + \lambda)^2 \left[ \sigma_{\tau^*}^2 + \left( \frac{1-\alpha}{\alpha} \right)^2 \sigma_{\kappa^*}^2 + \left( \frac{1-\alpha}{\alpha} \right)^2 \sigma_{\varepsilon_s^*}^2 + \sigma_{\varepsilon_s^{u*}}^2 + \left( \frac{1}{\alpha} \right)^2 \sigma_{\varepsilon_d^{u*}}^2 \right] + \sum COV
\end{aligned} \tag{10}$$

The first line shows that exchange rate volatility increases in the volatility of money supply, output, and interest rates in the domestic and foreign economy. A higher variability of output shocks ( $\sigma_{\varepsilon_s}^2$  and  $\sigma_{\varepsilon_s^*}^2$ ), unanticipated output shocks ( $\sigma_{\varepsilon_s^u}^2$  and  $\sigma_{\varepsilon_s^{u*}}^2$ ), and unanticipated demand shocks ( $\sigma_{\varepsilon_d^u}^2$  and  $\sigma_{\varepsilon_d^{u*}}^2$ ) increases exchange rate volatility as well by making inflation expectations more volatile.<sup>4</sup> The second and the third line reveal the key feature that more transparency of the domestic and the foreign central bank, i.e. a lower uncertainty of the public about the inflation target ( $\sigma_\tau^2$  and  $\sigma_{\tau^*}^2$ ) and the output target ( $\sigma_\kappa^2$  and  $\sigma_{\kappa^*}^2$ ) of the central banks, reduces exchange rate volatility by lowering the variability of inflation expectations.

Thus, by reducing the private sector's uncertainty about its policy objectives, the central bank can reduce the volatility of inflation expectations and, in turn, the exchange rate. Increasing central bank transparency may therefore reduce exchange rate volatility. The central bank can increase monetary policy transparency in several ways. First, using the direct communication channel, the central bank directly communicates its policy objectives thereby revealing the levels of  $\tau$  and  $\kappa$  to the public. Second, indirect central bank communication involves more comprehensive publication the central bank's data and models, which the public may use to infer the central bank's objectives. The central bank may publish inflation and output gap forecasts, which would enable the public to infer the output and demand shocks anticipated by the central bank and therefore infer the central banks policy objectives over time using the

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<sup>4</sup> Note that the private sector forms inflation expectations before the central bank sets the optimal interest rate before unanticipated shocks occur.



interest rate reaction function. What is more, the central bank may choose to publish the amount of unanticipated output and demand shocks,  $\varepsilon_s^u = \varepsilon_s - \varepsilon_s^a$  and  $\varepsilon_d^u = \varepsilon_d - \varepsilon_d^a$ , in economic reports, which would enable the public to infer the inflation and output gap targets after the shocks have been realized. To conclude, direct and indirect central bank communication can be improved to reduce exchange rate volatility. The central bank can either directly publishing the policy targets, publishing inflation and output targets, or publishing data on forecasting errors on output and demand shocks.

The model also predicts that the uncertainty effect of the central bank's policy targets depends critically on the price flexibility in the goods market,  $\theta$ , the actual conservativeness of the central bank,  $\alpha$ , and the interest rate sensitivity of money demand,  $\lambda$  (see Eq. (10)).

As sticky prices in the goods market lead to a higher degree of overshooting of the exchange rate in the short run beyond its long run PPP implied value, the uncertainty about the degree of overshooting becomes more detrimental to exchange rate stability. Thus, for countries with less flexible goods prices an increase in monetary policy transparency is more beneficial than for countries with flexible goods markets where the uncertainty of overshooting is less of an issue.

Given that less conservative central banks respond less to deviations from the inflation target than the output gap target, the additional uncertainty related to the second monetary policy objective and the trade-off between both targets becomes more pronounced. Hence, reducing the uncertainty about this target by improving monetary policy transparency has additional beneficial effects on exchange rate stability.

Finally, as a larger interest rate sensitivity of money demand implies a stronger reaction of the equilibrium exchange rate to changes in the interest rate differential in the long run, uncertainty about this interest rate differential and the accompanied uncertainty about inflation expectation differentials become more harmful for the stability of the exchange rate.

For interest rate sensitivity regimes, improvements in monetary policy transparency should be more effective for stabilizing the exchange rate.

### **3. Empirical Analysis**

#### **3.1 Data**

We use annual panel data for 62 currencies over the period from 1998 to 2010.<sup>5</sup> Table A1 describes the construction of our direct and indirect communication measure. Table A2 describes the definitions and sources of the remaining variables. Table A3 reports the summary statistics.

The dependent variable in our empirical model is the volatility of bilateral exchange rate returns. We use two volatility measures. First, we use the yearly standard deviation of weekly log returns of bilateral exchange rates. Such a historical volatility measure has been widely applied in the literature (see, e.g., Devereux and Lane, 2003; Berganza and Broto, 2012). As an alternative measure, we use the conditional exchange rate volatility derived from a GARCH(1, 1)-model that is based on daily bilateral exchange rate returns (see, e.g., Servén, 2003; Baum et al., 2004; Edwards and Rigobon, 2009).

In order to test the theoretical predictions as directly as possible, we exploit the disaggregated information of the Dincer and Eichengreen (2014) central bank transparency index to construct a direct communication and an indirect communication measure in accordance with the model of the previous section.

Direct communication captures to what extent a central bank discloses information concerning its monetary policy objective(s). That is whether the central bank discloses a formal statement about the monetary policy objectives and whether the primary objective contains a numeric target value.

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<sup>5</sup> Our sample is restricted by the transparency index of Dincer and Eichengreen (2014), which is only available from 1998 to 2010. Countries with strictly fixed exchange rates are excluded from the analysis.

To measure indirect central bank communication, we use the economic dimension and question number two of the operational dimension. We use the economic dimension since agents are better able to infer the true monetary objectives indirectly by using information about the current state of the economy, forecasts of inflation and output gap, and the central bank's macroeconomic model.

The operational dimension refers to the disclosure of information of the ex-post assessment of monetary policy by the central bank. Shocks that had an impact on the transmission mechanism of monetary policy and were unanticipated by the central bank, are informative for the public for learning the central bank's true monetary policy objectives. We therefore account for the publication of unanticipated shocks and include the score of the second question of the operational dimension in the indirect communication measure. Figure 1 and 2 depict the evolution of these two measures of central bank communication over time.

[Figure 1 and 2 here]

Apart from these variables that capture central bank transparency, we include a large number of control variables that empirical literature has found to impact the volatility of the exchange rate. First, the economic size of both countries represented in a currency pair might matter for bilateral exchange rate volatility as larger countries are generally found to have more volatile exchange rates (see, e.g., Bayoumi and Eichengreen, 1998). Size is measured as the log product of the GDPs of the respective countries. Furthermore, we control for log bilateral trade (see, e.g., Devereux and Lane, 2003). Similar to Canales-Kriljenko and Habermeier (2004) and Ganguly and Breuer (2010), we use the average of government debt to GDP ratio to control for confidence factors that might affect market sentiment. Given the evidence that high levels of foreign exchange reserves can reduce the likelihood of a currency crisis or sudden stop (see, e.g., Calvo and Reinhart, 2000; IMF, 1998), we also include the ratio of

reserves to GDP and expect this variable to reduce exchange rate volatility (Ganguly and Breuer, 2010; Hviding et al., 2004). Moreover, following the definition of Frankel and Rose (1996), we account for currency crises using a time dummy (see, e.g., Hausmann et al., 2006; Ganguly and Breuer, 2010).

Furthermore, we control for the de facto exchange rate regime, and use the average coarse de facto classification of both countries taken from Reinhart and Rogoff (2004). Fixed rate regimes are excluded from our analysis.<sup>6</sup>

In accordance to our theoretical model, we further include volatility measures for the inflation rate, the interest rate change, money supply (M1) growth and industrial production growth. These historical volatility measures are based on monthly year-on-year growth rates or changes in the case of interest rates.

In line with the optimal currency area theory (see, e.g., Hausmann et al., 2006; Ganguly and Breuer, 2010), we add various shock variables.<sup>7</sup> To capture asymmetric production shocks, we use the absolute difference in the growth rate of real GDP of the respective countries. We also include asymmetric shock variables for the terms-of-trade, measured as the absolute difference in the net barter terms of trade growth rate (see, e.g., Broda, 2004; Ganguly and Breuer, 2010). We also include asymmetric shocks to the banking system that might lead to price and exchange rate adjustments. This shock is measured by the absolute difference in the change of deposit money banks' assets to GDP.

In our robustness section, we include further variables that measure changes in other central bank characteristics. For this purpose, we include a variable that equals 1 if both countries have implemented an inflation targeting regime, 0.5 if only one country has an inflation targeting regime and zero otherwise. We also distinguish between full-fledged and soft inflation targeting regimes (see, e.g., Minea and Tapsoba, 2014). Furthermore, we include the

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<sup>6</sup> As a robustness test, we also include dummy variables for the fine classification for each country. Results are robust to this procedure and are available upon request.

<sup>7</sup> The general intuition of including these asymmetric variables is to capture exchange rate adjustment pressures that are induced by asymmetric economic developments.

average value of the Cukierman et al. (1992) index measuring the legal independence of the respective central banks.

To capture other financial market characteristic variables, we include the average bank capital to asset ratio, the average size of the banking system which is measured as the average deposit money banks' assets to GDP of both countries. We also include a variable called financial integration. This variable consist of the external assets and liabilities per GDP of both countries. We also include the average z-score for both countries measuring further financial market risks which can further increase exchange rate volatility.

We include additional structural variables like, for example, the average current account balance per GDP of the respective countries (see, e.g., Berganza and Broto, 2012), the average value of the Fernández et. al. (2015) overall capital inflow controls for the respective countries (see, e.g., Edwards and Rigobon, 2009) and the average per capita GDP to proxy economic development (see, e.g., Hausmann et al., 2006) .

Since other within changes in institutional quality might have an impact on the exchange rate volatility, we further include the average value of the Polity IV scores and all variables of the economic freedom database of the Frasier Institute.

To test whether additional asymmetric shock variables have an impact on the effect of central bank communication on exchange rate volatility, we include an asymmetric shock of the inflation rate, the growth rate of the current account, the growth rate of reserves, shock to total exports per GDP similar to Ganguly and Breuer (2010). We also include the absolute difference in lending rates as a further variable to control for changes in lending environment which can impact cross-border debt flows.

### 3.2 Methodology

In order to test the predictions of the theoretical model (see Eq. (10)) empirically, we use a bilateral fixed effects panel data approach as outlined in Eq. (11):

$$VS_{i,j,t} = \alpha_{i,j} + \tau_t + \beta_1 \cdot CBT_{i,j,t} + \Gamma X_{i,j,t} + \varepsilon_{i,j,t}, \quad (11)$$

where  $VS_{i,j,t} = std(\Delta s_{i,j,t}) \cdot 100$  is the exchange rate volatility of a country pair  $i, j$  measured by the yearly standard deviation of the weekly exchange rate return or (depending on the specification) the conditional exchange rate volatility based on a GARCH(1, 1)-model. We employ a bilateral measure of direct and indirect central bank communication by using the average value of communication in country  $i$  and  $j$ ,  $CBT_{i,j,t}$ , which assumes that both countries equally contribute to the stability of the exchange rate.  $X_{i,j,t}$  captures control variables as discussed in the previous section. We further control for bilateral exchange rate fixed effects  $\alpha_{i,j}$  as well as year fixed effects  $\tau_t$ .<sup>8</sup>

The theoretically predicted conditional effects of monetary policy transparency are tested with multiplicative interaction terms:

$$VS_{i,j,t} = \alpha_{i,j} + \tau_t + \beta_1 \cdot CBT_{i,j,t} + \Gamma X_{i,j,t} + \beta_2 \cdot CBT_{i,j,t} \times Z_{i,j} + \varepsilon_{i,j,t}, \quad (12)$$

where  $Z_{i,j}$  is the conditioning variable (i.e. the flexibility of goods prices, interest rate sensitivity of money demand, or monetary policy conservatism).

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<sup>8</sup> Instead of bilateral fixed effects, we included country fixed effects of the respective countries of the currency pair for our baseline estimations. Results remain quantitatively and qualitatively unaltered and robust to this procedure. The corresponding result tables are available upon request.

## 4. Results

### 4.1 Baseline Results

The results of our baseline specification Eq. (11) are shown in Tables 1a and 1b for direct and indirect central bank communication using the historical exchange rate volatility measure. Tables 2a and 2b report the results for the conditional volatility measure taken from a GARCH(1,1) model. Each specification includes a large set of control variables including structural variables, volatilities and shocks. The five specifications include different combinations of shocks. The volatility of industrial production is only included in Specification V, since data coverage for this variable is weak. All estimations include bilateral exchange rate fixed effects as well as year fixed effects and standard errors are clustered at the level of the bilateral exchange rate.

[Table 1a and 1b here]

Across all models, we find strong evidence that an increase in direct communication about central bank monetary policy objectives decreases bilateral exchange rate volatility. For the first four specifications in Table 1a, we find that an increase of the bilateral communication variable by one unit reduces bilateral exchange rate volatility by around 0.28 percentage points (hereinafter p.p.), on average. In the fifth specification that includes industrial production volatility the marginal effect of an increase of direct communication is around 1.1 p.p. on average. However, as we lose almost half of our sample when including this variable, we use specification IV for further analysis. In all specifications, the obtained marginal effect is statistically significant at the 1 percent level.

Table 1b reveals strong evidence that also improved indirect communication about monetary policy targets dampens bilateral exchange rate volatility.<sup>9</sup> For specifications I to IV, the marginal effect of a one unit increase in indirect central bank communication amounts to a

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<sup>9</sup> These results presented in Table 1a and b, hold also for historical volatility measures based on daily and monthly returns. More detailed results of these measures are available upon request.

reduction in volatility of around 0.28 p.p.. This effect is slightly lower in the fifth specification. However, the effect is again statistically significant across all specifications at the 1 percent level.

In the next step, we consider the standardized effect of a one within standard deviation change of the respective communication measure as a fraction of the within standard deviation of exchange rate volatility. We find for the direct and indirect communication measures that the standardized marginal effects amount for 3.44 percent and 8.46 percent of the standardized average change in volatility over the sample period, respectively.<sup>10</sup> Therefore, we can conclude that the effect of indirect communication on exchange rate volatility is twice as large as the effect of direct communication. A possible explanation for the larger effect of indirect communication may be that announcing the (numerical value of) a monetary policy objective (as done for direct communication) only provides a rough guide for the public to infer about these targets as credibility concerns of these targets might still prevail. On the contrary, indirect communication involves publishing important economic monetary policy related data and forecasts of the most relevant data, which will not only improve learning about monetary policy targets but also foster monetary policy credibility.

The results of control variables are largely in line with expectations. First, larger shocks and volatilities significantly increase exchange rate volatility. Second, several structural country characteristics show the predicted sign. Country pairs with larger levels of foreign exchange reserves, less flexible exchange rate regimes, a lower occurrence of currency crises (and, to a lesser extent, lower public debt levels) show less exchange rate volatility. Surprisingly, country size is negatively correlated with exchange rate volatility, which contradicts previous evidence (e.g., Bayoumi and Eichengreen, 1998). A possible explanation may be that our country pair fixed effect captures the cross country differences in actual country size and that our result reflects that economic growth is associated with less exchange rate volatility.

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<sup>10</sup> These calculations are based on the baseline estimation of Table 1a and 1b specification IV.



Table 2a and 2b provide similar evidence of the dampening effect of direct and indirect central bank communication on the conditional exchange rate volatility measure derived from a GARCH(1,1) model.

[Table 2a and 2b here]

In all specifications, direct and indirect communication is statistically significant at the 1 percent level. A one within standard deviation increase in the direct (indirect) communication measure, is associated with a 6.99 percent (10.94 percent) reduction in the within standard deviation in conditional exchange rate volatility. Similar to the findings for the historical exchange rate volatility measure, we find that indirect communication has a much larger effect on conditional exchange rate volatility than direct central bank communication.

## **4.2 Robustness**

To test the robustness of these baseline results, we employ a broad set of sensitivity analyses. First, we re-estimate our baseline specification (see Table 1, specification IV) and include the direct and indirect communication measures simultaneously. We further include the overall central bank transparency index of Dincer and Eichengreen (2014) as a single variable instead of the direct and indirect communication measures. Table 3 reports these results for the historical as well as the conditional volatility measure.

[Tables 3a and 3b]

Generally, we find that including both communication measures simultaneously does not alter our baseline results. While parameter values of the direct communication variable are slightly lower compared to our baseline estimation, the marginal effect remains statistically significant at the 5 percent level at least. For the indirect communication variable, we find that parameter values almost identical compared to the baseline estimation and remain also highly statistically significant at the 1 percent level. Also the inclusion of the overall transparency

index of Dincer and Eichengreen (2014) instead of both communication variables, yields a statistically significant negative effect on exchange rate volatility.

Apart from our direct and indirect communication variables, there are a number of other central bank characteristics such as the introduction of inflation targeting and changes in the political independence of the central bank that might affect exchange rate volatility. Table 4a and 4b present the results when including these measures separately and simultaneously to our baseline specification IV of Table 1a and 1b.

[Table 4a and 4b]

In all specifications, we find a statistically significant negative effect for both communication measures on the historical exchange rate volatility at the 1 percent level. As expected both inflation targeting and central bank independence have a negative parameter sign, however, statistical significance at conventional levels varies across these specifications.

Different characteristics of countries banking systems might also influence exchange rate volatility. Thus, we include measures such as the bank capital asset ratio and the z-score to capture the stability of the banking system. We further control for the average size of the banking system as well as for the financial integration of the country. The corresponding results are shown in Table 5a and 5b.

[Table 5a and 5b here]

Again for all specifications, we find confirming evidence for both communication measures to have a statistically significant negative effect on the exchange rate volatility at the 1 percent level. While financial integration and the size of the banking system only increase exchange rate volatility when included separately, the bank capital to asset ratio statistically significantly decreases bilateral exchange rate volatility even when included simultaneously with all other financial system variables at the 1 percent level.

Tables 6a and 6b present further sensitivity analyses including the current account balance, a measure for overall capital inflow controls by Fernández et. al. (2015) and real per capita GDP as a measure for economic development.

[Table 6a and 6b]

In line with our baseline results and previous robustness tests, all parameter values of the direct and indirect communication variables are statistically significant at the 1 percent level and reduce the historical exchange rate volatility. The current account balance and the introduction of capital account controls and economic development are associated with a reduction in exchange rate volatility in those specifications where these variables are statistically significant.

Changes in the political institution of countries, und thus, changes in the quality of institutions might have an impact in the exchange rate volatility. Therefore, we include the Polity IV scores and the economic freedom variables of the Fraser Institute to account for these factors. Tables 7a and 7b present the corresponding results for the direct and indirect communication variables.

[Tables 7a and 7b here]

As in our baseline estimation, direct and indirect communication is associated with a reduction in historical exchange rate volatility. Parameter values are again statistically significant at the 1 percent level. Our results suggest that a higher Polity IV score that is a more democratic and less autocratic regime is associated with a decrease in exchange rate volatility. Furthermore, a sound legal system can also contribute to more stable exchange rates as the statistically significant negative parameter of the legal system variable suggests. The positive statistically significant value of the parameter of the variable “Size of Government” suggests that countries which rely more heavily on governments to allocate goods and

services have lower exchange rate volatility.<sup>11</sup> This finding might be due to the fact that these governments are also more likely to intervene in foreign exchange markets to stabilize their currencies or are more likely to introduce capital controls.

Finally, apart from asymmetric shocks that have been captured already in the baseline estimation, we additionally include variables that capture asymmetric shocks of the inflation rate, the current account, exports and the lending rate. Results are depicted in Tables 8a and 8b.

[Tables 8a and 8b here]

Also the inclusion of different additional shock variables does not alter our baseline results. As expected all statistically significant asymmetric shock variables suggest that asymmetric nominal and real shocks lead to more volatile bilateral exchange rates.

The evidence presented in this section does not only apply to the historical exchange rate volatility, but also for the conditional volatility measure.<sup>12</sup>

### **4.3 The Inflation Expectations Channel**

One of the key features of the model presented in section 2 is that transparency about monetary policy objectives reduces exchange rate volatility by stabilizing inflation expectations. Thus, the effect critically depends on whether central bank transparency is able to anchor inflation expectations successfully. This, however, is only the case if changes in the current inflation rate have only a marginal or no impact at all on inflation expectations (see, e.g., Van der Cruysen and Demertzis, 2007; Strohsal et al., 2016).

To test this channel empirically, we employ a multiplicative interaction model that analyzes the marginal effect of inflation volatility on exchange rate volatility conditional on the level of

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<sup>11</sup> A larger value of this index indicates a lower degree of government intervention. Thus, an increase in this value can be interpreted as a reduction in government intervention.

<sup>12</sup> The sensitivity analysis presented in Tables 3a to 7b for the historical volatility measure has been applied to the conditional volatility measure. The direct as well as the indirect communication measure are always significant at the 1 percent level and exert a negative effect on the conditional bilateral exchange rate volatility. These results are available upon request.

direct or indirect central bank communication.<sup>13</sup> If inflation rates become more unstable in the short-run, their impact on the stability of inflation expectations should be lower the more successfully inflation expectations are anchored, and thus, the marginal effect of inflation volatility on exchange rate volatility should be lower the more transparent the central bank is concerning its monetary policy objectives. Tables 9 reports the empirical results of this interaction model for both direct and indirect communication as well as for both exchange rate volatility measures.

[Table 9 here]

For all estimation specifications, we find that the marginal effect of inflation volatility on exchange rate volatility is a decreasing function of the level of the direct as well as the indirect communication measure. The parameters of the multiplicative interaction term are statistically significant at least at the 5 percent level. This suggests that the marginal effect of inflation volatility on exchange rate volatility is diminishing in the level of central bank transparency, which is consistent with the channel that is proposed in section 2.<sup>14</sup>

Figure 3 displays the marginal effect of inflation volatility on exchange rate volatility conditional on both transparency measures including the respective 95 confidence interval.

[Figure 3 here]

Figure 3 shows that the marginal effect of inflation volatility on bilateral exchange rate volatility is decreasing in the level of direct and indirect central bank communication. For indirect communication values above 4.5, inflation volatility has no significant effect on exchange rate volatility.

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<sup>13</sup> We use the inflation volatility measure as this is the most precise measure to capture short-term inflationary shocks occurring during the current year. Because the “shock-variables” proposed by literature are always yearly growth rates, these variables capture rather economic divergence for which the exchange rate has to adjust.

<sup>14</sup> It is important to note that we do not claim here that we have tested the effect of central bank transparency on inflation expectations explicitly. Data limitations concerning inflation expectations will make it impossible to test this channel directly in our setting. However, assuming that this effect is behind the results we find, is not far fetched. There is actually empirical evidence by Van der Cruysen and Demertzis (2007). They find that central bank transparency helps anchoring inflation expectations.

These results suggest that in order to evaluate the economic importance of central bank transparency, one has to account for the fact that central bank transparency in general reduces the positive marginal effect of inflation volatility on exchange rate volatility. The average standardized marginal effect of inflation rate volatility amounts to 32.12 percent of the standardized average change in exchange rate volatility over the sample period. An increase of one unit of the direct or indirect communication measure decreases this standardized marginal effect by 4.67 p.p. and 6.4 p.p., respectively. For very large values of indirect communication, this marginal effect of inflation rate volatility even vanishes to zero. Thus, central bank transparency via inflation expectation anchoring seems to reduce the adverse impact of inflation rate volatility on exchange rate volatility by a great amount.

#### 4.4 Conditional Effects

The model presented in section 2 predicts that the marginal effect of central bank transparency on exchange rate volatility is higher for countries with lower flexibility of goods prices, a less conservative central bank and a higher interest rate sensitivity of money demand (see Eq. (10)).

To test these predictions, we use a multiplicative interaction model. First, we use a measure that originates from Frankel and Romer (1999) and has been proposed by Bravo-Ortega and Di Giovanni (2006) to proxy price rigidities in the goods market:

$$RE_i = \sum_{j \neq i} w_j \cdot \ln(dist_{i,j}), \quad (13)$$

$$\text{where } w_j = \frac{Trade_j}{\sum_k Trade_k}. \quad (14)$$

The remoteness of a country  $i$ ,  $RE_i$ , equals the sum of the log geographical distance  $\ln(dist_{i,j})$  to its trading partners  $j$  weighted by trade weight  $w_j$ , i.e. the trade contribution of

country  $j$  to total world trade, where  $k$  indexes all countries in the world. Intuitively, this measure can be understood as the geographical distance of a country to the center of world trade. First, a larger distance or remoteness implies less competition in the goods markets of country  $j$ , and second, it implies a relatively larger non-tradable goods sector. Both factors should contribute to less flexible prices in the goods markets (Bravo-Ortega and Di Giovanni, 2006). That is, the remoteness proxy is inversely related to our goods prices flexibility measure,  $\theta$ , introduced in section 2. Therefore, we expect the marginal effect of central bank transparency on exchange rate volatility to be more pronounced for more remote countries. These results are presented in the results Tables 10a and 10b column I. The total marginal effect of central bank transparency on exchange rate volatility, conditional on the remoteness measure including the respective 95 percent confidence intervals is depicted in Figure 4.

[Figure 4 here]

Confirming our theoretical prediction presented in section 2, we find that the marginal effect of central bank transparency is decreasing for more remote countries, i.e. countries with less flexible prices in the goods market. This is true for both communication measures (Panel A and Panel B). For less remote countries, the marginal effect becomes statistically insignificant, while for more remote countries the dampening effect of central bank transparency is increasing. As prices in the goods market are less flexible in more geographically remote countries, the degree of overshooting of the exchange rate in the short run becomes more pronounced and more important for exchange rate movements. Therefore, *ceteris paribus*, any reduction in the uncertainty about the short run over- and undervaluation of the exchange rate to its PPP implied long run equilibrium value, will lead to a stronger stabilizing effect on the exchange rate than in countries where the degree of exchange rate overshooting is less of an issue. By communicating about its monetary policy objectives, the

central bank can reduce the uncertainty about inflation expectations and thereby reduce the uncertainty about the degree of exchange rate overshooting.

The model predicts further that the marginal effect of central bank transparency on exchange rate volatility is more pronounced for less conservative central banks, i.e. central banks which put higher weight on the output gap objective. As empirical measures of central bank conservatism are scarce in the literature, we employ a simple measure proposed by Leveuge and Lucotte (2014). The intuition and calculation of this measure is depicted in Figure 5 and Eq. (15):

[Figure 5 here]

$$CONS_i = \frac{1}{90} \left[ \text{atan} \left( \frac{\sigma_{y_i}^2}{\sigma_{\pi_i}^2} \right) \cdot \frac{180}{\rho_i} \right] \quad (15)$$

Figure 5 depicts the Taylor-curve and the inflation-output variability trade-off the central bank faces. These measures can be derived by using the historical data on inflation and industrial production. The conservatism measure  $CONS_i$  of country  $i$  is calculated by using the trigonometrical formula for the angle of the straight line that goes through the origin and Taylor curve as depicted in Figure 5. Multiplying this formula by  $(1/90)$  rescales the value to values between zero and one. This formula is given by Eq. (15).

The results of the multiplicative interaction model for central bank conservatism is given by Table 10a and 10b column II. The corresponding plot of the total marginal effect of direct as well as indirect central bank communication on the historical bilateral exchange rate volatility measure with corresponding 95 percent confidence interval is displayed in Figure 6.

[Figure 6]



The marginal effect of direct (Panel A) as well as indirect (Panel B) central bank communication on the historical exchange rate volatility is more pronounced for lower levels of central bank conservatism, confirming the theoretical prediction. The total marginal effect is again statistically significantly negative and becomes only insignificant for very large values of central bank conservatism in the case of indirect central bank communication.

An important component that determines the uncertainty of inflation rate expectations is the degree to which the central bank targets the inflation rate. A more conservative central bank that responds more strongly to inflation rate deviations than to output gap deviations, contributes already to a lower degree of uncertainty about the central bank's policy response and thereby to lower levels of inflation rate expectation uncertainty. Hence, the stabilizing effect of direct and indirect communication about monetary policy objectives on inflation rate expectations is more amplified for less conservative central banks as the trade off between the inflation rate and the output gap presents a bigger threat to inflation expectation anchoring. In this situation, a more enhanced communication about monetary policy objectives can alleviate this trade off uncertainty even further which leads to a more pronounced stabilized effect on exchange rate volatility by reducing domestic inflation expectation uncertainty. Our empirical findings are also in line with this mechanism of the model.

Finally, we test the prediction that the effect of central bank transparency is more pronounced for countries with a higher degree of interest rate sensitivity of money demand. Since there are no proxy variables available that capture interest rate sensitivity of money demand for our large country sample, we choose to estimate the interest rate sensitivity empirically in a first stage and include this approximation in a second stage as a modifying variable in the multiplicative interaction model. However, there are numerous empirical methods and monetary aggregates that have been used in previous studies that have produced different results (see, e.g., Sriram, 2001). None of those studies have analyzed differences for a broad set of countries. One of the major challenges in this regard is the lack of availability of data

and especially industrial production data.<sup>15</sup> In order to estimate the interest rate sensitivity for a sufficient number of countries in the first stage, we use an estimation equation Eq. (16) similar to Hetzel (1984):

$$\Delta \ln(M1_t/N_t) = \alpha + \beta \pi_t + \lambda \Delta \ln(i_t) + \varepsilon_t \quad (16)$$

The dependent variable is the growth rate of M1 divided by population growth rate. We use year-over-year monthly growth rates to account for seasonal effects. Determinants include the year-over-year inflation growth rate and interest rate growth rate. We do not include per capita income growth, since the poor data coverage would severely reduce the sample. Based on Eq. (16) we estimate the interest rate sensitivity  $\lambda_i$  for each country individually for the period 1998-2010. The results of the interaction models including interest rate sensitivity as the conditioning variable are presented in Tables 10a and 10b column III. Figure 7 depicts the marginal effects.

[Figure 7 here]

Figure 7 shows that the effect of central bank transparency on bilateral exchange rate volatility is more pronounced for higher levels of interest rate sensitivity, i.e. for more negative values of  $\lambda_i$ . This empirical finding is in line with the theoretical prediction derived in section 2. The interest rate sensitivity of money demand determines the reaction of the long run equilibrium of the exchange rate to long run interest rate differentials. For more sensitive money demand, the current exchange rate becomes more sensitive to changes in the long run equilibrium. Thus, any increase in the uncertainty of the long run interest rate differential will affect exchange rate volatility more severely. Since the long run interest rate differential is

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<sup>15</sup> Data is sometimes only available as year-over-year (YoY) monthly or quarterly growth rates which makes it impossible to reconstruct the underlying index. For most estimation procedures such an index would be needed and therefore we use the estimation equation of Hetzel (1984) that is based on growth rates.

determined by the inflation expectation differentials, the effect of enhanced monetary policy transparency on exchange rate volatility will be more pronounced a for larger interest rate sensitivity of money demand as the uncertainty about inflation expectations becomes more important for the long run exchange rate and its volatility.

[Table 10a and 10b here]

## **5. Conclusion**

In this paper, combine two well established theoretical models to derive empirically testable hypotheses on the effect of central bank transparency on exchange rate volatility.

The model predicts that an increase in central bank transparency decreases bilateral exchange rate volatility. It further provides a channel through which central bank transparency affects this volatility. The stabilizing effect of central bank transparency on bilateral exchange rates works through the anchoring of inflation rate expectations. Apart from the average effect of central bank transparency, the model implies that the effect of transparency on exchange rate volatility is more pronounced for countries with a lower flexibility of prices in the goods market, with less conservative central banks and a higher interest rate sensitivity of money demand.

Empirically, we employ a panel model for historical and conditional bilateral exchange rate volatility measures for 62 currencies from 1998 to 2010. In line with the theoretical model, we find strong empirical evidence that an increase in transparency of monetary policy objectives decreases bilateral exchange rate volatility. These results are robust for a large set of sensitivity tests and hold for both direct and indirect communication about monetary policy targets. We provide additional empirical evidence that this stabilizing effect on the exchange rate is archived via the stabilization of inflation expectations. Using interaction models to capture heterogeneity in the marginal effect of central bank transparency, we find that this

effect critically depends on the flexibility of prices in the goods market, central bank conservatism and interest rate sensitivity of money demand. These results do not only confirm our theoretically derived hypotheses but also underline that the expected effectiveness of regime shifts in central bank transparency in reducing exchange rate volatility will vary across countries.

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## Tables and Figures

**Table 1a: Historical Exchange Rate Volatility and Direct Central Bank Communication**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV	V
Direct Communication	-0.272*** (0.073)	-0.286*** (0.075)	-0.282*** (0.075)	-0.276*** (0.073)	-1.042*** (0.136)
Size	-0.270** (0.132)	-0.403*** (0.130)	-0.331** (0.130)	-0.364*** (0.131)	-0.669*** (0.191)
In Trade	0.005 (0.012)	0.010 (0.012)	0.009 (0.012)	0.006 (0.012)	-0.031 (0.022)
Gov. Debt	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.001)	0.004*** (0.001)
Reserves	-0.005** (0.002)	-0.004* (0.002)	-0.004* (0.002)	-0.005** (0.002)	-0.002 (0.003)
FX-Regime	0.457*** (0.052)	0.478*** (0.054)	0.470*** (0.054)	0.480*** (0.052)	0.788*** (0.068)
FX-Crisis	1.075*** (0.048)	1.069*** (0.049)	1.084*** (0.051)	1.041*** (0.049)	1.112*** (0.084)
Inflation Volatility	0.361*** (0.014)	0.378*** (0.013)	0.378*** (0.013)	0.361*** (0.014)	0.257*** (0.013)
M1 Volatility	0.032*** (0.006)	0.032*** (0.006)	0.033*** (0.006)	0.030*** (0.006)	-0.002 (0.005)
Interest Rate Volatility	0.019*** (0.003)	0.020*** (0.003)	0.021*** (0.003)	0.019*** (0.003)	0.028*** (0.004)
Real GDP Shock	0.035*** (0.005)			0.036*** (0.005)	0.052*** (0.005)
Bank System Shock		0.009*** (0.001)		0.009*** (0.001)	0.012*** (0.001)
Terms-Of-Trade Shock			0.003** (0.001)	0.003*** (0.001)	0.003** (0.002)
Industrial Production Volatility					0.024*** (0.007)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	10,606	10,606	10,606	10,606	5,873
R-Squared	0.582	0.582	0.577	0.588	0.638

**Notes:** This table reports the estimation results of the baseline model to analyze the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 1b: Historical Exchange Rate Volatility and Indirect Central Bank Communication**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV	V
Indirect Communication	-0.297*** (0.036)	-0.273*** (0.036)	-0.286*** (0.036)	-0.278*** (0.036)	-0.177*** (0.042)
Size	-0.303** (0.131)	-0.436*** (0.129)	-0.365*** (0.128)	-0.392*** (0.130)	-0.565*** (0.192)
ln Trade	0.006 (0.012)	0.011 (0.012)	0.010 (0.012)	0.006 (0.012)	-0.031 (0.022)
Gov. Debt	0.002* (0.001)	0.002 (0.001)	0.002* (0.001)	0.001 (0.001)	0.006*** (0.001)
Reserves	-0.005** (0.002)	-0.004* (0.002)	-0.004* (0.002)	-0.005** (0.002)	-0.004 (0.003)
FX-Regime	0.484*** (0.051)	0.505*** (0.054)	0.496*** (0.054)	0.505*** (0.052)	0.827*** (0.068)
FX-Crisis	1.067*** (0.048)	1.063*** (0.049)	1.078*** (0.050)	1.036*** (0.048)	1.122*** (0.085)
Inflation Volatility	0.363*** (0.014)	0.380*** (0.013)	0.380*** (0.013)	0.362*** (0.014)	0.261*** (0.013)
M1 Volatility	0.033*** (0.006)	0.033*** (0.006)	0.034*** (0.006)	0.032*** (0.006)	0.001 (0.005)
Interest Rate Volatility	0.017*** (0.003)	0.019*** (0.003)	0.019*** (0.003)	0.017*** (0.003)	0.030*** (0.004)
Real GDP Shock	0.036*** (0.005)			0.037*** (0.005)	0.055*** (0.006)
Bank System Shock		0.009*** (0.001)		0.009*** (0.001)	0.012*** (0.001)
Terms-Of-Trade Shock			0.002* (0.001)	0.003** (0.001)	0.003* (0.002)
Industrial Production Volatility					0.009 (0.007)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	10,606	10,606	10,606	10,606	5,873
R-Squared	0.586	0.584	0.580	0.591	0.632

**Notes:** This table reports the estimation results of the baseline model to analyze the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 2a: Conditional Volatility and Direct Central Bank Communication**

Dep. Var.: Conditional Vola. (daily)	I	II	III	IV	V
Direct Communication	-0.070*** (0.013)	-0.074*** (0.013)	-0.073*** (0.013)	-0.070*** (0.013)	-0.214*** (0.026)
Size	0.076*** (0.023)	0.057** (0.024)	0.062*** (0.023)	0.063*** (0.024)	-0.075*** (0.029)
ln Trade	0.000 (0.002)	0.001 (0.002)	0.001 (0.002)	0.000 (0.002)	-0.001 (0.003)
Gov. Debt	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Reserves	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.001)
FX-Regime	0.073*** (0.009)	0.077*** (0.009)	0.078*** (0.009)	0.077*** (0.009)	0.094*** (0.010)
FX-Crisis	0.108*** (0.006)	0.108*** (0.006)	0.109*** (0.006)	0.102*** (0.006)	0.157*** (0.010)
Inflation Volatility	0.035*** (0.003)	0.037*** (0.003)	0.038*** (0.003)	0.035*** (0.003)	0.037*** (0.003)
M1 Volatility	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Interest Rate Volatility	0.003*** (0.000)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.000)	0.004*** (0.001)
Real GDP Shock	0.007*** (0.001)			0.007*** (0.001)	0.007*** (0.001)
Bank System Shock		0.001*** (0.000)		0.001*** (0.000)	0.001*** (0.000)
Terms-Of-Trade Shock			0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Industrial Production Volatility					0.005*** (0.001)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	10,681	10,681	10,681	10,681	5,768
R-Squared	0.540	0.533	0.530	0.546	0.662

**Notes:** This table reports the estimation results of the baseline model to analyze the effect of direct central bank communication on the conditional bilateral exchange rate volatility measure. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 2b: Conditional Volatility and Indirect Central Bank Communication**

Dep. Var.: Conditional Vola. (daily)	I	II	III	IV	V
Indirect Communication	-0.050*** (0.005)	-0.047*** (0.005)	-0.048*** (0.005)	-0.048*** (0.005)	-0.039*** (0.006)
Size	0.072*** (0.023)	0.054** (0.024)	0.059** (0.023)	0.061*** (0.024)	-0.052* (0.029)
ln Trade	0.000 (0.002)	0.001 (0.002)	0.001 (0.002)	0.000 (0.002)	-0.001 (0.003)
Gov. Debt	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Reserves	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.001 (0.001)
FX-Regime	0.081*** (0.009)	0.085*** (0.009)	0.085*** (0.009)	0.084*** (0.009)	0.102*** (0.011)
FX-Crisis	0.106*** (0.006)	0.107*** (0.006)	0.108*** (0.006)	0.101*** (0.006)	0.159*** (0.010)
Inflation Volatility	0.035*** (0.003)	0.038*** (0.003)	0.038*** (0.003)	0.035*** (0.003)	0.038*** (0.003)
M1 Volatility	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Interest Rate Volatility	0.003*** (0.000)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.000)	0.004*** (0.001)
Real GDP Shock	0.007*** (0.001)			0.007*** (0.001)	0.008*** (0.001)
Bank System Shock		0.001*** (0.000)		0.001*** (0.000)	0.001*** (0.000)
Terms-Of-Trade Shock			0.001*** (0.000)	0.001*** (0.000)	0.001** (0.000)
Industrial Production Volatility					0.002* (0.001)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	10,681	10,681	10,681	10,681	5,768
R-Squared	0.544	0.535	0.533	0.549	0.650

**Notes:** This table reports the estimation results of the baseline model to analyze the effect of indirect central bank communication on the conditional bilateral exchange rate volatility measure. The indirect communication variable consists of the economic central bank subcategory and question 2 of the operational subcategory taken from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 3: Combined Transparency Measures and Exchange Rate Volatility**

Dep. Var. - Volatility measure:	historical	historical	conditional	conditional
	I	II	III	IV
Direct Communication	-0.175** (0.074)		-0.055*** (0.013)	
Indirect Communication	-0.261*** (0.037)		-0.042*** (0.005)	
Overall Transparency		-0.123*** (0.018)		-0.021*** (0.003)
Controls	YES	YES	YES	YES
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,606	10,606	10,681	10,681
R-Squared	0.591	0.591	0.551	0.550

**Notes:** This table reports the estimation results of the baseline model when including the direct and indirect central bank communication (see I and II), simultaneously. We further report the baseline results when including the overall Dincer and Eichengreen (2014) transparency index (see II and IV). The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014) and the indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). The dependent variable are either historical volatility measures, based on weekly bilateral exchange rate returns (see I and II) or conditional volatility measures, based on daily bilateral exchange rate returns (see III and IV). As our dependent variables are bilateral variables, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. We include the standard set of control variables in each estimation (see Tables 1a, 1b - specification IV). Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 4a: Robustness - Central Bank Characteristics**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV
Direct Communication	-0.246*** (0.092)	-0.235** (0.092)	-0.262*** (0.073)	-0.232** (0.093)
Controls	YES	YES	YES	YES
Soft IT	-0.145** (0.072)			-0.142* (0.073)
Strict IT		-0.175** (0.070)		
Central Bank Independence			-0.333 (0.351)	-0.312 (0.368)
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,354	10,354	10,478	10,226
R-Squared	0.589	0.589	0.589	0.590

**Notes:** This table reports additional results testing the robustness of the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to capture other central bank characteristics. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 4b: Robustness - Central Bank Characteristics**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV
Indirect Communication	-0.276*** (0.038)	-0.272*** (0.038)	-0.280*** (0.037)	-0.279*** (0.039)
Controls	YES	YES	YES	YES
Soft IT	-0.073 (0.063)			-0.069 (0.063)
Strict IT		-0.099 (0.062)		
Central Bank Independence			-0.636* (0.345)	-0.579 (0.361)
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,354	10,354	10,478	10,226
R-Squared	0.592	0.592	0.592	0.593

**Notes:** This table reports additional results testing the robustness of the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to capture other central bank characteristics. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 5a: Robustness - Financial System Variables**

Dep.Var.: Historical Vola. (weekly)	I	II	III	IV	V
Direct Communication	-0.367*** (0.116)	-0.265*** (0.073)	-0.266*** (0.074)	-0.306*** (0.070)	-0.374*** (0.118)
Controls	YES	YES	YES	YES	YES
Bank Capital Asset Ratio	-0.056*** (0.011)				-0.060*** (0.012)
Size of the Banking System		0.003*** (0.001)			0.000 (0.002)
Financial Integration			0.009*** (0.002)		-0.040 (0.027)
Z-Score				0.001 (0.003)	0.006 (0.005)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	5,274	10,606	10,606	10,239	5,274
R-Squared	0.550	0.589	0.588	0.592	0.551

**Notes:** This table reports additional results testing the robustness of the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to capture other financial market characteristics. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.



**Table 5b: Robustness - Financial System Variables**

Dep.Var.: Historical Vola. (weekly)	I	II	III	IV	V
Indirect Communication	-0.342*** (0.054)	-0.271*** (0.036)	-0.273*** (0.036)	-0.265*** (0.035)	-0.359*** (0.056)
Controls	YES	YES	YES	YES	YES
Bank Capital Asset Ratio	-0.058*** (0.012)				-0.067*** (0.013)
Size of the Banking System		0.003*** (0.001)			-0.001 (0.002)
Financial Integration			0.008*** (0.002)		-0.031 (0.027)
Z-Score				0.002 (0.003)	0.011** (0.006)
Bilateral FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	5,274	10,606	10,606	10,239	5,274
R-Squared	0.555	0.591	0.591	0.594	0.556

**Notes:** This table reports additional results testing the robustness of the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to capture other financial market characteristics. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 6a: Robustness - Other Structural Variables**

Dep.Var.: Historical Vola. (weekly)	I	II	III	IV
Direct Communication	-0.240*** (0.075)	-0.301*** (0.082)	-0.278*** (0.074)	-0.280*** (0.084)
Controls	YES	YES	YES	YES
Current Account Balance	-0.017*** (0.004)			-0.010** (0.004)
Capital Account Controls		-0.780*** (0.137)		-0.934*** (0.146)
Economic Development			-0.537* (0.281)	-0.355 (0.335)
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,606	7,982	10,425	7,830
R-Squared	0.589	0.621	0.583	0.618

**Notes:** This table reports additional results testing the robustness of the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a and 1b) to capture other central bank characteristics. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 6b: Robustness - Other Structural Variables**

Dep.Var.: Historical Vola. (weekly)	I	II	III	IV
Indirect Communication	-0.282*** (0.036)	-0.229*** (0.034)	-0.277*** (0.036)	-0.238*** (0.034)
Controls	YES	YES	YES	YES
Current Account Balance	-0.019*** (0.004)			-0.012*** (0.004)
Capital Account Controls		-0.680*** (0.129)		-0.820*** (0.134)
Economic Development			-0.220 (0.271)	0.074 (0.314)
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,606	7,982	10,425	7,830
R-Squared	0.593	0.623	0.586	0.620

**Notes:** This table reports additional results testing the robustness of the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to capture other structural variables. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 7a: Robustness - Institutional Quality**

Dep.Var.: Historical Vola. (weekly)	I	II	III	IV	V	VI	VII	VIII
Direct Communication	-0.193*** (0.075)	-0.432*** (0.087)	-0.428*** (0.086)	-0.457*** (0.087)	-0.429*** (0.086)	-0.435*** (0.087)	-0.429*** (0.086)	-0.467*** (0.089)
... Controls	YES	YES	YES	YES	YES	YES	YES	YES
... Polity IV	-0.039*** (0.007)							
FSI - Summary Index		0.051 (0.071)						
FSI - Freedom to Trade			-0.023 (0.035)					0.004 (0.039)
FSI - Size of Government				0.090*** (0.026)				0.105*** (0.030)
FSI - Sound Money					0.031 (0.032)			0.046 (0.035)
FSI - Legal System						-0.150*** (0.034)		-0.159*** (0.036)
FSI - Regulation							-0.013 (0.043)	-0.031 (0.049)
Bilateral FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	9,569	8,976	8,948	8,976	8,976	8,976	8,976	8,948
R-Squared	0.589	0.608	0.608	0.609	0.608	0.609	0.608	0.610

**Notes:** This table reports additional results testing the robustness of the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a and 1b) to capture institutional quality. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 7b: Robustness - Institutional Quality**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV	V	VI	VII	VIII
Indirect Communication	-0.131*** (0.031)	-0.225*** (0.036)	-0.231*** (0.037)	-0.217*** (0.036)	-0.229*** (0.036)	-0.222*** (0.036)	-0.226*** (0.036)	-0.219*** (0.036)
...								
Controls	YES	YES	YES	YES	YES	YES	YES	YES
...								
Polity IV	-0.039*** (0.007)							
FSI - Summary Index		0.024 (0.069)						
FSI - Freedom to Trade			-0.055 (0.034)					-0.028 (0.037)
FSI - Size of Government				0.050** (0.025)				0.063** (0.028)
FSI - Sound Money					0.041 (0.031)			0.051 (0.034)
FSI - Legal System						-0.139*** (0.034)		-0.139*** (0.036)
FSI - Regulation							0.006 (0.042)	-0.001 (0.048)
Bilateral FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	9,569	8,976	8,948	8,976	8,976	8,976	8,976	8,948
R-Squared	0.590	0.609	0.609	0.609	0.609	0.610	0.609	0.610

**Notes:** This table reports additional results testing the robustness of the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a and 1b) to capture institutional quality. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 8a: Robustness Additional Shock Variables**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV	V	VI
Direct Communication	-0.274*** (0.073)	-0.280*** (0.073)	-0.277*** (0.073)	-0.269*** (0.073)	-0.645*** (0.085)	-0.719*** (0.082)
...						
Controls	YES	YES	YES	YES	YES	YES
...						
Inflation Shock	0.026*** (0.005)					0.057*** (0.006)
Current Account Shock		0.007* (0.004)				-0.003 (0.003)
Reserve Shock			0.002 (0.002)			-0.000 (0.002)
Export Shock				0.014*** (0.003)		0.009*** (0.003)
Lending Rate Shock					0.011*** (0.001)	0.010*** (0.001)
Bilateral FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	10,606	10,606	10,606	10,606	8,811	8,811
R-Squared	0.595	0.588	0.588	0.590	0.609	0.640

**Notes:** This table reports additional results testing the robustness of the effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to control for different asymmetric shocks. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 8b: Robustness Additional Shock Variables**

Dep. Var.: Historical Vola. (weekly)	I	II	III	IV	V	VI
Indirect Communication	-0.268*** (0.035)	-0.281*** (0.036)	-0.279*** (0.036)	-0.271*** (0.036)	-0.300*** (0.037)	-0.283*** (0.035)
...						
Controls	YES	YES	YES	YES	YES	YES
...						
Inflation Shock	0.025*** (0.005)					0.056*** (0.005)
Current Account Shock		0.007** (0.004)				-0.003 (0.003)
Reserve Shock			0.002 (0.002)			-0.000 (0.002)
Export Shock				0.013*** (0.003)		0.009*** (0.003)
Lending Rate Shock					0.012*** (0.002)	0.011*** (0.001)
Bilateral FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	10,606	10,606	10,606	10,606	8,811	8,811
R-Squared	0.597	0.591	0.591	0.593	0.609	0.638

**Notes:** This table reports additional results testing the robustness of the effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We add further variables to specification IV of the baseline estimation (see Table 1a or 1b) to control for different asymmetric shocks. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 9: Inflation Expectation Channel**

Dep. Var. - Volatility measure:	historical	historical	conditional	conditional
	I	II	III	IV
Direct Communication	-0.089 (0.082)	—	-0.033** (0.016)	—
Indirect Communication	—	-0.097** (0.038)	—	-0.023*** (0.007)
Controls	YES	YES	YES	YES
Inflation Volatility	0.523*** (0.068)	0.530*** (0.031)	0.068*** (0.016)	0.056*** (0.007)
Direct Communication X Inflation Volatility	-0.105** (0.042)	—	-0.022** (0.009)	—
Indirect Communication X Inflation Volatility	—	-0.143*** (0.021)	—	-0.019*** (0.005)
Bilateral FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	10,606	10,606	10,681	10,681
R-Squared	0.591	0.600	0.551	0.559

**Notes:** This table reports the results of the multiplicative interaction model that test whether the level of direct or indirect central bank communication has an impact on the marginal effect of inflation rate volatility on historical as well as conditional bilateral exchange rate volatility measures. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. Control variables are those of specification IV of the baseline estimation (see Table 1a or 1b). All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.



**Table 10a: Conditional Effects of Direct Central Bank Communication**

Dep. Var.: Historical Vola. (weekly)	I	II	III
Direct Communication	2.685 (1.768)	-6.320*** (1.447)	0.301* (0.163)
Controls	YES	YES	YES
Direct Communication X Remoteness	-0.340* (0.207)		
Direct Communication X Conservatism		5.863*** (1.514)	
Direct Communication X Interest Rate Sensitivity			8.987*** (2.469)
Bilateral FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	10,606	6,136	6,908
R-Squared	0.588	0.655	0.611

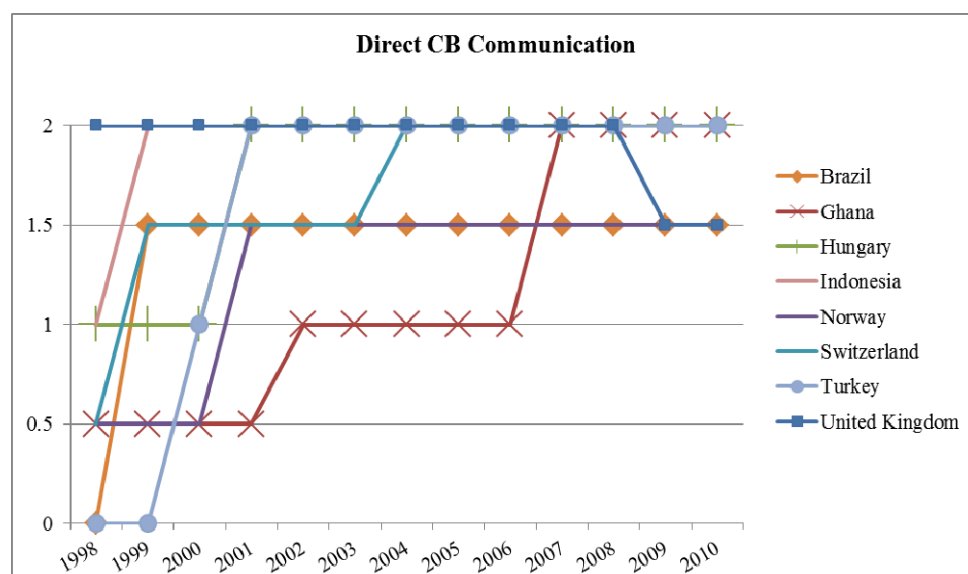
**Notes:** This table reports the results of testing for the conditional effect of direct central bank communication on the historical bilateral exchange rate volatility measure. We use geographical remoteness (Bravo-Ortega and Di Giovanni, 2006) as a proxy for price flexibility, a empirical measure for central bank conservatism (Levieuge and Lucotte, 2015) and an estimated interest rate sensitivity parameter to test the theoretical predictions of the model. The direct communication variable consists of questions 1 and 2 of the political subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. Control variables are those of specification IV of the baseline estimation (see Table 1a or 1b). All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Table 10b: Conditional Effects of Indirect Central Bank Communication**

Dep. Var.: Historical Vola. (weekly)	I	II	III
Indirect Communication	1.036 (0.737)	-1.824*** (0.321)	-0.140** (0.068)
Controls	YES	YES	YES
Indirect Communication X Remoteness	-0.152* (0.086)		
Indirect Communication X Conservatism		1.851*** (0.347)	
Indirect Communication X Interest Rate Sensitivity			1.687** (0.831)
Bilateral FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	10,606	6,136	6,908
R-Squared	0.591	0.652	0.608

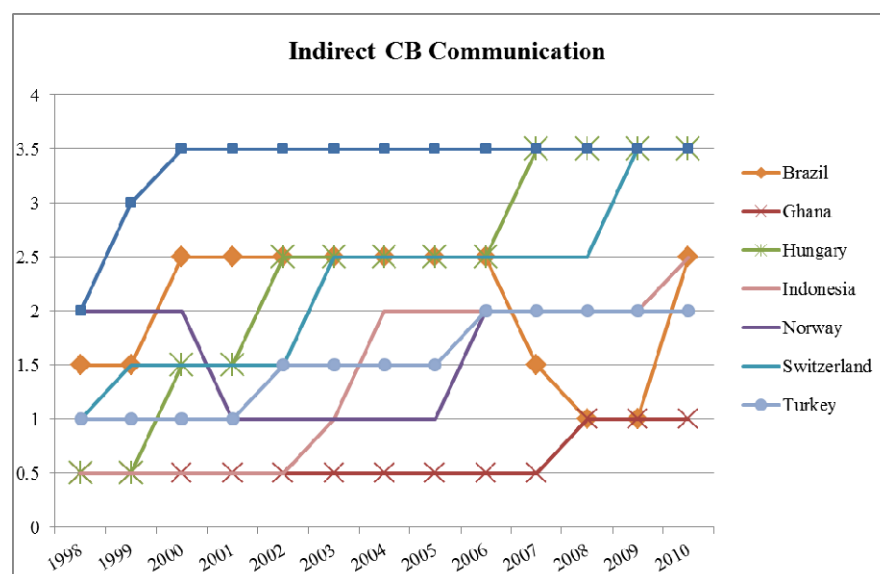
**Notes:** This table reports additional results of testing the conditional effect of indirect central bank communication on the historical bilateral exchange rate volatility measure. We use geographical remoteness (Bravo-Ortega and Di Giovanni, 2006) as a proxy for price flexibility, a empirical measure for central bank conservatism (Levieuge and Lucotte, 2015) and an estimated interest rate sensitivity parameter to test the theoretical predictions of the model. The indirect communication variable consists of the economic subcategory and question 2 of the operational subcategory retrieved from the central bank transparency index of Dincer and Eichengreen (2014). As our dependent variable is a bilateral variable, the explanatory variables are also defined as bilateral variables. Control variables are those of specification IV of the baseline estimation (see Table 1a or 1b). All specifications contain year fixed effects as well as bilateral exchange rate fixed effects. Currencies that have a strict de facto exchange rate regime are not included in this analysis. Standard errors are clustered by the exchange rate level and are depicted in parenthesis. \*\*\*, \*\*, and \* denote the 1%, 5% and 10% level of significance, respectively.

**Figure 1: The Evolution of the direct central bank measure over time for selected central banks.**



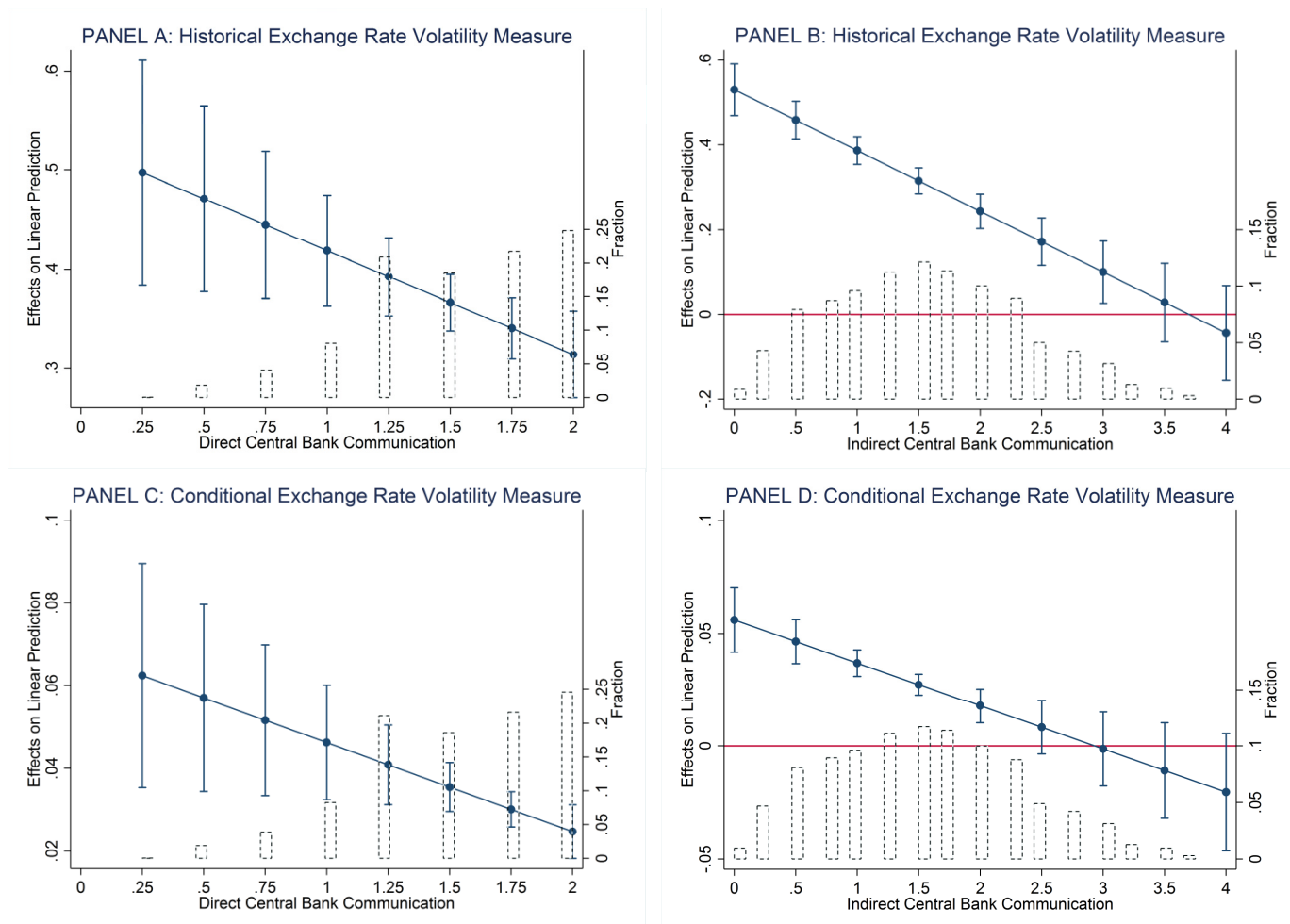
**Notes:** This figure depicts the evolution of the direct communication measure over time for selected central banks. This measure contains subcategories of the political dimension of the central bank transparency index of Dincer and Eichengreen (2014).

**Figure 2: The Evolution of the indirect communication measure over time for selected central banks.**



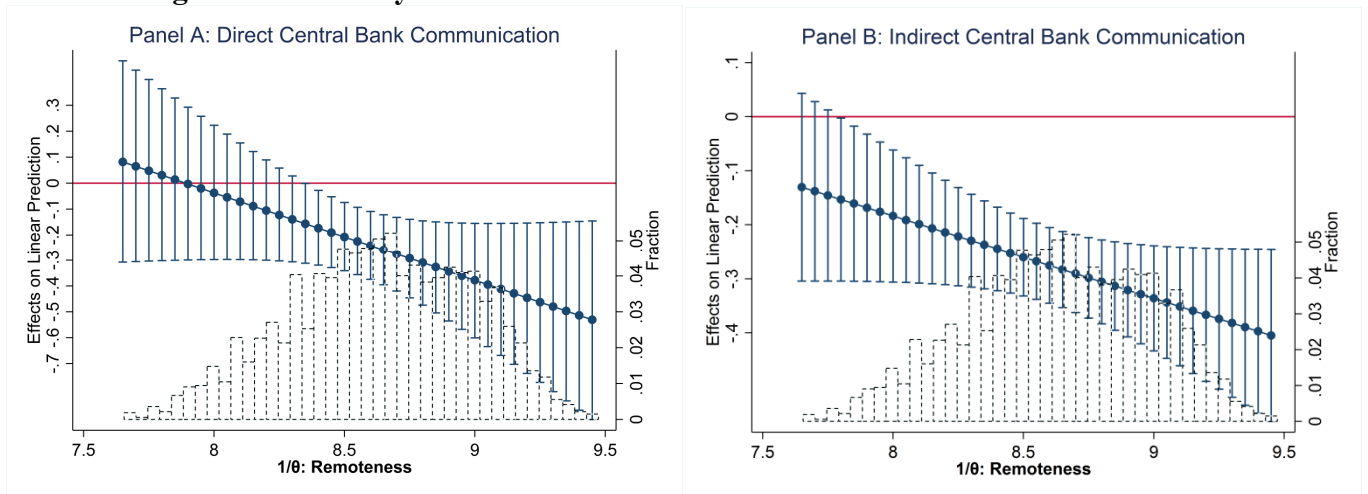
**Notes:** This figure depicts the evolution of the indirect communication measure over time for selected central banks. This measure contains subcategories of the economic and procedural dimension of the central bank transparency index of Dincer and Eichengreen (2014).

**Figure 3: Marginal Effect of Inflation Volatility on Exchange Rate Volatility Conditional on Central Bank Transparency.**



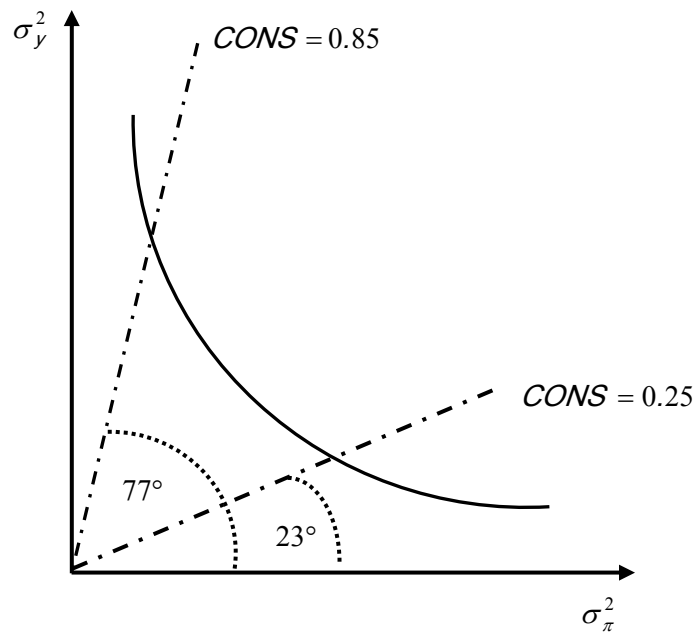
**Notes:** This figure depicts the marginal effects of inflation rate volatility on bilateral exchange rate volatility conditional to direct and indirect central bank communication variables including the respective 95 percent confidence intervals. Panel A and B display this marginal effect of inflation volatility conditional on direct (Panel A) and indirect (Panel B) communication for the historical exchange rate volatility measure and Panel C and D display those marginal effect for the conditional exchange rate volatility measures. The histogram of the respective conditioning variables is included.

**Figure 4: Marginal Effect of Direct and Indirect Central Bank Communication on Exchange Rate Volatility Conditional on Remoteness.**



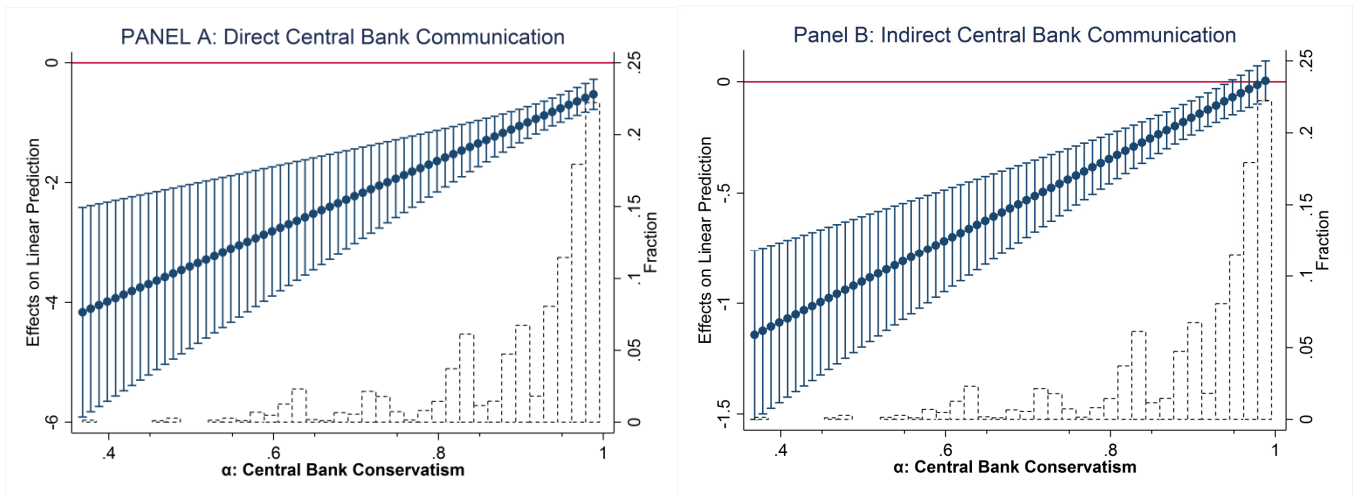
**Notes:** This figure depicts the marginal effects of direct (Panel A) and indirect (Panel B) central bank communication on the historical bilateral exchange rate volatility measure conditional on geographical remoteness. The remoteness measure is based on Bravo Ortega and Di Giovanni (2006) and is negatively related to price flexibility in the good market. The histogram of the respective conditioning variables is included.

**Figure 5: Central Bank Conservatism Measure of Leveuge and Lucotte (2014).**



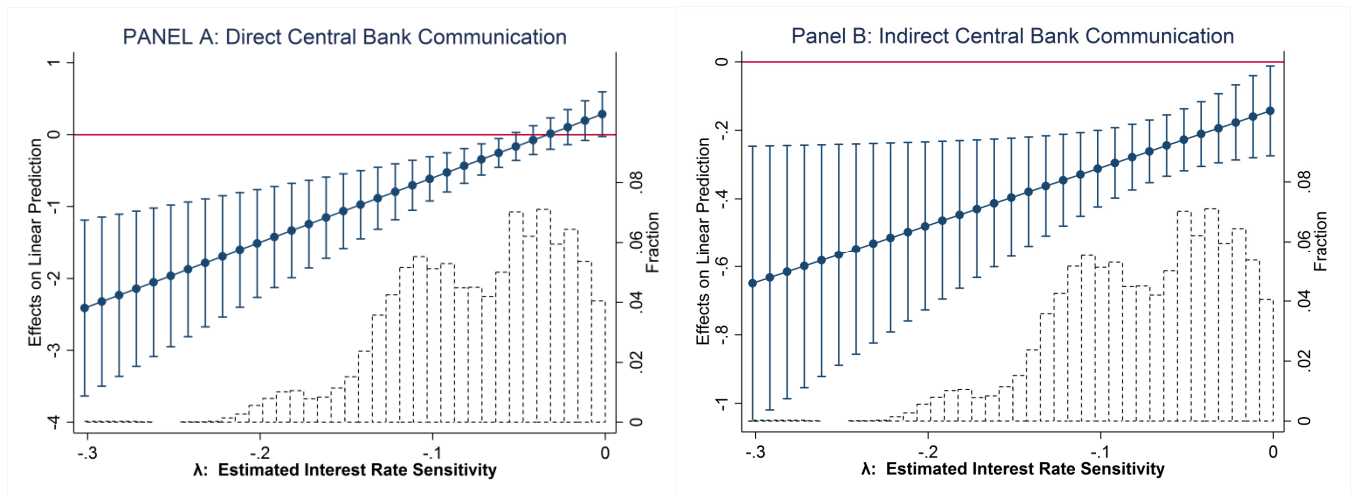
**Notes:** This figure is a replicated version of Leveuge and Lucotte (2014). It graphically depicts the relation of the empirical conservatism measure to the Taylor curve and the inflation-output variability trade-off.

**Figure 6: Marginal Effect of Direct and Indirect Central Bank Communication on Exchange Rate Volatility Conditional on Central Bank Conservatism.**



**Notes:** This figure depicts the marginal effects of direct (Panel A) and indirect (Panel B) central bank communication on the historical bilateral exchange rate volatility measure conditional on the central bank conservatism. The central bank conservatism measure is based on Leveuge and Lucotte (2014). The histogram of the respective conditioning variables is included.

**Figure 7: Marginal Effect of Direct and Indirect Central Bank Communication on Exchange Rate Volatility Conditional on Interest Rate Sensitivity of Money Demand.**



**Notes:** This figure depicts the marginal effects of direct (Panel A) and indirect (Panel B) central bank communication on the historical bilateral exchange rate volatility measure conditional on the interest rate sensitivity of money demand. The values of the estimated interest rate sensitivity are based on a money demand estimation equation similar to Hetzel (1984). The histogram of the respective conditioning variables is included.

## Appendix

**Table A1: Direct and Indirect Communication Measures**

<b>Direct Communication Measure:</b>		
<b>Question:</b>	<b>Evaluation:</b>	<b>Score:</b>
Question 1: Is there a formal statement of the objective(s) of monetary policy, with an explicit prioritization in case of multiple objectives?	No	0
	Multiple objectives without prioritization	0.5
	One objective or explicit prioritization of an objective	1
Question 2: Is there a quantification of the primary objective(s)?	No	0
	Yes	1
<b>Indirect Communication Measure:</b>		
<b>Question:</b>	<b>Evaluation:</b>	<b>Score:</b>
Question 1: Is the basic economic data relevant for the conduct of monetary policy publicly available? (The focus is on the following five variables: money supply, inflation, GDP, unemployment rate, and capacity utilization.)	Quarterly time series for at most two out of the five variables.	0
	Quarterly time series for three or four out of the five variables.	0.5
	Quarterly time series for all five variables.	1
Question 2: Does the central bank disclose the macroeconomic model(s) it uses for policy analysis?	No	0
	Yes	1
Question 3: Does the central bank regularly publish its own macroeconomic forecasts?	No numerical central bank forecasts for inflation and output.	0
	Numerical central bank forecasts for inflation and/or output published at less than quarterly frequency.	0.5
	Quarterly numerical central bank forecasts for inflation and output for the medium term (one to two years ahead), specifying the assumptions about the policy instrument (conditional or unconditional forecasts).	1
Question 4: Does the central bank regularly provide information on (unanticipated) macroeconomic disturbances that affect the policy transmission process?	No or not very often.	0
	Yes but only through short-term forecasts or analysis of current macroeconomic developments (at least quarterly).	0.5
	Yes, including a discussion of past forecast errors (at least annually).	1

**Notes:** This table describes the information provided by the Dincer and Eichengreen (2014) transparency index which is used for the construction of the direct and indirect communication measures. It depicts the relevant questions asked about the disclosure practices of central banks and how the evaluation of each question translates into a score assigned for each question. The overall score of each communication measure is the sum of the score for each question. In our analysis we use the bilateral average of the respective central banks. For all questions and dimensions of the overall transparency index see Dincer and Eichengreen (2014) pp. 237-240.

**Table A2: Variables and Data Source**

Variable	Definition	Source
Historical Volatility	Annual standard deviation of the weekly bilateral exchange rate return	WM / Reuters closing spot rates, Thompson Reuters
Conditional Volatility	Conditional volatility retrieved from a GARCH(1, 1) approach based on daily bilateral exchange rate returns	WM / Reuters closing spot rates, Thompson Reuters
Direct Communication	Questions 1 and 2 of the political subcategory taken from the central bank transparency index of Dincer and Eichengreen (2014)	Dincer and Eichengreen (2014)
Indirect Communication	Economic subcategory and question 2 of the operational subcategory taken from the central bank transparency index of Dincer and Eichengreen (2014)	Dincer and Eichengreen (2014)
In Trade	Log bilateral trade	UN Comtrade
Gov. Debt	Government Debt per GDP (average of the respective countries)	IMF - World Economic Outlook
Size	Economic size measured as log product of real GDP of the respective countries	World Bank - World Development Indicators
Reserves	Total reserves (including gold) per GDP (average of respective countries)	World Bank - World Development Indicators
FX-Regime	Continuous variable based on de facto exchange rate classification of Reinhart and Rogoff (average of the respective countries)	Reinhart and Rogoff (2004)
FX-Crisis	Dummy variable that equals 1 if at least one of the respective currencies experiences a currency crash in accordance to the definition of Frankel and Rose (1996).	WM / Reuters closing spot rates, Thompson Reuters
Inflation Volatility	Annual standard deviation based on monthly inflation rates (average of the respective countries)	International Financial Statistics - IMF, Thompson Reuters
M1 Volatility	Annual standard deviation based on monthly M1 growth rates (average of the respective countries)	IMF - Monetary and Financial Statistics, Thompson Reuters
Interest Rate Volatility	Annual standard deviation based on monthly interest rate growth rates (average of the respective countries)	IMF - International Financial Statistics



**Continue Table A2...**

Variable	Definition	Source
Real GDP Shock	Absolute value of the difference in yearly real GDP growth rates between the respective countries	World Bank - World Development Indicators
Bank System Shock	Absolute value of the difference in the change of deposit money bank's assets to GDP between the respective countries.	World Bank - Global Financial Development Database
Terms-Of-Trade Shock	Absolute value of the difference in the growth rate of the net barter terms of trade index between the respective countries	World Bank - World Development Indicators
Industrial Production Volatility	Annual standard deviation based on monthly M1 growth rates	IMF - International Financial Statistics, Thompson Reuters, World Bank - Global Economic Monitor
Soft IT	Variable that equals 1 if both countries have a soft inflation targeting regime (IT), 0.5 if only one country has a soft IT and zero otherwise.	Minea and Tapsoba (2014), Rose (2007) and central bank homepages
Strict IT	Variable that equals 1 if both countries have a strict inflation targeting regime (IT), 0.5 if only one country has a strict IT and zero otherwise.	Minea and Tapsoba (2014), Rose (2007) and central bank homepages
Central Bank Independence	Legal central bank independence measure of Cukierman et al. (1992) (average of the respective countries)	Garriga (2016)
Bank Capital Asset Ratio	Bank Capital to Asset Ratio (average of both countries)	World Bank - Global Financial Development Database
Size of Banking System	Deposit money banks' assets to GDP (average of the respective countries)	World Bank - Global Financial Development Database
Financial Integration	Sum of total external assets and total external liabilities as a share to GDP (average of the respective countries)	Lane and Milesi-Ferretti (2007) database - "External Wealth of Nations" Dataset, 1970-2011
Z-Score	Z-score (average of the respective countries)	World Bank - Global Financial Development Database
Current Account Balance	Current Account Balance per GDP (average of the respective countries)	IMF - World Economic Outlook

**Table A2 continued...**

Variable	Definition	Source
Polity IV	Polity IV scores (average of the respective countries)	Systemic Peace / Polity IV Project
FSI - Summary Index	Summary Index of Economic Freedom Index (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
FSI - Freedom to Trade	Freedom to Trade subcategory of Economic Freedom (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
FSI - Size of Government	Size of Government subcategory of Economic Freedom (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
FSI - Sound Money	Sound Money subcategory of Economic Freedom (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
FSI - Legal System	Legal System subcategory of Economic Freedom (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
FSI - Regulation	Regulation subcategory of Economic Freedom (average of the respective countries)	Fraser Institute - Economic Freedom of the World project
Inflation Shock	Absolute value of the difference in yearly inflation rates between the respective countries	IMF - World Economic Outlook
Current Account Shock	Absolute value of the difference in the change of the current account per GDP between the respective countries	IMF - World Economic Outlook
Reserve Shock	Absolute value of the difference in the growth rate of real reserves (incl. gold) between the respective countries	World Bank - World Development Indicators
Export Shock	Absolute value of the difference in the change of overall exports per GDP between the respective countries	World Bank - World Development Indicators
Lending Rate Shock	Absolute value of the difference in the lending rate between the respective countries	IMF - International Financial Statistics

**Notes:** This table describes the variables used in the empirical analysis, it provides information concerning the definition of these variables as well as the data sources on which these variables are based. All variables are defined as bilateral variables.

**Table A3: Summary Statistics**

Variable	mean	sdv.	within sdv.	min	max
Historical Volatility	1.68	1.12	0.92	0.01	10.80
Conditional Volatility	0.83	0.29	0.12	0.11	2.98
Direct Communication	1.54	0.39	0.11	0.25	2
Indirect Communication	1.56	0.78	0.28	0	3.75
Bilateral Trade (in 2005 mm USD)	2436.67	17821.55	2155.20	0.00	532069.40
Government Debt per GDP	53.46	23.32	9.75	7.02	171.94
Real GDP (in 2005 mm USD)	668085.30	1399612.00	83956.26	1743.47	9216162.00
Reserves per GDP	18.42	11.38	3.17	1.62	95.68
FX-Regime	1.68	0.47	0.19	1	4
FX-Crisis	0.09	0.29	0.27	0	1
Inflation Volatility	1.30	1.00	0.82	0.08	12.58
M1 Volatility	4.37	2.67	2.02	0.51	28.55
Interest Rate Volatility	6.32	4.82	3.31	0.00	41.72
Real GDP Shock	3.08	2.63	2.19	0.00	18.70
Bank System Shock	6.56	10.46	7.72	0.00	110.89
Terms-Of-Trade Shock	7.14	7.39	6.06	0.00	65.85
Industrial Production Volatility	4.68	2.42	1.82	0.42	18.40
Inflation Targeting (Soft Def.)	0.43	0.34	0.13	0	1
Inflation Targeting (Strict Def.)	0.43	0.34	0.13	0	1
Central Bank Independence	0.57	0.14	0.03	0.13	0.90
Bank Capital Asset Ratio	9.22	2.37	1.02	3.1	18.98
Size of Banking System	65.38	32.02	8.92	8.06	223.94

**Table A3 continued...**

Variable	mean	sdv.	within sdv.	min	max
Financial Integration	2.70	3.88	2.58	0.51	46.49
Z-Score	14.04	6.86	2.26	0	49.49812
Current Account Balance	-1.88	5.31	2.37	-27.78	21.04
Capital Account Inflow Controls	0.37	0.23	0.06	0	1
Economic Development	16.80	2.17	0.17	10.37	22.01
POLITY IV	6.57	3.06	0.89	-6	10
FSI - Summary Index	7.00	0.56	0.16	5.12	8.71
FSI - Freedom to Trade	7.21	0.76	0.22	4.72	9.26
FSI - Size of Government	6.61	0.82	0.31	3.45	9.15
FSI - Sound Money	8.18	0.95	0.38	3.97	9.81
FSI - Legal System	6.16	1.21	0.27	2.50	9.24
FSI - Regulation	6.84	0.62	0.26	4.48	8.63
Inflation Shock	3.57	4.07	3.43	0	42.89
Current Account Shock	3.56	3.30	2.42	0.001	24.13
Reserve Shock	3.49	3.88	3.20	0.000242	50.35
Export Shock	3.89	4.12	3.29	0.000043	42.65
Lending Rate Shock	9.74	11.99	7.01	0	116.52
Remoteness	8.64	0.35	0	7.66	9.47
Conservatism	0.9	0.11	0	0.37	0.99
Interest Rate Sensitivity	-0.0751	0.0485	0	-0.3018	0

**Notes:** This table reports the summary statistics for the variables used in the empirical analysis. It includes the mean, the standard deviation (sdv.), the within standard deviation (within sdv.) and the minimum and maximum values for the dependent variables as well as for all explanatory variables. Since we conduct our analysis on the level of bilateral exchange rates, all variables are also defined on a bilateral level.

**Table A4: Currencies in the baseline estimation**

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Albanian Lek, Argentinian Peso, Australian Dollar, Bangladeshi Taka, Brazilian Real, Botswana Pula, Belarusian Ruble, Canadian Dollar, Chinese Yuan Renmimbi, Colombian Peso, Czech Koruna, Egyptian Pound, Ethiopian Birr, Fijian Dollar, Georgian Lari, Ghanaian Cedi, Guatemalan Quetzal, Croatian Kuna, Hungarian Forint, Indonesian Rupiah, Israeli Shekel, Indian Rupee, Icelandic Krona, Jamaican Dollar, Japanese Yen, Kenyan Shilling, Kuwaiti Dinar, Latvian Lat, Lithuanian Litas, Macedonian Denar, Maltese Lira, Malawian Kwacha, Malaysian Ringgit, Mauritian Rupee, Mexican Peso, Moldovan Leu, Mozambican Metical, New Zealand Dollar, Nigerian Naira, Pakistani Rupee, Peruvian Sol, Philippine Peso, Polish Zloty, Russian Ruble, Rwandan Franc, Seychellois Rupee, Singapore Dollar, Slovak Koruna, South Korean Won, Sri Lankan Rupee, Swedish Krona, Swiss Franc, Tanzanian Shilling, Thai Baht, Tunisian Dinar, Turkish Lira, UK Pound, Ugandan Shilling, US Dollar, Uruguayan Peso, Vanuatu Vatu, South African Rand, Zambian Kwacha

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**Notes:** This table reports the all currencies that are included in the baseline estimation of Tables 1a – 2b.



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