Monetary Policy and Carry Trade[1]

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Abstract

This paper discusses the relation between monetary policy and currency risk premium in the context of a model in which central banks diverge in terms of the preferences and act either under discretion or commitment. The model is able to reproduce sizable foreign currency risk premium under discretion when the central bank in the foreign country is less conservative than the monetary authority at home which leads to higher nominal interest rates and a counter-cyclical inflation in the foreign country. The model when calibrated to match key moments of real and nominal macroeconomic variables of Latin America countries can explain the excess returns of the currencies of the region

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1. Introduction

The positive returns of carry trade investments, in which investors go long in high interest rate currencies and borrow in low interest rate currencies, challenge the standard arbitrage theory that connects short-term interest rates and exchange rates. Currencies with higher short-term interest rates should depreciate relative to currencies with lower interest rates to avoid arbitrage opportunities in a world with free capital flows. Motivated by the fact that short-term interest rates are to a large extent a by-product of monetary policy, this paper asks whether the failure of the standard theory, namely the positive returns of carry trade, can be explained by monetary policy asymmetries across countries.

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With this in mind, we build a two-country model in which central banks have different preferences that translate into asymmetric responses to consumption growth shocks and show in which cases monetary asymmetries can lead to realistic levels of currency risk premium. We find that when the central bank in the foreign country is less conservative than the monetary authority at home and acts under discretion, foreign nominal interest rates are higher as the economy ends up in a sub-optimal time-inconsistency equilibrium in which foreign agents are subject to inflationary risk. This inflationary risk leads to a cross-country difference in the nominal price of consumption risk and to a positive foreign currency risk premium proportional to the weight on output in the loss function of the foreign central bank.

Exploiting the differences in the monetary institutional arrangements between Latin America and the US, we calibrate the model to replicate key features of four Latin America economies (Brazil, Colombia, Chile and Mexico) and find that the model, while disciplined to match key moments of real and nominal variables, can reproduce the observed pattern of carry trade returns in the region. We choose these sample of countries to calibrate the model as carry trade investments are common in Latin America and because of the important differences in monetary institutions within the region.[2][3]

We document that carry trade returns in Latin America are positive, on average, but quite heterogeneous. More importantly, carry trade returns are by the most part explained by the nominal and not the real component. Real carry trade returns are for most countries in our sample small or in some cases negative. The annual nominal carry trade returns, in excess of real returns, vary from less than 1% in Chile to 4% in Colombia and Mexico. In terms of annual Sharpe Ratios, nominal carry trade returns in excess of real returns range in the region from 0.12 to 0.56. This heterogeneity in returns across the region is difficult to explain by differences in business cycles dynamics, currency crashes or different market sizes or trade frictions. Moreover, as the most of carry trade returns in the region are compensation for nominal risk, explanations based on real factors offer limited explanatory power. We argue in this paper that both the average and the cross-country returns of carry trade investments in Latin America can be explained by monetary policy asymmetries.

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[2] Carry trade is a common investment strategy in Latin America. Investors either buy short-term government bonds denominated in local currency or take long forward positions in domestic currencies across Latin America using the U.S. dollar (USD) as the funding currency.

[3] At the end of the 90s, Latin America experienced a wave of legal reforms towards central bank independence, but the scope of these reforms within the region was rather mixed. In some countries, like Colombia, the Finance Minister is a voting member of the central bank´s board, in others, like Brazil, the monetary authority is entrusted to promote economic development, while in others, like Chile, the monetary authority has an explicit mandate to maintain price stability. Carriere-Swallow, Jacome, Luis, Magud, and Werner (2016) present a detailed account of legal reforms in the last few decades of monetary institutions in Latin America

The model here presented features two-countries, home and foreign, and investors that exhibit preferences for an early resolution of uncertainty and with access to a full set of state-contingent securities. Aggregate consumption in real terms follows an auto regressive process with time-varying volatility shocks which are positively correlated across countries. Preferences and shocks determined the pricing kernel of investors in real terms while monetary policy sets inflation and helps to determine the nominal pricing kernel. We calibrate the model so countries have the same preferences and endowment shocks, so there is no currency risk premium in real terms. The central bank of the home country is of the conservative type, namely only cares about quadratic target-deviations of inflation and puts no weight on changes in output growth. In its turn, the foreign central bank seeks to minimize deviations from both inflation and output growth to specific targets. In equilibrium, inflation and nominal interest rates in the foreign country are higher, as in the benchmark Barro and Gordon (1983) model, and foreign inflation is counter-cyclical as the central bank tries to stimulate the economy in bad times. This inflationary risk produces a higher nominal price of consumption risk of foreign agents and leads to a positive risk premium of foreign currency.

We contrast the solution under discretion with the case in which both central banks commit to follow a Taylor rule where short-term nominal interest rates move in response to changes in inflation and output growth as in Backus, Gavazzoni, Telmer, and Zin (2013). We solve for the inflation processes consistent with the Taylor rule at home and abroad and show that when the foreign central bank exhibits a pro-cyclical and accommodative monetary policy relative to the home country, the model also predicts a positive risk premium in the foreign currency. However, the model under commitment cannot reproduce sizable currency risk premiums unless there is a large difference in policy parameters and risk aversion is twice a large as in the discretionary model. Moreover, the commitment case cannot reproduce the cross-country heterogeneity in currency risk premiums when the model uses as input the estimates of Taylor rule coefficients for the sample of Latin America economies.

This paper is related to a large literature devoted to study the nature of carry trade returns and the failure of the uncovered interest parity first documented in the seminal works of Tryon et al. (1979), Bilson (1981) and Fama (1984). In this paper we argue that cross-country differences in monetary policies can help to explain carry trade returns observed in the data in compensation of nominal risks. This explanation is close to the work of Backus, Gavazzoni, Telmer, and Zin (2013) in which monetary policy in the form of a Taylor rule can be a source of currency risk premium. We differ from their work as we focus on the case of monetary policy under discretion in which central banks have different preferences. We also differ in the economies selected to calibrated the model.

While they focus on reproducing key features of the Australian economy, we use the case of Latin America countries, which we believe is a good sample to study the role of discretionary policy.

As the model here described belongs to the family of affine models, this paper is related to the work of Backus, Foresi, and Telmer (2001). In addition, our work relates to Lustig, Roussanov, and Verdelhan (2011), as they argue that carry trade returns can be explained by different cross-country exposure to a common shock, namely a global risk. Given that in our setup volatility shocks are correlated across countries, our model provides of an endogenous explanation based on monetary policy asymmetries of why countries have different exposures (loadings) relative to a common shock.

There is a long list of papers, like Farhi and Gabaix (2016), that explains carry trade returns based on real factors. Hollifield and Yaron (2001) document that most of the deviations from the uncovered interest rate parity can be attributed to real and not nominal factors. Through the less of our model, we find this result not surprising given the sample used in reaching this conclusion: US, Germany, Canada, UK and Japan, countries with monetary authorities regarded as of the conservative type.

Finally, this paper relates to long list of works that study time-inconsistency and discretionary monetary policy such as Kydland and Prescott (1977), **?**, Barro and Gordon (1983) and Clarida, Galí, and Gertler (1999), among others.

In the next section we discuss carry trade investment in Latin America and contrast our explanation with alternative hypothesis in the literature. Section 3 presents the model and section 4 discusses the nature of currency risk premium in this environment. Section 5 present the model simulations and the quantitative results and the final section concludes.

2. Carry Trade in Latin America

Carry trade is a common investment strategy in Latin America.[4] Investors either buy short-term government bonds denominated in local currency or take long forward positions in domestic currencies across Latin America using the U.S. dollar (USD) as the funding currency. The first form of carry trade is quite common in Brazil and Colombia, where government securities denominated in local currency are easy to purchase. In Mexico, where the derivatives market is very liquid, carry trade investments are done through long positions in the forward market. In Brazil, in addition to the debt instruments, investors often use non-deliverable forwards in order to invent in the domestic currency.

Real carry-trade returns, abstracting from bid-ask spreads, are defined as:

$$r^r x_{t+1} = e_{t+1} - e_t + r^*_t - r_t \tag{1}$$

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[4] See BIS (2015) for a detailed account of carry-trade practices in the region

where e_t is the log of the real exchange rate expressed in units of USD per unit of the destination currency, r_t is the real short-term nominal interest rate in the U.S, which throughout the paper will be regarded as the "home" country, and i_t^* is the real interest rate in the different Latin American countries of our sample. The carry-trade returns, the gains from holding short-term assets denominated in local currency being funded in U.S. dollars, can be breakdown between the spot changes in the real exchange rate $(e_{t+1} - e_t)$, namely the gains associated to the appreciation of the destination currency, and the interest rate differential of real rates $(r_t^* - r_t)$.

In nominal terms carry-trade returns can be defined as:

$$rx_{t+1} = s_{t+1} - s_t + i_t^* - i_t \tag{2}$$

where s_t is the log of the nominal exchange rate expressed in units of USD per unit of the destination currency; i_t and i_t^* are the nominal short-term interest rate in home and foreign, respectively. Absent market frictions or currency risk premium, arbitrage theory implies that the real carry-trade returns should be zero and there should be a relation between the spot changes in the real exchange rate and the interest rate differential governed by the Uncovered Interest Rate (UIP) parity:

$$s_{t+1} - s_t = c + b\left(i_t - i_t^*\right) + residuals \tag{3}$$

where b, the UIP coefficient, should be one, and the intercept c and the residuals should be zero. We can also test whether the UIP holds in real terms by running the following regression:

$$e_{t+1} - e_t = d + b^r\left(r_t - r_t^*\right) + residuals \tag{4}$$

Table (1) reports the average carry trade returns and the UIP coefficient of both nominal and real returns for Brazil, Colombia, Chile and Mexico for the 2001-2014 period. In line with many papers that document the failure of UIP in the time series, we find a negative b coefficient for Brazil and Mexico and large standard deviations of the coefficients for the other currencies, implying temporary deviations from the UIP in nominal terms.

We also find that nominal carry-trade returns are positive for all the countries in our sample but vary greatly within the region. For our sample period the annual Sharpe Ratio of carry trade investments in the Brazilian Real (BRL) is 0.7, which is 40% larger than the Sharpe Ratio of the stock market in the U.S. In contrast, the annual Sharpe Ratio of carry trade investment in Chile is 0.21, less than half of the equity returns in the U.S.

Carry-trade returns in real terms are much smaller and in most cases are close to zero and for the case of Mexico they are negative. In general, the nominal component of the carry-trade investments in the region accounts for most of its profitability.

What explains these differences in nominal carry-trade returns across the region? Latin America countries are subject to similar aggregate shocks. In fact they are perceived by many investors as one investment region. Output dynamics are very similar in all the countries as result of comparable production structures and similar external shocks. It is hard to argue that business cycles dynamics can explain the observed differences in the dynamics of exchange rates in the region and the carry-trade returns discussed before.

This evidence suggests that an important part of the explanation is related to nominal and not real factors as suggested by Hollifield and Yaron (2001) and Farhi and Gabaix (2016) when discussing nominal and real risks in developed economies.

Brazil and Mexico have liquid domestic financial markets, much bigger than the rest of the countries in the region, so it is also hard to explain the higher returns of carry trade in Brazil relative to other countries can be due to liquidity risks. Regarding trade frictions, most of these countries are open to international flows and regulation restricting financial investments is relatively homogeneous within the region. The similarity in domestic financial markets makes also harder for stories based on market segmentation like Bacchetta and Van Wincoop (2006) and Alvarez et al. (2002). Currency crashes, as suggested by Brunnermeier, Nagel, and Pedersen (2009), doesn't seem to fit the pattern of cross-country returns as there is no relation between the probability of sudden exchange rates devaluations, at least in the ex-post observed sample, and the carry-trade returns. It is also hard to explain the cross-country dispersion in carry trade returns based on a "peso problem" explanation such as the one proposed by Burnside, Eichenbaum, Kleshchelski, and Rebelo (2011). There is no relation between the cross-section based on the differences in skewness across countries in the spot changes of the nominal exchange rate in the sample. [5]

In this paper we argue that carry-trade returns in Latin America can be explained by the currency risk premium induced by differences in monetary policy in the region. Since the beginning of 2000, Latin America central banks adopted inflation targeting using short-term interest rates as their main policy instrument. However, the preferences, credibility and institutional setup of these central banks are different. We study how these differences can generate various currency risk premiums as local monetary authorities diverge in terms of their commitment to fight inflation in response to macroeconomic shocks.[6]

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[5] Differences in the fiscal situation of each country that materialize in default risk can play a role in the observed currency risk premium across countries. However, we believe this source of risk has limited explanatory power as for many years in our sample, sovereign debt in the countries under consideration was classified as investment grade. The best example is the case of Chile and Mexico that are investment grade since 1994 and 2000, respectively. We compute the carry trade returns adjusted for default risk using Credit Default Swaps and find similar patterns. Results are available upon request.

[6] In this paper we don´t address the issue of exchange rate predictability and focus on the conditions under which monetary policy can generate inflationary risk and currency risk premium. Example of papers

We propose and calibrate a model in which the monetary authority lacks commitment and has different preferences regarding how policy should try to stimulate real activity. In this setup, less conservative central banks create an inflationary bias that affects both the level and the volatility of inflation and introduces inflationary risk in the economy. Alternatively, we analyze a monetary regime in which central banks commit to a Taylor Rule but have response coefficients to aggregate shocks that vary from country to country. In the quantitative section we discuss how much risk premium and carry-trade returns these two alternative specifications deliver when the model is calibrated to match key moments of aggregate macroeconomic series for each country.

3. Model

This section describes the basic environment and equations of the model. A detailed explanation and the full derivation of all expressions is available in the online appendix.

3.1. Preferences and Shocks

There are two countries: home and foreign. The representative agent in the home country has the following Epstein and Zin (1989) recursive preferences over a stochastic stream of consumption (c_t):

$$U_t = \left[(1-\beta)\, c_t^{\gamma} + \beta f_t \left(U_{t+1}\right)^{\gamma}\right]^{\frac{1}{\gamma}} \tag{5}$$

where β and ρ represent the discount parameter and the inter-temporal elasticity of substitution, respectively. The function f_t is defined by the following expression:

$$f_t\left(U_{t+1}\right) = E_t\left[U_{t+1}^{\alpha}\right]^{\frac{1}{\alpha}} \tag{6}$$

and captures the preference of investors to the early resolution of uncertainty. The parameter α governs the relative risk aversion and depending on whether is lower or higher than the inter-temporal elasticity of substitution it determines whether agents have preferences for early or late resolution of uncertainty. The real stochastic discount factor of agents in this economy (n_{t+1}) can be written as:

$$n_{t+1} = \beta \left(\frac{c_{t+1}}{c_t}\right)^{\gamma-1} \left(\frac{U_{t+1}}{f_t\left(U_{t+1}\right)}\right)^{\alpha-\gamma} = \beta \left(y_{t+1}\right)^{\gamma-1} \left(\frac{U_{t+1}}{f_t\left(U_{t+1}\right)}\right)^{\alpha-\gamma}$$

where y_{t+1} represents the growth rate of consumption, which in this economy is equal to the output growth rate given the absence of physical capital. The processes for output growth and the volatility of consumption shocks are defined by:

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that study exchange rates predictability and monetary policy include Mark (1995), Chinn and Meese (1995), Mark and Sul (2001)andMolodtsova and Papell (2009).

$$y_{t+1} = \left(1-\rho_y\right)\bar{y} + \rho_y y_t + v_t^{\frac{1}{2}}\varepsilon_{t+1}^{y} \tag{7}$$

$$v_{t+1} = \left(1-\rho_v\right)\bar{v} + \rho_v v_t + \sigma\varepsilon_{t+1}^{v} \tag{8}$$

where ρ_y and ρ_v govern the auto-correlation of the two processes and ε_t^y and ε_t^v are the innovations of each process. The unconditional mean of the output growth rate and its volatility are $\bar{y}$ and $\bar{v}$, respectively, while the conditional variance of the volatility of output growth is σ^2.

The foreign country has symmetrical preferences and stochastic processes for its output growth rate (y_t^*) and volatility (v_t^*), with correlations η_{y,y^*} and η_{v,v^*} for the two-pairs of innovations: $\{\varepsilon_t^y, \varepsilon_t^{*y}\}$ and $\{\varepsilon_t^v, \varepsilon_t^{*v}\}$.

The linearize logarithm of the real pricing kernel of home investors, as in Hansen, Heaton, and Li (2008), is:

$$-\,log\left(n_{t+1}\right) = \delta^r + \delta_y^r y_t + \delta_v^r v_t + \lambda_y^r v_t^{\frac{1}{2}}\varepsilon_{t+1}^{y} + \lambda_v^r\sigma\varepsilon_{t+1}^{v} \tag{9}$$

with the following coefficients:

$$\delta^r = -log\beta + \left(1-\rho_y\right)\left(1-\gamma\right)\bar{y} + \tfrac{\alpha}{2}\left(\alpha-\gamma\right)w_v^2\sigma^2$$

$$\delta_y^r = \rho_y\left(1-\gamma\right) \qquad \delta_v^r = \tfrac{\alpha}{2}\left(\alpha-\gamma\right)\left(1+w_y\right)^2$$

$$\lambda_y^r = \left(1-\gamma\right) - \left(\alpha-\gamma\right)\left(1+w_y\right) \qquad \lambda_v^r = \left(\gamma-\alpha\right)w_v$$

$$w_y = \tfrac{\beta\rho_y}{1-\beta\rho_y} \qquad w_v = \tfrac{\alpha\beta}{2\left(1-\beta\rho_v\right)\left(1-\beta\rho_y\right)^2}$$

The coefficients (loadings)λ_y^r and λ_v^r, can be interpreted as the real price of consumption and volatility risk,respectively, as they capture the effect of shocks in the investor´s pricing kernel. The domestic pricing kernel for a risk-free bond in real terms is $E_t\left(n_{t+1}R_t\right) = 1$, so the one-period real interest rate of the economy is $r_t = -logE_t\left(n_{t+1}\right)$, which under the assumption of log-normality can be written as: $r_t = E_t\left[-log\left(n_{t+1}\right)\right] + V_t\left[-log\left(n_{t+1}\right)\right]$. Using the expression for the real stochastic discount factor (9) we can write the real interest rate of the home country as:

$$r_t = \delta^r - \frac{1}{2}\left(\lambda_v^r\sigma\right)^2 + \delta_y^r y_t + \left(\delta_v^r - \frac{1}{2}\lambda_y^{2r}\right)v_t \tag{10}$$

Both the real stochastic discount factor and the real interest rate are functions of preference parameters and shocks. Nominal variables are determined by monetary policy that in is turn determines inflation. The nominal stochastic discount factor can be represented by the following expression:

$$m_{t+1} = n_{t+1} e^{-\pi_{t+1}} \tag{11}$$

The nominal one-period interest rate satisfies:

$$i_t = -log E_t \left(m_{t+1} \right) \tag{12}$$

The domestic pricing kernel that price any asset in the home currency with returns R_t is given by $E_t \left(m_{t+1} R_{t+1} \right)$. Analogously, the foreign pricing kernel that price any asset in the foreign currency with returns R_t^* is given by $E_t \left(m_{t+1}^* R_{t+1}^* \right)$. The home pricing kernel must also price the returns of foreign assets once expressed in the home currency: $E_t \left(m_{t+1} \frac{S_{t+1}}{S_t} R_{t+1}^* \right)$, where S_t denotes the nominal exchange rate between the home and foreign currency.

Under the assumption of complete markets the domestic and foreign pricing kernels that price both local and foreign denominated assets are unique and satisfy:[7]

$$\frac{S_{t+1}}{S_t} = \frac{m_{t+1}^*}{m_{t+1}} = \frac{n_{t+1}^* e^{-\pi_{t+1}^*}}{n_{t+1} e^{-\pi_{t+1}}} \tag{13}$$

Given this relation, changes in the exchange rate are explained by differences between the pricing kernel of home and foreign investors that have a real and a nominal component. Assuming that preferences and shocks are symmetrical across countries, exchange rate dynamics are fully explained by differences in nominal variables. In the next section we discuss how nominal variables are determined by monetary policy and highlight the role of asymmetric preferences in the objective function of the home and foreign central bank.

3.2. Monetary Policy

This section describes two alternative cases for the monetary policy design problem. In the first case, the central bank seeks to minimize a loss function that depends on squared deviations of output and inflation from their respective targets. The policy parameter that governs the trade-off between these two goals, namely the relative weight of output deviations in relation to deviations of inflation from its target, is a primitive of the model and captures the asymmetric preferences of different central banks. The monetary authority of each country chooses every period the instrument, the short-term nominal interest rate, to engineer the preferred sequence of inflation and output in order to maximize its objective function.

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[7] Because the model here presented belongs to the class of affine models, the distinction between complete and incomplete markets it not empirically relevant, as pointed out by Backus et al. (2001).

In the alternative monetary policy arrangement, the central bank of each country commits to follow a Taylor-rule, a response of the nominal interest rate to innovations of inflation and output. Asymmetric preferences or institutional differences in monetary policy appear in this case as different Taylor-rule coefficients.

In either of two scenarios, asymmetric preferences in the policy goals of the monetary authority of each country translate into difference in the dynamics of nominal variables and then affect exchange rate dynamics.

3.2.1. Discretionary policy

As in Kydland and Prescott (1977), Barro and Gordon (1983), Clarida et al. (1999), and other papers, we consider a central banks that is unable to commit to a specific monetary rule and chooses inflation every period in a discretionary way. The monetary authority minimizes a loss function that depends on quadratic deviations from a inflation ($\hat{\pi}_t$) and output growth rate targets ($\hat{y}_t$):

$$\mathcal{L} = min_{\pi_t} \left(\pi_t - \hat{\pi}_t\right)^2 + \lambda \left(\tilde{y}_t - \hat{y}_t\right)^2 \tag{14}$$

subject to the following Phillips curve:

$$\tilde{y}_t = y_t + \phi \left(\pi_t - E_t \pi_t\right) \tag{15}$$

The preference of the central bank depend on the relative weight on output losses, $0 < \lambda < 1$, which defines how conservative the central bank is. The inflation target $\hat{\pi}_t$ is time-varying and we model it as: $\hat{\pi}_t = \hat{\pi} + \epsilon_t^{\pi}$, where ϵ_t is a i.i.d shock with mean zero and variance $\sigma^2_{\epsilon^{\pi}}$. The output growth rate target $\hat{y}_t$ is higher than the mean of the endowment shock by a factor of κ, as the central bank seeks to stabilize the economy to a higher level than the unconditional mean of output growth rate: $\hat{y}_t = \kappa \bar{y}$.[8] In the rational expectation equilibrium, the lack of commitment by the central bank and the temptation to stimulate the economy leads to an inflationary bias proportional to the weight that the monetary authority gives to output growth in the loss function. Private agents take into account how the central banks adjusts policy as it is free to re-optimize at discretion in every period.

The inflation process in this case is described by:

$$\pi_t = \hat{\pi}_t + \phi \lambda \left(k \bar{y} - y_t\right) \tag{16}$$

The unconditional mean of inflation is higher as a sub-optimal equilibrium emerges in which monetary policy doesn't affect output as the private sector anticipates the tempta-

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[8] One possible explanation for this growth target is that the central bank wants to offset some real friction, like mark-up shocks, that are not explicit in the model.

tion of the monetary authority to inflate the economy ($\pi_t = E_t\pi_t$)[9]:

$$E\left[\pi_t\right] = \hat{\pi} + \phi\lambda\left(k-1\right)\bar{y} \tag{17}$$

In addition, the discretionary monetary policy creates a trade-off between inflation and output that leads to inflation risk: inflation increases when the economy is subject to a bad shock as the temptation to stimulate the economy increases.[10]

If the central bank is of the conservative type, $\lambda = 0$, or has a target equal to the realization of the endowment, the inflationary risk disappears, the volatility of inflation is $\sigma^2_{\epsilon^\pi}$ and monetary policy does not create a short-run trade-off between inflation and output growth.

The process of inflation determined by (16) combined with the real stochastic discount factor (9) yields the following nominal stochastic discount factor under discretion:

$$\begin{aligned} -log\left(m_{t+1}\right) = -log\left(n_{t+1}\right) + \pi_{t+1} = \left[\delta^r + \hat{\pi}_{t+1} + \phi\lambda\bar{y}\left(\kappa - 1 + \rho_y\right)\right] + \left[\delta^r_y - \phi\lambda\right]y_t \\ + \delta^r_v v_t + \left[\lambda^r_y - \phi\lambda\right]v_t^{\frac{1}{2}}\varepsilon^y_{t+1} + \lambda^r_v\sigma\varepsilon^v_{t+1} \end{aligned} \tag{18}$$

The short-term nominal interest rate of the economy consistent with this monetary policy arrangement is given by:

$$i_t = \delta^d + \delta^d_y y_t + \left(\delta^d_v - \frac{1}{2}\lambda^{d2}_y\right)v_t \tag{19}$$

where,

$$\delta^d_y = \delta^r_y - \phi\lambda\rho_y \qquad \delta^d_v = \delta^r_v$$

$$\lambda^d_y = \lambda^r_y - \phi\lambda \qquad \lambda^d_v = \lambda^r_v$$

$$\delta^d = \delta^r + \hat{\pi} + \phi\lambda\bar{y}\left(\kappa - 1 + \rho_y\right) - \tfrac{1}{2}\left(\lambda^r_v\sigma\right)^2 - \tfrac{1}{2}\sigma^2_{\epsilon^\pi}$$

Note that monetary policy in this regime only alters the price of consumption risk but has no effect on the price of volatility risk, as the central bank doesn't respond directly to volatility shocks.

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[9] Potentially, one can write-down a more complex and realistic policy objective such that the central bank is only tempted to stimulate the economy in bad times. Introducing this non-linearity in the model will not, though, change the key component needed in the model to introduce currency risk premia, the inflationary risk that leads to nominal losses, inflation, in times with negative realization of the endowment shock.

[10] This short-run trade-off between inflation and output is also present in the standard Neokeynesian model, either under discretion or commitment, when the economy is subject to cost push-up shocks. The trade-off can be improved, however, if the central bank can commit as shown in Clarida, Galí, and Gertler (1999).

3.3. Commitment in the form of a Taylor Rule

In an alternative scenario, similar to the one study by Backus, Gavazzoni, Telmer, and Zin (2013), the monetary authority commits to follow a Taylor rule that responds to inflation and the growth rate of the economy. The Taylor Rule takes the following form:

$$i_t = \tau + \tau_\pi \pi_t + \tau_y y_t \tag{20}$$

A central bank is described by the triple $\left(\tau, \tau_\pi, \tau_y\right)$. In equilibrium the inflation rate is such that the short-term interest rate implied by the nominal stochastic discount factor of the representative investor (12) equates the policy rate (20). This implies that the inflation rate solves the following difference equation:

$$\pi_t = -\frac{1}{\tau_\pi}\left(\tau + \tau_y y_t + logE_t n_{t+1} e^{-\pi_{t+1}}\right) \tag{21}$$

The solution takes the following the form:

$$\pi_t = a + a_y y_t + a_v v_t \tag{22}$$

with the following coefficients:

$$a = \tfrac{1}{\tau_\pi - 1}\left[\delta^r + a_y\left(1 - \rho_y\right)\bar{y} + a_v\left(1 - \rho_v\right)\bar{v} - \tfrac{1}{2}\left(\lambda_v^r + a_v\right)^2 \sigma^2 - \tau\right]$$

$$a_y = \tfrac{\delta_y^r - \tau_y}{\tau_{\pi - \rho_y}} \qquad\qquad a_v = \tfrac{\delta_v^r - \frac{1}{2}\left(\lambda_y^r + a_y\right)^2}{\tau_\pi - \rho_v}$$

This solution to the inflation process gives us the expression for the nominal interest rate under commitment:

$$i_t^c = \delta^c + \delta_y^c y_t + \left(\delta_v^c - \frac{1}{2}\lambda_y^{c2}\right) v_t$$

where,

$$\delta^c = \delta^r + a + a_y\left(1 - \rho_y\right)\bar{y} + a_v\left(1 - \rho_v\right)\bar{v} - \tfrac{1}{2}\left(\lambda_v^c \sigma\right)^2$$

$$\delta_y^c = \delta_y^r + a_y \rho_y \qquad\qquad \delta_v^c = \delta_v^r + a_v \rho_v$$

$$\lambda_y^c = \lambda_y^r + a_y \qquad\qquad \lambda_v^c = \lambda_v^r + a_v$$

4. Currency Risk Premium

The covered interest rate parity implies that

$$f_t - s_t = i_t - i_t^*$$

where f_t is the logarithm of the one-period forward exchange rate and s_t is the logarithm of the sport exchange rate in units of U.S. dollars (USD) per unit of foreign currency (say, Mexican Peso,MXN). Following Fama (1984) decomposition, the interest rate differential can be written as:

$$i_t - i_t^* = (f_t - E_t s_{t+1}) + (E_t s_{t+1} - s_t) = p_t + q_t \tag{23}$$

This expression breads down the interest rate differential, also known as the forward premium, as the sum of the expected depreciation rate, q_t, and the currency risk premium, p_t, which is the expected payoff of investing in the home currency on a forward contract. Taking logs in both sides to equation (13) gives us an expression for the depreciation rate:

$$s_{t+1} - s_t = log\,(m_{t+1}^*) - log\,(m_{t+1}) \tag{24}$$

Using this condition and the equation for the nominal interest rate (12), we can write the Fama (1984) as:

$$i_t - i_t^* = logE_t\,(m_{t+1}^*) - logE_t\,(m_{t+1}) = p_t + q_t \tag{25}$$

with,

$$q_t = E_t log\,(m_{t+1}^*) - E_t log\,(m_{t+1}^*) \tag{26}$$

$$p_t = \frac{1}{2}\left(Var_t log\,(m_{t+1}^*) - Var_t log\,(m_{t+1})\right) \tag{27}$$

The UIP coefficient in the regression (3) is defined according to this decomposition as: $b = cov\,(q_t, p_t + q_t)\,/Var\,(p_t + q_t)$. If $b < 0$, the expected depreciation rate and the currency risk premium need to satisfy: $cov\,(p_t, q_t) < 0$ and $Var\,(p_t) > Var\,(q_t)$. These conditions say that a negative UIP coefficient implies that the means and the variances of the difference between the stochastic discount factors, home and foreign, must move in opposite directions and the variation in the variances must exceed that of the means. If the currency risk premium is zero or constant, the UIP coefficient should be one.

Using the expression for nominal interest rates, home and foreign, we can write the forward premium as:

$$i_t - i_t^* = (\delta - \delta^*) + \delta_y y_t - \delta_y^* y_t^* + \left(\delta_v - \frac{1}{2}\lambda_y^2\right) v_t - \left(\delta_v^* - \frac{1}{2}\lambda_y^{*2}\right) v_t^* \tag{28}$$

and decompose this expression into the expected depreciation term and the currency risk premium:

$$q_t = \left[\left(\delta - \frac{1}{2}\lambda_v^2 \sigma^2\right) - \left(\delta^* - \frac{1}{2}\lambda_v^* \sigma^{2*}\right)\right] + \left[\delta_y y_t - \delta_y^* y_t^*\right] + \left[\delta_v v_t - \delta_v^* v_t^*\right] \tag{29}$$

$$p_t = \frac{1}{2}\left[\left(\lambda_v^{2*}\sigma^{2*} - \lambda_v^2\sigma^2\right) + \left(\lambda_y^{*2}v_t^* - \lambda_y^2 v_t\right) + \left(\sigma_{\epsilon^\pi}^{2*} - \sigma_{\epsilon^\pi}^2\right)\right] \tag{30}$$

Using this notation, the carry-trade return of investing in foreign currency is equal to:

$$-p_t = E_t s_{t+1} - s_t + i_t^* - i_t \tag{31}$$

which is the sum of the expected appreciation of the foreign currency and the interest rate differential. Assuming the preferences and shocks are symmetric across countries, so the volatility of the real stochastic discount factor is the same for home and foreign investors, the foreign currency risk premium is equal to the difference in the variance of inflation and the co-variance between the real pricing kernel and the inflation process:

$$-p_t = \frac{1}{2}Var_t\left(\pi_{t+1}\right) - \frac{1}{2}Var_t\left(\pi_{t+1}^*\right) + cov\left(log\left(n_{t+1}^*\right), \pi_{t+1}^*\right) - cov\left(log\left(n_{t+1}\right), \pi_{t+1}\right) \tag{32}$$

The monetary policy design of each country determines the variance of inflation and its correlation with the real stochastic discount factor. More specifically, the path of inflation and nominal interest rates engineered by the central bank in response to real shocks, change the price of consumption and volatility risk of investors and with them the foreign currency risk premium. As pointed out by Backus et al. (2013), the investor with the relative more volatile nominal pricing kernel perceives investing in foreign currency as relative risky because shocks that drive the real pricing kernel also dominate the relative variance of the difference of pricing kernels, which determines the exchange rate movements. Monetary policy reduces the volatility of the nominal stochastic discount factor when it generates inflation risk, which turns negative the correlation between inflation and output growth.

In the next section we discuss currency risk premium under discretion and commitment and show that foreign currency risk premium increases when the foreign central is less conservative, namely puts a higher relative weight to output deviations from target, or it is relatively more pro-cyclical and accommodative in its Taylor-rule responses to shocks.

4.1. Currency risk premium under discretionary policy

Assuming a perfect correlation between innovation in the volatility process for home and foreign (η_{v,v^*}=1), the foreign currency risk premium under discretion is given by:

$$-p_t = \frac{1}{2}\left[\left(\lambda_y^r - \phi\lambda\right)^2 - \left(\lambda_y^{r*} - \phi^*\lambda^*\right)^2\right]v_t + \frac{1}{2}\left(\sigma_{\epsilon^\pi}^2 - \sigma_{\epsilon^\pi}^{2*}\right) \tag{33}$$

If home and foreign investors have the same preferences, but the home country has a conservative central bank (the Fed), while the foreign monetary authority acts under discretion, the currency risk premium of holding the foreign currency is positive and given by:

$$-p_t = \left[\lambda^r_y \phi^* \lambda^* - \frac{(\phi^* \lambda^*)^2}{2}\right] v_t + \frac{1}{2}\left(\sigma^2_{\epsilon^\pi} - \sigma^{2*}_{\epsilon^\pi}\right) \tag{34}$$

The more weight the foreign central bank puts on output growth, the higher the risk premium of the foreign currency. Note that in this case the price of volatility risk plays no role in explaining currency risk premium as the two countries have the same λ^d_v loading.

4.2. Currency risk premium under commitment

It can be shown that in this, the risk premium in foreign currency is increasing in the difference between the Taylor rule coefficient with respect to output, $\tau^*_x - \tau_x$, and decreasing with respect to the difference in the inflation coefficient: $\tau^*_\pi - \tau_\pi$.[11] In other words, the more pro cyclical and accommodative is the monetary policy in the foreign country relative to the home country, the higher the currency risk premium of investing in the foreign currency.

For the case of perfectly correlated volatility shocks across countries (η_{v,v^*}=1), symmetric coefficients for preferences and stochastic processes and no autocorrelation of the output growth rate ($\rho_y = 0$), the foreign currency risk premium is determined by the difference of the τ_y/τ_π ratio between home and foreign:

$$-p_t = \frac{1}{2}\left[\left(\lambda^r_v + \frac{\delta^r_v - \frac{1}{2}\left(\lambda^r_y - \tau_y/\tau_\pi\right)^2}{\tau_\pi - \rho_v}\right)^2 - \left(\lambda^r_v + \frac{\delta^r_v - \frac{1}{2}\left(\lambda^r_y - \tau^*_y/\tau^*_\pi\right)^2}{\tau^*_\pi - \rho_v}\right)^2\right]\sigma^2 \tag{35}$$

$$+ \frac{1}{2}\left[\left(1 - \alpha - \tau_y/\tau_\pi\right)^2 - \left(1 - \alpha - \tau^*_y/\tau^*_\pi\right)^2\right] v_t \tag{36}$$

The first term in brackets of equation (35) captures the effect of asymmetric prices of volatility risk on the foreign currency risk premium. The higher the squared value of the price of volatility risk of home (λ^2_v) versus foreign investors (λ^{2*}_v), the larger the foreign currency risk premium. The value of the price of volatility risk and the foreign currency risk premium depend crucially in the Taylor-rule coefficients. On one hand, given that the real price of volatility λ^r_v and the parameter δ^r_v are both negatives, the risk premium is positive whenever $\tau_y/\tau_\pi < \tau^*_y/\tau^*_\pi$. On the other hand, there is an offsetting effect coming from the difference of τ_π and τ^*_π because increasing τ_π (or reducing τ^*_π), keeping all other parameters constant, lowers (increases) the coefficient λ^2_v (λ^{2*}_v) as τ_π (τ^*_π) appears in the denominator. This offsetting effect can be explained by the precautionary effect of volatility shocks. Higher volatility reduces nominal interest rates (precautionary effect). The a_v coefficient captures the relation between inflation and volatility and its

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[11] This relationship between currency risk premium and Taylor coefficients is also present in Backus, Gavazzoni, Telmer, and Zin (2013)

negative sign is result of this precautionary effect. If we reduce τ_{π}^{*} keeping $\tau_{y}^{*}/\tau_{\pi}^{*}$constant, the a_{v}^{*} coefficient tends to be higher in absolute terms (more negative), which leads to a reduction in the foreign currency risk premium, because the precautionary effect is larger and with it the volatility of foreign inflation. Note that the volatility of inflation is given by: $Var(\pi_t) = a_y^2 Var(y_t) + a_v^2 Var(v_t) + 2a_y a_v cov(y_t, v_t)$.

The second term of equation (35) captures the effect of asymmetric loadings (coefficients) of the price of risk of consumption. Whenever $\tau_y/\tau_\pi < \tau_y^*/\tau_\pi^*$ the foreign currency risk premium is positive and increases with v_t. In other words, the more pro-cyclical and accommodative the foreign central bank in relative terms, the lower the price of consumption risk of foreign investors and the higher the foreign currency risk premium.

5. Quantitative Analysis

5.1. *Calibration preferences and shocks*

Table (2) presents the set of parameters used to simulate the model at a monthly frequency. We keep the parameters governing preferences and shocks across the two monetary regime constant in order to isolate the effect of monetary policy in the nominal variables of the economy, including the currency risk premium. The baseline calibration matches key moments of Colombia's economy while Table (7) in the appendix presents the results of the model calibrated to target moments of each country.

We set the same parameter values of preferences and endowments for the US and the Latin America economies, so the model cannot produce any currency premium in real terms. The symmetric calibration of the real economy helps us to highlight the role of differences in monetary policy at producing currency risk premium in nominal terms.

The discount parameter β is set to match a level of 1.33% of real interest rates in annual terms. The elasticity of intertemporal substitution γ is 1/3 and set α to -39, so investors in the model have strong preferences for an early resolution of uncertainty. The level of risk aversion is unarguably high, but in line with recent papers in the asset pricing literature such as Lettau, Ludvigson, and Wachter (2008) and Piazzesi and Schneider (2007) and much lower than other papers that try to produce currency risk premium like Backus, Gavazzoni, Telmer, and Zin (2013). Output growth rate and volatility shocks are calibrated to match key properties of the business cycle in Latin America. The unconditional mean of output growth ρ_y is set to match Colombia´s monthly output growth rate and the auto-correlation of the growth rate is chosen to be zero as in the data. The unconditional mean of volatility $\bar{v}$ targets the volatility of output growth rate while the parameter of the autocorrelation of the volatility process ρ_v targets the average auto-correlation of real interest rates. We set the cross-country correlation of the consumption growth rate and the volatility innovations to numbers close to one to generate the co-movement in output and output volatility observed in the data. For the discretionary case, the conditional volatility parameter σ_v is set to be as large as possible subject to the constraint that the probability of having a negative realization for the volatility process is lower than 12%. For the Taylor rule model we set a lower volatility parameter such that the fraction of a negative realization is lower than 5% so as to have a positive risk premium.

5.2. *Calibration monetary policy*

The calibration of the monetary side of the economy treats differently the home country (US) and the foreign countries (Latin America economies). We assume that the Fed is either of the conservative type, so $\lambda\phi$=0, in the discretion case, or follows a Taylor Rule with $\tau_\pi = 1.5$ and $\tau_y = 0.5$ in the commitment case.

For the discretionary case, we set the parameters governing the preferences of the monetary authority so as to match the linear relation between inflation and output growth. Under discretion, the monetary parameter is identified by: $\lambda^*\phi^* = cov\left(\pi_t^*, y_t^*\right)/var\left(y_t^*\right)$. In the baseline calibration we set the value of this parameter to -0.29 using the covariance of inflation and output and the variance of output of Colombia. In Figure (1) we change this parameter consistently with the data for each country in our sample.

For the commitment case, we estimate Taylor Rules for our countries in our sample allowing for a gradually adjustment towards the target:

$$i_t = \sum_{j=1}^{N} \rho_{i,t-j} i_{t-j} + \left(1 - \sum_{j=1}^{N} \rho_{i,t-j}\right)\left(\tau + \tau_\pi \pi_t + \tau_y y_t\right)$$

We select the optimal lag for each country based on the statistical significance of the lag coefficients for the rule. For Brazil, Colombia and Mexico the optimal lag is two while for Chile is one. In Table (3) we report the monetary parameters under the two monetary regimes.

5.3. *Model simulation*

Table (5) compares the outcome of the simulation of the model, under the two monetary regimes, with the data. The model is designed to match the mean and cross-country correlation of consumption growth of the foreign country with the US and also the level of the real interest rate of the foreign country. The model is silent about real risk premium because preferences and shocks are calibrated symmetrically across countries. We test the two versions of the model in their ability to match nominal variables and to produce nominal risk premium of the foreign currency.

The model under discretion can produce much higher levels of currency risk premium than the model with the Taylor rule. The model under discretion produces an annual risk premium of 3.35%, which falls short of the 4.06% observed in the data but it is significantly higher than the 0.47% implied by the model under commitment.

A key difference between the two monetary regimes is that in the model under discretion monetary policy asymmetries only affect the price of consumption risk, while in the commitment model they affect the price of both the consumption and volatility risk but in opposite directions. In the Taylor-rule specification when the foreign central bank is relatively more pro-cyclical and accommodative $\left(\tau_y/\tau_\pi > \tau_y^*/\tau_\pi^*\right)$ the consumption price of risk of foreign agents is lower, so the loadings on the random volatility factor are asymmetric and the foreign currency risk premium is higher. The same asymmetries, however, lead to a more negative price of volatility risk of foreign agents lowering the mean of the foreign currency risk premium given that the risk premium of the model depends on the squared values of the price of risk.

This channel is a product of the precautionary effect of the volatility shocks that reduce the nominal interest rate. This precautionary effect explains the negative sign of the a_v coefficient (the parameter that governs the response of inflation to volatility shocks) and the positive relation between nominal interest rates and inflation coming from the volatility shocks. When the foreign central bank has a relative more accommodative policy $(\tau_\pi > \tau_\pi^*)$ this relation between interest rates and inflation is stronger, which leads to a more negative a_v^* coefficient. This in its turn increases the volatility of foreign inflation in response to volatility shocks reducing the risk premium implied by the model. This second channel is not present in the discretion model as the central bank engineers a path of inflation that doesn't respond directly to volatility shocks.

Both specifications, discretion and commitment, fall short at reproducing the volatility of nominal interest rates, which is not surprising given that the model lacks shocks that directly affect nominal variables, such as monetary shocks. For the same reason the model is not well equipped to reproduce the volatility of the exchange rate, a limitation that is shared by many models with full risk sharing (see Brandt, Cochrane, and Santa-Clara (2006)).

In addition to compare the model with the data from one country we are also interested in testing whether the model can explain some of the cross-section evidence regarding risk premium. The top panel of figure (1) shows the currency risk premium in annual terms implied by the baseline using different values of the monetary parameter $(\lambda\phi)$ estimated from each of the five countries in our sample keeping the real parameters constant. The figure also shows the annualized nominal currency risk premium, in excess of real returns, observed in our sample of countries. The results suggest that differences in monetary policy alone can help to explain the cross-country nominal returns of carry trade. The currency risk premium in the model and the data raises when the monetary parameter is more negative, namely when inflation is more counter-cyclical.

The bottom panel of figure (1) presents the currency risk premium implied by the Taylor rule model. In this case the model can not reproduce the cross-country pattern of carry trade returns, which seem to point towards the opposite relation between currency premium and the policy parameter. Moreover, the model predicts negative risk premia for the currencies of Brazil and Mexico, two of the countries with the largest carry trade returns in our sample.

Finally, we test how robust are our findings regarding the role of monetary policy in currency risk premium to changes in two key parameters: the risk aversion coefficient (α) and the parameter governing the conditional volatility of the time-varying shocks (σ).

Figure (2) compares the two models when changing these two parameters and keeping all other constant. This graph shows that in discretionary model the foreign currency risk premium is a linear and increasing function of the risk aversion coefficient. Equation (34) shows that the risk premium increases with the real price of consumption risk, which in the case of zero autocorrelation of the consumption growth rate, as it is the case in our baseline calibration, is just the difference between the risk aversion and the intertemporal elasticity parameters. The currency risk premium of this specification is also increasing with the conditional volatility parameter, but it is much less sensitivity to changes to this parameter.

In the Taylor rule model the risk premium also increases if the risk aversion coefficient is higher but only if the conditional volatility parameter is at the same time lower. A higher risk aversion coefficient increases the value of the price of risk of consumption but also increases the value of the price of risk of volatility, augmenting the offsetting effect that is not present in the discretionary model.

6. Discussion

Monetary policy is usually at the center of the discussion when analyzing exchange rate dynamics. However, the connection between monetary policy, carry trade returns and the uncovered interest rate parity remains still an open question. Backus, Gavazzoni, Telmer, and Zin (2013) have shown the connection between currency risk premium and monetary policy in the context of a model in which central banks follow a Taylor rule. Taylor rules provide of a good approximation of monetary policy in many countries, but for the case of emerging markets, important considerations about institutional design and the ability to commit of central banks leaves the door open to discuss different monetary policies. In this paper we discuss two alternative monetary policy arrangements (discretionary policy and commitment through a Taylor rule) and show that discretionary policy can help to explain the currency risk premium observed in Latin America countries. The main insight of the model here presented is that central banks operating under discretion that are less conservatives and tempted to stimulate the economy using inflation, can lead to a sub-optimal equilibrium where nominal interest rates are higher and domestic investors are subject to inflationary risk. Currencies with higher nominal interest rates, because of an inflationary bias, and inflationary risk should pay a risk premium. This explanation connects the level of nominal interest rate with the co-variance between inflation and consumption growth, which are two important ingredients to explain carry trade returns.

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Tables and Figures

Table 1: **UIP and Carry-Trade in Latin America**

	Brazil	Colombia	Chile	Mexico
Exchange rates, forward discount and returns (real)				
Mean Real Exchange Rate changes ($\triangle e_{t+1}$)	-1.27	-2.71	-1.28	-4.51
Std Real Exchange Rate changes	12.76	9.83	10.30	8.85
Mean Forward Discount ($r_t^* - r_t$)	6.67	1.86	1.55	3.03
Std. Forward Discount	0.78	0.47	0.59	0.56
Mean Carry Trade Returns ($r^r x_{t+1}$)	5.15	0.22	1.02	-1.52
Std. Carry Trade Returns	13.06	9.95	10.52	8.98
Sharpe Ratio Carry Trade	0.39	0.02	0.09	-0.16
UIP Coefficient	0.07	1.80	1.10	1.17
	[1.59]	[1.67]	[1.42]	[1.27]
Exchange rates, forward discount and returns (nominal)				
Mean Nominal Exchange Rate changes ($\triangle s_{t+1}$)	1.78	-0.22	-0.45	-2.34
Std Nominal Exchange Rate changes	12.28	9.67	9.50	8.40
Mean Forward Discount ($i_t^* - i_t$)	10.53	4.45	2.47	5.66
Std. Forward Discount	0.85	0.52	0.64	0.68
Carry Trade Returns (rx_{t+1})	8.83	4.28	2.01	3.32
Std. Carry Trade Returns	12.58	9.65	9.39	8.84
Sharpe Ratio Carry-trade	0.70	0.44	0.21	0.40
UIP Coefficient	-0.42	0.98	2.98	-0.25
	[1.31]	[1.43]	[1.12]	[0.94]
Carry Trade nominal vs real				
Difference Carry Trade Returns Nominal vs Real (%, annualized)	3.68	4.06	0.99	4.84
Difference Carry Trade Returns (Sharpe ratio) Nominal vs Real	0.31	0.42	0.12	0.56

Source: Bloomberg and central banks. Data at monthly frequency from January 2001 to March 2014. Real variables are computed using the consumer price index of each country. e_t is the log of the real exchange rate expressed in units of USD per unit of the local currency. r_t is the real short-term interest rate in the U.S. and r_t^* is the real short-term interest rate in each destination country. s_t is the log of the nominal exchange rate expressed in units of USD per unit of the local currency. i_t is the nominal short-term interest rate in the U.S. and i_t^* is the nominal short-term interest rate in each destination country. All moments are annualized and reported in percentage points. Sharpe ratios are computed as ratios of annualized means to annualized standard deviations. Carry trade returns in real and nominal terms are calculated using (1) and (2), respectively. The UIP coefficient in real and nominal terms come from the regressions (4) and (3). Standard errors in brackets.

Table 2: **Parameter Values (Preferences and Shocks)**

Variable	**Symbol**	**Value**
Discount Factor	β	0.9873
Risk Aversion	$1-\alpha$	40
Elasticity substitution	$(1-\gamma)^{-1}$	1.5
Mean output growth rate	$\bar{y}$	0.0035
Autocorrelation output growth rate	ρ_y	0
Mean volatility	$\bar{v}$	3.2e-05
Autocorrelation volatility	ρ_v	0.95
Conditional volatility	σ_v	10e-05
Correlation output innovations	$\eta_{y,y*}$	0.43
Correlation volatility innovations	$\eta_{v,v*}$	0.99

Table 3: **Monetary Policy Parameters (baseline)**

	Home	**Foreign**
Discretionary Case		
Preferences central bank ($\lambda\phi$)	0.00	-0.14
Taylor Rule		
Inflation coefficient τ_π	1.50	3.48
Output coefficient τ_y	0.50	1.48
Ratio coefficients $\left(\tau_y/\tau_\pi\right)$	0.33	0.43

Table 4: **Monetary Policy Parameters (full sample)**

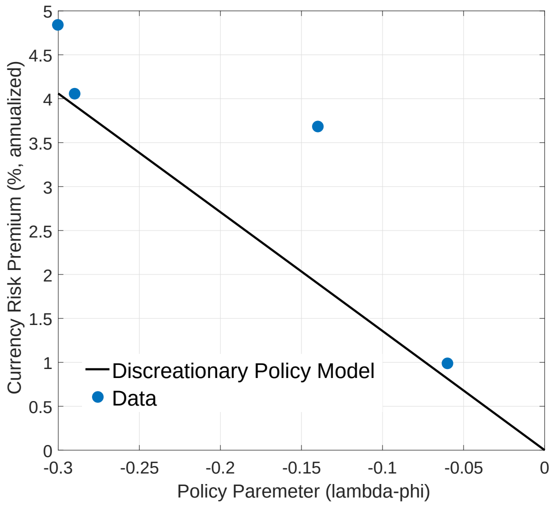
	Brazil	**Colombia**	**Chile**	**Mexico**
Discretionary Case				
Preferences central bank ($\lambda\phi$)	-0.14	-0.29	-0.06	-0.30
Taylor Rule				
Inflation coefficient τ_π	3.48	1.07	1.03	1.51
Output coefficient τ_y	1.48	0.66	2.25	0.64
Ratio coefficients $\left(\tau_y/\tau_\pi\right)$	0.43	0.62	2.18	0.42

Table 5: **Sample and Simulated Moments**

Moments	Data	Model	
		Discretion	Commitment
Output Growth			
Mean output growth	4.23	4.23	4.23
correlation with U.S. output growth	0.42	0.42	0.42
Real Interest Rate			
Mean	1.33	1.33	1.33
Standard Deviation	1.12	2.36	0.22
Annual Inflation			
Mean	4.90	4.90	4.90
Standard Deviation	1.95	2.71	1.49
correlation with output	-0.30	-0.57	-0.90
Short- Term Nominal Interest Rate (annualized)			
Mean	6.62	5.75	7.30
Standard Deviation	2.56	1.52	0.66
Currency Risk Premium			
Mean Carry-trade returns	4.06	3.35	0.47
Sharpe Ratio Carry-Trade Returns	0.42	0.36	0.43

Figure 1: **Currency Risk Premiums: Discretionary and Taylor Rule model**

Discretionary Model



Taylor Rule Model

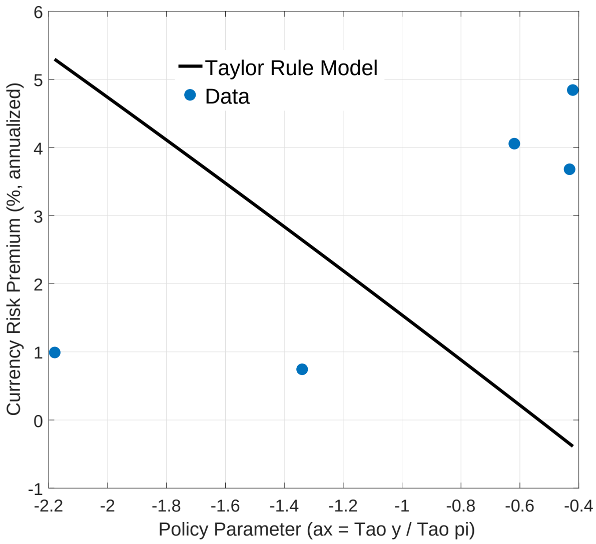
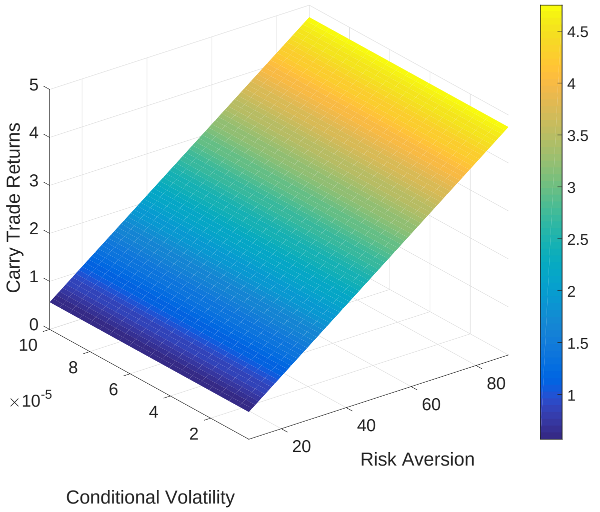
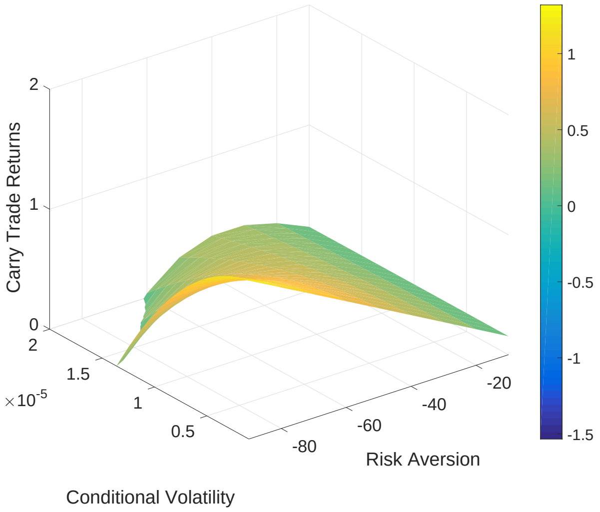


Figure 2: **Currency Risk Premiums: Discretionary and Taylor Rule model**

Discretionary Model



Taylor Rule Model



Online Appendix

Derivation stochastic discount factor

Let’s define the utility-consumption ratio

$$W_t = \frac{U_t}{c_t} = \left[(1-\beta) + \beta f_t\left(\frac{U_{t+1}}{c_{t+1}}\frac{c_{t+1}}{c_t}\right)^{\gamma}\right]^{\frac{1}{\gamma}}$$

which in logs is defined as:

$$log\left(W_t\right) = w_t = \frac{1}{\gamma}log\left[(1-\beta) + \beta f_t\left(\frac{U_{t+1}}{c_{t+1}}\frac{c_{t+1}}{c_t}\right)^{\gamma}\right]$$

that can be simplified to:

$$w_t = \frac{1}{\gamma}log\left[(1-\beta) + \beta exp\left\{\left[\gamma log\left[f_t\left(exp\left(wc_{t+1} + y_{t+1}\right)\right)\right]\right]\right\}\right]$$

Let´s define the following function:

$$g_t = log\left[f_t\left(exp\left(wc_{t+1} + y_{t+1}\right)\right)\right]$$

that allows to re-write w_t as:

$$w_t = \frac{1}{\gamma}log\left[(1-\beta) + \beta exp\left\{\gamma g_t\right\}\right]$$

We can guess a solution to the form

$$w_t = \bar{w} + w_y y_t + w_v v_t$$

Iterating the solution and taking expectations:

$$E_t\left[w_{t+1} + y_{t+1}\right] = E_t\left[\bar{w} + \left(1 + w_y\right)\left(1 - \rho_y\right)\bar{y} + \left(1 + w_y\right)\rho_y y_t + w_v\left(1 - \rho_v\right)\bar{v} + w_v\rho_v v_t\right]$$

$$V_t\left[w_{t+1} + y_{t+1}\right] = \left(1 + w_y\right)^2 v_t + w_v^2\sigma^2$$

We can simplify the auxiliary function g_t:

$$g_t = E_t\left[w_{t+1} + y_{t+1}\right] + \frac{\alpha}{2}V_t\left[w_{t+1} + y_{t+1}\right]$$

$$g_t = \bar{w} + \left(1 + w_y\right)\left(1 - \rho_y\right)\bar{y} + \left(1 + w_y\right)\rho_y y_t + w_v\left(1 - \rho_v\right)\bar{v} + w_v\rho_v v_t + \frac{\alpha}{2}\left(1 + w_y\right)^2 v_t + \frac{\alpha}{2}w_v^2\sigma^2$$

Using the log-linear approximation of w_t we have:

$$w_t = \beta\bar{w} + \left(1 + w_y\right)\left(1 - \rho_y\right)\beta\bar{y} + \left(1 + w_y\right)\beta\rho_y y_t + w_v\left(1 - \rho_v\right)\beta\bar{v} + w_v\rho_v\beta v_t + \frac{\alpha}{2}\beta\left(1 + w_y\right)^2 v_t + \frac{\alpha}{2}\beta w_v^2\sigma^2$$

Using our initial conjecture $w_t = \bar{w} + w_y y_t + w_v v_t$, we can find the unknown coefficients:

$$w = \tfrac{\beta}{1-\beta}\left[\left(1 + w_y\right)\left(1 - \rho_y\right)\bar{y} + w_v\left(1 - \rho_v\right)\bar{v} + \tfrac{\alpha}{2}w_v^2\sigma^2\right] \quad w_y = \tfrac{\beta\rho_y}{1-\beta\rho_y}$$

$$w_v = \tfrac{\alpha\beta\left(1+w_y\right)^2}{2(1-\beta\rho_v)} = \tfrac{\alpha\beta}{2(1-\beta\rho_v)\left(1-\beta\rho_y\right)^2}$$

The real stochastic discount factor of the representative agent is:

$$n_{t+1} = \beta\left(y_{t+1}\right)^{\gamma-1}\left(\frac{U_{t+1}}{c_t}\frac{c_{t+1}}{c_{t+1}}\frac{1}{f_t\left(\frac{U_{t+1}}{c_t}\frac{c_{t+1}}{c_{t+1}}\right)}\right)^{\alpha-\gamma}$$

which in logs is:

$$log\left(n_{t+1}\right) = log\beta + \left(\gamma - 1\right)y_{t+1} + \left(\alpha - \gamma\right)\left[logW_{t+1} + y_{t+1} - log\left[f_t\left(W_{t+1}X_t\right)\right]\right]$$

Using the same approximation we used before we have:

$$\begin{aligned} w_{t+1} + y_{t+1} - log\left[f_t\left(exp\left(wc_{t+1} + y_{t+1}\right)\right)\right] = {} & \bar{w} + \left(1 + w_y\right)y_{t+1} + w_v v_{t+1} - E_t\left(1 + w_y\right)y_{t+1} \\ & - E_t\left(w_v\right)v_{t+1} - \frac{\alpha}{2}V_t\left[\left(1 + w_y\right)y_{t+1}\right] - \frac{\alpha}{2}V_t\left[\left(w_v\right)v_{t+1}\right] \end{aligned}$$

Given that we have the following expression:

$$logW_{t+1} - log\left(f_t\left[W_{t+1}\right]\right) = \left(1 + w_y\right)v_t^{\frac{1}{2}}\varepsilon_{t+1}^y + w_v\sigma\varepsilon_{t+1}^v - \frac{\alpha}{2}\left(1 + w_y\right)^2 v_t - \frac{\alpha}{2}w_v\sigma^2$$

we can find the expression for the real stochastic discount factor:

$$-log\left(n_{t+1}\right) = \delta^r + \delta_y^r y_t + \delta_v^r v_t + \lambda_y^r v_t^{\frac{1}{2}}\varepsilon_{t+1}^y + \lambda_v^r\sigma\varepsilon_{t+1}^v$$

where,

$$\delta^r = -log\beta + \left(1 - \rho_y\right)\left(1 - \gamma\right)\bar{y} + \tfrac{\alpha}{2}\left(\alpha - \gamma\right)w_v^2\sigma^2 \qquad \delta_y^r = \rho_y\left(1 - \gamma\right)$$

$$\delta_v^r = \tfrac{\alpha}{2}\left(\alpha - \gamma\right)\left(1 + w_y\right)^2 \qquad \lambda_y^r = \left(1 - \gamma\right) - \left(\alpha - \gamma\right)\left(1 + w_y\right)$$

$$\lambda_v^r = \left(\gamma - \alpha\right)w_v$$

Table 6: **Parameter Values (Preferences and Shocks)**

Simulation of the model calibrated for each country

Variable	**Symbol**	**Value**			
		Brazil	**Colombia**	**Chile**	**Mexico**
Discount Factor	β	0.9799	0.9873	0.9874	0.9835
Risk Aversion	$1-\alpha$	40	40	40	40
Elasticity substitution	$(1-\gamma)^{-1}$	1.5	1.5	1.5	1.5
Mean output growth rate	$\bar{y}$	0.0030	0.0035	0.0037	0.0017
Autocorrelation output growth rate	ρ_y	0	0	0	0
Mean volatility	$\bar{v}$	8.7e-05	3.2e-05	5.6717e-05	6.6261e-05
Autocorrelation volatility	ρ_v	0.95	0.95	0.95	0.95
Conditional volatility	σ_v	12e-05	10e-05	10e-05	12e-05
Correlation output innovations	$\eta_{y,y*}$	0.42	0.43	0.64	0.62
Correlation volatility innovations	$\eta_{v,v*}$	0.99	0.99	0.99	0.99

Table 7: **Sample and Simulated Moments Calibrated for each country**

	Brazil			**Colombia**			**Chile**			**Mexico**		
	Data	**Discretion**	**Taylor**	**Data**	**Discretion**	**Taylor**	**Data**	**Discretion**	**Taylor**	**Data**	**Discretion**	**Taylor**
Output growth (mean)	3.61	3.61	3.61	4.23	4.23	4.23	4.39	4.39	4.39	2.10	2.10	2.10
Output corr. with U.S. output	0.42	0.42	0.42	0.42	0.42	0.42	0.64	0.64	0.64	0.61	0.61	0.61
Real Interest Rate (mean)	6.06	6.06	6.06	1.33	1.33	1.33	1.04	1.04	1.04	2.50	2.50	2.50
Real Interest Rate (S.D.)	3.24	2.90	0.51	1.12	2.36	0.22	1.63	2.37	0.46	2.01	2.65	0.48
Inflation (mean)	5.40	5.40	5.40	4.90	4.90	4.90	3.13	3.13	3.13	4.47	4.47	4.47
Inflation (S.D.)	1.17	1.59	1.40	1.95	2.71	1.49	2.21	2.32	11.07	0.97	2.00	1.31
corr. Inflation with output	-0.23	-0.31	-0.99	-0.30	-0.57	-0.90	-0.07	-0.14	-0.55	-0.60	-0.59	-0.94
Nominal Interest Rate (mean)	12.21	9.57	13.17	6.62	5.75	7.30	4.60	4.03	13.10	7.70	7.11	8.47
Nominal Interest Rate (S.D.)	3.53	2.60	0.34	2.56	1.52	0.66	2.52	2.19	9.50	3.59	1.98	0.64
Mean Carry-trade returns	3.68	1.80	0.55	4.06	3.35	0.47	0.99	0.90	8.30	4.84	3.76	0.37
SR Carry-Trade Returns	0.31	0.16	0.314	0.42	0.36	0.43	0.12	0.10	4.40	0.56	0.37	0.21