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Business Cycle Insurance, Inflation and Currency Returns^{*}

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Abstract

In countries where the real exchange rate is counter-cyclical¹, local currency has poor business cycle insurance properties as it loses value when the economy is in a recession and the residents require high returns to invest in local currency assets. In this paper, we offer the co-movement of local economic performance and the real exchange rate as an important determinant of average currency returns. We find that the correlation between GDP and the real exchange rate movements is a significant determinant of average local currency excess returns even after controlling for other well known determinants. We argue that this correlation is partly driven by trade invoicing since high dollar invoicing leads to weak expenditure swtiching channel. We build a nonlinear, open-economy, general equilibrium model in which the residents and the foreigners trade in financial assets for insurance as well as speculative purposes. The simple insurance view in the model is able to generate key facts about excess currency returns in the data. In the model, business cycle properties of the exchange rate determine the relative insurance demand of agents which governs average excess currency returns.

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 $^{^1\}mathrm{Throughout}$ the paper exchange rate is defined as local currency per dollar

1 Introduction

In this paper, we show that the co-movement between local economic conditions and the exchange rate is a crucial factor explaining average excess currency returns. In economies where the real exchange rate is counter-cyclical, dollar assets provide good income insurance because they appreciate in economic downturns. In these economies, residents tend to invest more in dollar denominated assets and they require higher returns to invest in local currency (Dalgic (2018)). We show that the covariance between GDP and the exchange rate emerge as a key determinant of excess currency returns even after controlling for other key determinants such as foreign debt in the banking system, average current account balance, trade centrality and size. In Figure 1, we plot the average excess returns against the correlation between real GDP growth and real exchange rate, a high and negative correlation between GDP and the real exchange rate is associated with significantly higher average excess returns. Similarly, we find that currencies which tend to depreciate in global downturns also yield higher returns as they have bad insurance properties for international investors. In line with Lustig et al. (2011), we find that two principal components drive significant portion of currency returns. The exposure of a currency to these two components are significantly related to the average currency returns. We find that the first components is highly correlated with global asset prices while the second component is related to VIX index. Exposure to the first component is highly correlated with foreign debt in the banking system whereas the exposure to the second component is related to average trade balance as well as the covariance between GDP and the exchange rate. Using data on exchange rate expectations, we further show that average expected returns are also high in countries with negative GDP-Exchange rate correlation, which means that international investors also require positive returns to invest in currencies that tend to depreciate in recessions. We provide a model of currency returns which will deliver the key empirical patterns. The model takes the view of currency markets as insurance markets. In the model, the residents and the foreigners have different income streams and trade in currency markets to get business cycle insurance. The model is able to generate the data facts, the main determinants of interest rate spreads are the foreign debt and the covariance of exchange rate with local consumption as well as global shocks.



Figure 1: Correlation (GDP,ER) and Excess Returns controlled for other determinants Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are $\Delta \log$ GDP and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI.

Unlike in the classical Dornbusch model, an increase in the interest rates of a country does not lead to an immediate appreciation followed by a depreciation but instead, the currencies with high interest rate continues to appreciate, which creates opportunities for carry trade (Fama (1984)). Still, Hansen and Hodrick (1980) document that there is not a significant average currency returns among developed economies. The recent work focuses not only on developed economies but also developing economies and documents average excess returns (Lustig and Verdelhan (2007); Hassan (2013); Richmond (2019)). Lustig et al. (2011) also uncover two factors, one them is related to average currency returns, the other one is related to the return difference between currencies with high vs low interest rates. Verdelhan (2018) shows that these two factors jointly explain a significant portion of currency returns. In this paper, we show how the two factors co-move with outside macroeconomic variables. Hassan (2013) argues that the size of the economy matters in terms of currency returns. Currencies of larger economies provide income insurance during global downturns. In our dataset, we find some limited evidence in favor of this hypothesis. In particular, when additional controls are added, the effect of nominal USD GDP disappears. Maggiori (2012) argues that the depth of the financial system matters. In our data set we proxy the depth of the financial system by the sum of foreign assets and liabilities of the banking system as a share of GDP ((FL+FA)/GDP). A deeper and more connected system will have higher financial intermediation with the rest of the world. Richmond (2019) argues that trade networks matter for average currency returns. He shows that countries that are central to trade networks tend to have lower currency returns. One possible interpretation is that countries with diverse trade partners are not subject to large swings in trade, which makes the exchange rate more stable. Lustig and Verdelhan (2007) show that average currency returns are related to the correlation between US durable good consumption and the exchange rate. In this work, we use a related concept, the correlation between local real GDP growth and the exchange rate. A negative correlation means that the currency returns are low when the economy is in recession. Low returns during a bad performing economy is undesirable from the perspective of risk averse agents, who demand high returns from those currencies (Dalgic (2018); Christiano et al. (2020)).Engel et al. (2021) shows that between developed economies, UIP violations are not stable. In particular, they do not find significant violations following 2007 and ZLB period. They show that inflation differential can be used to predict currency returns. This paper is also related to idea of rare disasters, currencies which are subject to long run rare risks should command higher returns even though an econometrician might not observe the event happening in the data (Farhi and Gabaix (2016)). Still, we observe that certain currencies tend to depreciate more during global downturns (Wiriadinata (2018); Lustig and Verdelhan (2007)) and these currencies offer higher average returns. Bacchetta and van Wincoop (2019) argue that portfolio adjustment costs can explain major puzzles in currency markets. Ready et al. (2017) show that currencies of commodity exporters yield higher returns compared to manufacturing exporters. Gourinchas et al. (2022) explain UIP deviations using a model of preferred habitat.

Our results are also related to the idea that international investors require positive excess returns to invest in currencies since it is difficult to diversify currency risk because during global downturns, USD tends to appreciate against other currencies (Gourinchas et al. (2017)). We provide evidence that currencies that are more exposed to common factors yield higher returns on average. These currencies tend to lose against USD during global downturns. There is some evidence that emerging market sovereigns are able to borrow in their own currencies (Du and Schreger (2016)) yet most advanced economy investors still invest in their home currencies ('currency bias' Maggiori et al. (2020)). Still, a lot of small economy currencies tend to depreciate a lot during global downturns (Hofmann et al. (2022)).

We show that the negative comovement between GDP and the exchange rate can be partially explanied by trade invoicing. Countries whose exports are mostly invoiced in dollars see a muted response of exports following an exchange rate depreciation (Gopinath et al. (2020)), which leads to more adverse effects following a rise in USD interest rates (Akinci and Queralto (2018); Camara et al. (2021)).

The limits on monetary policy as a result of free capital flows is underlined by Rey (2015), also by Kalemli-Ozcan (2019). Dollar invoicing and it's implications about monetary policy are discussed in ?, they show that domestic monetary policy cannot stimulate exports via monetary policy shocks but otherwise silent about the implications about asset returns and portfolio choices, Zhang (2022) estimates response of US monetary shocks on different countries based on dollar-invoicing ration, he also argues that dollar-invoicing countries have limited monetary policy. Dalgic (2018), looks at the implications of countercyclical exhcange rate on portfolio choices but doesn't talk about monetary policy or export price stickiness.

The story we have refers to the average currency returns not the time series behavior. Dalgic (2018) and Akinci et al. (2022) show that uncertainty shocks can drive up interest rate spread in the time series.

2 Data Results: Determinants of Currency Returns

In this section, we discuss variables that explain average excess currency returns. (i) Mismatch in the financial system, (ii) Negative net foreign assets, (iii) Trade network centrality and (iv) cov(GDP, S/P) emerge as the main variables that can explain excess currency returns. Then we show that currency returns

are heavily correlated with each other, which explains why foreign investors do not wipe away the excess returns. We uncover two main principal components which explain 60% of the variation in currency returns across countries. One of the components is heavily correlated with our covariance term. Finally using currency expectation data, we show that realized average excess returns correspond to expected excess returns; investors are aware of the potential excess returns.

2.1 Currency Returns: Monthly Data

We collect data from 25 countries between 02/2003 - 11/2018. The data is from FX4casts, which includes short term interest rates as well as exchange rates. My definition of currency returns are the difference between exchange rate adjusted short term interest rates., ,

$$R_t^L \frac{S_t}{S_{t+1}} - R_t^{US} \tag{1}$$

From a macroeconomics perspective, the object that we am interested in is the unconditional average returns and the determinants of unconditional returns,

$$\mathbb{E}\left(R_t^L \frac{S_t}{S_{t+1}} - R_t^{US}\right)$$

We further add 8 countries using forward returns. In section C we show how to derive currency returns using forward contracts.

2.2 Comovement between GDP and Exchange Rate

We measure the comovement between GDP and exhcange rate by calculating the correlation between log real GDP changes and log changes in nominal dollar exchange rate divided by CPI, which corresponds to running the following regression,

$$\frac{\Delta GDP_t}{\sigma_{GDP}} = \alpha + \rho \frac{\Delta \frac{S_t}{P_t}}{\sigma_{S/P}} + \epsilon_i$$

The estimate $\hat{\rho}$ corresponds to the correlation coefficients. Countries in our dataset have widely different volatilies of GDP growth and exchange rate and correlation coefficient suitably scales variables by their respective standard deviations. Another benefit of using correlation coefficient is that it is direction invariant, which variable is used as left hand side variable do not change the estimates. Here, we do not claim any causality between GDP or exhcange rate movements so that the correlation coefficient is the appropriate measure to estimate the comovement between GDP and exchange rate.

A negative correlation between GDP growth and the exchange rate indicates that the local currency returns go down when the economy is in recession, which makes local currency risky from the perspective of local residents. In these economies, dollar assets provide a better insurance against business cycle fluctuations, which lowers demand for local currency assets. Local residents require higher returns to invest in local currency assets(Dalgic (2018); Christiano et al. (2020)). Figure 1 plots excess returns against the correlation between GDP and exchange rate movements after controlling for size, centrality, average trade balance and FL/FA.

2.3 Foreign Assets and Liabilities of the Banking System

First variable we consider is the ratio of foreign liabilities over foreign assets in the banking system (FL/FA). FL/FA is found to be a good predictor of banking crises (Yeyati (2006); Christiano et al. (2020)). High foreign liabilities can make the banking system susceptible to panics and roll-over problems, which will be accompanied by currency depreciation and low returns for investors ; against which the investors will ask for higher returns(Wiriadinata (2018); Bocola and Lorenzoni (2019)). In 2, we plot average excess returns against average FL/FA. In economies where the banking system carries high foreign debt, we see higher expected currency returns.



Figure 2: FL/FA and excess returns

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variable is the ratio of foreign liabilities to foreign assets in the banking system

2.4 Reserves

Against foreign borrowing, central banks can hold reserves, which should reduce the risk of rollover crises. However, we do not see a significant relationship between reserves and average excess returns. In figure 3, we plot average excess returns against reserves as a share of GDP



Figure 3: Reserves and excess returns

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variable is the reserves as a share of GDP

2.5 External Balance

The third variable we consider is external balance as a share of GDP, which is a proxy for net investment position of a country which is found to be an important determinant of currency returns (Della Corte et al. (2016)). There is a clear negative relationship between



Figure 4: Reserves and excess returns

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variable is the average net external balance as a share of GDP,

2.6 Size and Trade Centrality

Country size (Hassan (2013)) and trade network centrality (Richmond (2019)) is found to be significant determinants of excess currency returns. Shocks to larger and/or to more central economies affect smaller economies but shocks to smaller economies do not spill over to larger economies. Then, assets of larger or more central economies provide insurance not only against country specific shocks, but also against global shocks. Thus, local currency assets of larger and/or more central economies should provide lower returns since there is high demand for them. Figure 5



Figure 5: Size, centrality and excess returns

Data source: FX4Casts, IMF IFS, ?. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables is the average log nominal GDP and average trade network centrality

2.7 Determinants of Excess Returns

Table 1 runs a regression of average returns on the variables discussed in the previous section. Similar to Hassan and Zhang (2020), including GDP to the regression makes trade centrality insignificant, this is in line with Richmond (2019) which argues that either size or connectedness makes an economy central to international trade.

			Dependent variable:		
			Average Return		
	(1)	(2)	(3)	(4)	(5)
FL/FA	0.006***	0.005**		0.005	0.004
	(0.002)	(0.002)		(0.004)	(0.004)
Net Foreign Assets/GDP	-0.019^{**}	-0.016^{*}		-0.016**	-0.017^{***}
с ,	(0.009)	(0.009)		(0.007)	(0.006)
GDP(Share of US)	0.005	0.005		× ,	0.014^{*}
	(0.005)	(0.005)			(0.008)
Reserves/GDP	0.048^{*}	0.025	0.028	0.030	0.116^{*}
	(0.029)	(0.035)	(0.027)	(0.033)	(0.068)
$\operatorname{Corr}(\Delta GDP, \Delta S/P)$		-0.032^{***}	-0.031^{***}	-0.024^{*}	-0.040^{**}
		(0.012)	(0.011)	(0.012)	(0.018)
Trade Centrality			-5.417^{***}	-2.292	-9.035^{*}
			(1.305)	(2.214)	(5.251)
Constant	0.023	0.021	0.029***	0.010	0.067^{*}
	(0.018)	(0.019)	(0.011)	(0.018)	(0.040)
Observations	29	28	19	16	16
\mathbb{R}^2	0.219	0.360	0.510	0.697	0.770
Adjusted \mathbb{R}^2	0.089	0.214	0.412	0.546	0.617
Residual Std. Error	$0.022 \ (df = 24)$	$0.021 \ (df = 22)$	$0.013 \ (df = 15)$	$0.012 \ (df = 10)$	$0.011 \ (df = 9)$

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 1: Determinants of Returns

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

3 Why Foreign Investors do not Invest more?

In the previous section, we established several variables which predict average excess currency returns. In principle, deep-pocket international investors can invest in diversified portfolio of currencies and make excess returns. However, the literature shows that currency returns demonstrate significant correlation. Here, we run a principal component analysis on currency returns against the US Dollar. In line with Lustig et al. (2011), there are two components highly correlated with currency returns. In table 2, we show that average excess returns are positively related to a currency's loading on the two components. Similary, in figure 6 we plot excess returns against component loadings.

	Dependent variable:				
	Excess Returns				
	(1)	(2)	(3)		
Component 1	0.012^{*}		0.011**		
	(0.006)		(0.005)		
Component 2	· · · ·	0.007^{***}	0.007***		
-		(0.002)	(0.002)		
Constant	0.0001	0.002***	0.0003		
	(0.001)	(0.0003)	(0.001)		
Observations	25	25	25		
\mathbb{R}^2	0.136	0.458	0.571		
Adjusted \mathbb{R}^2	0.098	0.435	0.532		
Residual Std. Error	$0.002 \ (df = 23)$	$0.002 \ (df = 23)$	$0.001 \ (df = 22)$		
Note:		*p<0.1; **p	<0.05; ***p<0.01		

Га	\mathbf{bl}	le 2 :	Average	excess	returns	\mathbf{VS}	component	loadings	

Data source: FX4Casts. Left hand variable is the average monthly currency returns of 25 countries between 02/2003 - 11/2018. Right hand variables are the coefficients of each country for the two principal component of currency returns. Both components are scaled such that a positive coefficient means positive covariance with the returns.



Figure 6: Average excess returns vs component loadings

Data source: FX4Casts. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are the coefficients of each country for the two principal component of currency returns. Both components are scaled such that a positive coefficient means positive covariance with the returns.

In table 3, we regress currency returns of 5 countries on principle components. Note that except for Japan, regression have very high R^2 , which indicates that common factors drive significant portion of currency returns.

		Dependent variable:			
	Turkey	Chile	Mexcio	Euro Area	Japan
	(1)	(2)	(3)	(4)	(5)
Component 1	0.258^{***}	0.167^{***}	0.167^{***}	0.191^{***}	0.035
	(0.025)	(0.016)	(0.014)	(0.005)	(0.028)
Component 2	0.406***	0.118***	0.156***	-0.219^{***}	-0.130^{**}
-	(0.093)	(0.028)	(0.041)	(0.029)	(0.051)
Constant	0.005^{**}	0.003***	0.001	0.0005	-0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Observations	190	190	190	190	190
\mathbb{R}^2	0.599	0.460	0.553	0.876	0.097
Adjusted \mathbb{R}^2	0.595	0.454	0.548	0.874	0.087
Residual Std. Error (df = 187)	0.033	0.024	0.021	0.010	0.027
Note:			*p<	<0.1; **p<0.05;	***p<0.01

Table 3: Average excess returns vs component loadings

Data source: FX4Casts. Left hand variable is the returns of selected currencies between 02/2003 - 11/2018. Right hand variables are the two principal component of currency returns. Both components are scaled such that a positive coefficient means positive covariance with the returns.

Now the question is what are these components? Unfortunately, principal component analysis does not tell us much about these factors. In table 4, we regress returns of S&P500 index, log changes in VIX index and the change in Global Financial Cycle (GFC, ?) on the two principal components. Note that the first component is highly correlated with S&P500 returns and GFC while the second component is somewhat correlated with changes in VIX index.

	Dependent variable:			
	S&P 500 Return	as $\Delta \log(\text{VIX})$	$\Delta \mathrm{GFC}$	
	(1)	(2)	(3)	
Component 1	0.175***	-0.532^{***}	1.455***	
	(0.027)	(0.085)	(0.202)	
Component 2	0.063	-0.589^{**}	0.719^{*}	
-	(0.059)	(0.283)	(0.418)	
Constant	0.009***	-0.001	-0.003	
	(0.003)	(0.007)	(0.017)	
Observations	190	190	190	
\mathbb{R}^2	0.309	0.199	0.494	
Adjusted \mathbb{R}^2	0.302	0.191	0.488	
Residual Std. Error (df = 187)	0.033	0.151	0.190	
Note:	*	p<0.1; **p<0.05;	***p<0.01	

Table 4: Average excess returns vs component loadings

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

	Dependen	t variable:
	Component 1	Component 2
	(1)	(2)
S&P 500 Returns	1.533^{***}	-0.080
	(0.341)	(0.110)
$\Delta \log(\text{VIX})$	-0.070	-0.085^{***}
	(0.053)	(0.032)
ΔGFC	-0.013	0.001
	(0.009)	(0.004)
Observations	190	190
\mathbb{R}^2	0.306	0.045
Adjusted \mathbb{R}^2	0.299	0.035
Residual Std. Error $(df = 187)$	0.105	0.058
Note:	*p<0.1; **p<	0.05; ***p<0.01

Table 5: Average excess returns vs component loadings

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

3.1 Determinants of Component Exposures

Similarly in table 6, we regress exposures to principal components on the variables discussed. First factor exposure is highly correlated with FL/FA whereas the second factor exposure is highly correlated with external balance / GDP and the correlation between GDP growth and the exchange rate.

Overall, the interpretation of these results is that countries which have high foreign liabilities in the banking system have higher exposure to the first principal component, which co-moves highly with global asset price returns. Currencies of countries with high foreign debt depreciate more when global asset prices fall. Then, foreign investors are willing to invest in these currencies only if they yield high returns. Exposure the ratio of foreign liabilities to foreign assets in the banking system to the second component is related to current account deficits and negative covariance between GDP and exchange rates.

	Depender	nt variable:
	Exposure 1	Exposure 2
	(1)	(2)
FL/FA	0.023**	-0.026
	(0.011)	(0.025)
Net Foreign Assets/GDP	-0.025	-0.097
	(0.037)	(0.072)
Reserves/GDP	-0.048	-0.700
	(0.254)	(0.534)
$\operatorname{Corr}(\Delta GDP, \Delta S/P)$	-0.027	-0.245^{***}
	(0.080)	(0.092)
GDP(Nominal USD)	0.016	0.021
	(0.019)	(0.030)
Constant	0.192^{**}	0.130
	(0.086)	(0.133)
Observations	28	28
\mathbb{R}^2	0.201	0.249
Adjusted \mathbb{R}^2	0.020	0.078
Residual Std. Error $(df = 22)$	0.075	0.186
Note:	*p<0.1; **p<	0.05; ***p<0.01

 Table 6: Determinants of Exposures

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

4 Currency Invoicing and GDP-ER Co-movement

Recent literature finds a link between dollar invoicing and currency returns. Gopinath and Stein (2020) argue that the dominant role of the US dollar as the main currency of invoicing leads to lower returns for dollar denominated assets. Gopinath et al. (2020) find that dollar invoicing is related to inflation pass through. In figure 7, we show the positive relation between share of dollar invoicing in imports and average currency returns. In 8, we show that the correlation between GDP and the exchange rate is highly related to dollar invoicing. In countries where the imports are mostly invoiced in dollars, we tend to see more countercyclical exchange rate.



Figure 7: Dollar Invoicing and average excess returns Data source: FX4Casts, ?. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variable is the average dollar invoicing share of imports.



Figure 8: Dollar invoicing and Correlation of the exchange rate with GDP Data source: IMF, IFS, ?. Y-axis variables are $\Delta \log$ GDP and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI. X-axis variable is the average dollar invoicing share of imports.

5 Inflation and GDP-ER Co-movement

In countries where the exports are mostly invoiced in USD, expenditure switching channel is muted. In these economies, the monetary policy faces a dilemma following external shocks. Economies with flexible export prices can respond to external shocks that cause exchange rate depreciations (capital flight, foreign interest rate shock etc.) by increasing exports which stimulates the economy. On the other hand, in countries with sticky export prices, external shocks are more contractionary because of weak response of exports (see Camara et al. (2021)).

Figure 9 plots average inflation against GDP-ER correlation. In countries with high inflation we tend to see countercyclical exchange rate

Figure 10 plots average inflation against average excess returns. In countries with high average inflation, demand for local currency assets is low, which drives up local currency interest rates.

Figure 11 plots export dollar invocing against average inflation. In line with our theory, in countries with high dollar invoicing, monetary policy cannot react sharply against external shocks because exchange rate shocks are recessionary. In these economies, we see high average inflation.



Figure 9: Average Inflation vs GDP-ER Correlation

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are $\Delta \log$ GDP and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI.



Figure 10: Average Inflation vs Average Excess Returns

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are $\Delta \log GDP$ and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI.



Figure 11: Average Inflation vs Dollar invoicing in exports

Data source: IMF, IFS, ?. Y-axis variables are $\Delta \log GDP$ and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI. X-axis variable is the average dollar invoicing share of imports.

In addition to average inflation, we also look at price level volatility². The results are virtually the same.

²we estimate price level volatility as the standard deviation of $\log(P_t)$, where P_t is the CPI index



Figure 12: Price Level Volatility vs GDP-ER Correlation

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are $\Delta \log GDP$ and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI.



Figure 13: Price Level Volatility vs Average Excess Returns

Data source: FX4Casts, IMF IFS. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables are $\Delta \log \text{GDP}$ and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI.



Figure 14: Price Level Volatility vs Dollar invoicing in exports

Data source: IMF, IFS, ?. Y-axis variables are $\Delta \log GDP$ and $\Delta \log \frac{S}{P}$. S is the Dollar exchange rate and P is the CPI. X-axis variable is the average dollar invoicing share of imports.

6 Currency Return Expectations

In this section, we make use of the exchange rate expectations provided by FX4Casts. Quarterly exchange rate expectations start ranges between 2003Q1-2018Q4. Using the same dataset, Ince and Molodtsova (2017) looks at the accuracy of forecasts in the time series. Here, we are going to look at whether investors consider the

6.1 Expected vs Realized Returns

Figure 15 plots average quarterly realized excess returns against quarterly expectations. Here, our focus is on the average forecasted vs realized returns.





Similar to realized returns, we employ principle component analysis on currency return expectations. In table



Figure 16: Expected average currency return principle vs component loadings

Table 7 regresses average excess returns on the loadings on principal components obtained from return forecasts.

		Dependent variable:			
		Excess Returns			
	(1)	(2)	(3)		
Component 1	0.008		-0.007		
	(0.011)		(0.008)		
Component 2		-0.028^{***}	-0.031^{***}		
		(0.005)	(0.005)		
Constant	0.009^{***}	0.005***	0.004**		
	(0.002)	(0.001)	(0.002)		
Observations	26	26	26		
\mathbb{R}^2	0.028	0.467	0.484		
Adjusted \mathbb{R}^2	-0.012	0.445	0.439		
Residual Std. Error	0.007 (df = 24)	0.006 (df = 24)	$0.006 \ (df = 23)$		

Table 7: Average excess	returns vs \mathbf{v}	$\operatorname{component}$	loadings
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 $Note: *p{<}0.1; **p{<}0.05; ***p{<}0.01$ Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

In table,

	Dependent variable:			
	S&P 500 Returns	$\Delta \log(\text{VIX})$	$\Delta { m GFC}$	
	(1)	(2)	(3)	
Component 1	0.148^{**}	0.708^{**}	0.332	
	(0.062)	(0.316)	(0.577)	
Component 2	-0.550^{***}	-0.353	-3.608^{**}	
	(0.190)	(0.389)	(1.582)	
Constant	0.023**	-0.003	-0.007	
	(0.010)	(0.023)	(0.074)	
Observations	63	63	63	
\mathbb{R}^2	0.103	0.026	0.068	
Adjusted \mathbb{R}^2	0.073	-0.007	0.037	
Residual Std. Error $(df = 60)$	0.065	0.258	0.505	

 Table 8: Component Determinants

Note: p<0.1; **p<0.05; ***p<0.01Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

	Depender	nt variable:
	Exposure 1	Exposure 2
	(1)	(2)
FL/FA	0.008	-0.095^{**}
	(0.028)	(0.046)
Net Foreign Assets/GDP	0.055	0.131
с ,	(0.063)	(0.083)
Reserves/GDP	0.327	0.414
,	(0.313)	(0.520)
$\operatorname{Corr}(\Delta GDP, \Delta S/P)$	-0.256^{**}	0.322^{**}
	(0.115)	(0.139)
GDP(Nominal USD)	0.037	-0.013
	(0.022)	(0.047)
Constant	-0.194^{**}	0.065
	(0.079)	(0.156)
Observations	20	20
\mathbb{R}^2	0.380	0.565
Adjusted \mathbb{R}^2	0.158	0.409
Residual Std. Error $(df = 14)$	0.098	0.149

Table 9: Exposure Determinants

Note:

*p<0.1; **p<0.05; ***p<0.01

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

7 Model

So far we have established that the covariance between economic performance and the exchange rate is a significant driver of interest rate spreads across countries and this covariance term is significantly related to dollar invoicing. In countries where most exports are denominated in dollars, expenditure switching channel is weaker because depreciations cannot stimulate exports. With export response muted, economic performance is weaker following a depreciation. In this section, we build a small open economy New Keynesian model based on Camara et al. (2021), in which exports are priced in dollars and the export price stickiness will influence the strength of the expenditure switching channel and influence the interest rate spreads.

7.1 Households

Households in the model supply labor and capital to firms and save in dollars. They maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(u\left(C_t\right) - \exp\left(\tau_t\right) \frac{l_t^{1+\varphi}}{1+\varphi} - \frac{1}{2}\gamma \left(D_t^* - \Upsilon_t\right)^2 \right)$$

the last term is non-pecuniary costs associated with deviating from the target portfolio(Υ_t). These costs can be thought of coming from a preferred habitat model (Gourinchas et al. (2022)). We assume,

$$\Upsilon_t = (1 - \omega)D_{t-1}^* + \omega \bar{D}^*$$

where D_{t-1}^* denotes the previous period dollar holdings and \overline{D}^* is the steady state target. We set ω small so that the non-pecuniary costs of portfolio adjustments are in the spirit of delayed portfolio adjustments a la Bacchetta and van Wincoop (2019). Household budget,

$$D_t + S_t D_t^* + P_t^c C_t + P_t^k \left[K_t - (1 - \delta) K_{t-1} \right] = r_t K_{t-1} + D_{t-1} R_{d,t-1} + S_t R_{d,t-1}^* D_{t-1}^* + W_t l_t$$

where D_t, D_t^* , and K_t are peso and dollar deposits, and capital respectively. S_t . P_t^c and P_t^k are the nominal exchange rate, consumer price index and the price of capital.

7.2 Goods Production

7.2.1 Domestic Homogeneous Goods

Domestic homogenous good Y_t is produced from intermediate domestic goods and is used as a input for consumption, investment and export goods.

$$Y_t = \left[\int_0^1 Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}, \varepsilon > 1$$

7.2.2 Intermediate Goods

Intermediate goods are produced by monopolists using capital and labor, Production function of intermediate good firms:

$$Y_{i,t} = K_{i,t-1}^{\alpha} (A_t l_{i,t})^{1-\alpha}, a_t \sim \text{exogenous shock to technology.}$$

Firms are subject to the Calvo Price-Setting Friction:

$$P_{i,t} = \begin{cases} \tilde{P}_t & \text{with probability } 1 - \theta \\ P_{i,t-1} & \text{with probability } \theta \end{cases}$$

7.2.3 Final Consumption Goods

These are the consumption goods purchased and consumed by domestic households. They are produced by a representative, competitive firm using:

$$C_{t} = \left[(1 - \omega_{c})^{\frac{1}{\eta_{c}}} \left(C_{t}^{d} \right)^{\frac{\eta_{c}-1}{\eta_{c}}} + \omega_{c}^{\frac{1}{\eta_{c}}} \left(C_{t}^{m} \right)^{\frac{\eta_{c}-1}{\eta_{c}}} \right]^{\frac{\eta_{c}}{\eta_{c}-1}}$$

Consumer price index is defined as

$$P_{t}^{c} = \left[(1 - \omega_{c}) P_{t}^{1 - \eta_{C}} + \omega_{c} (P_{t}^{m})^{1 - \eta_{c}} \right]^{\frac{1}{1 - \eta_{c}}}$$

let scaled prices, $(p_t^c \equiv P_t^c/P_t, p_t^m \equiv P_t^m/P_t)$

$$p_t^c = \underbrace{\left[(1 - \omega_c) + \omega_c \left(p_t^m \right)^{1 - \eta_c} \right]^{\frac{1}{1 - \eta_c}}}_{(8)}$$

where p_t^m is the import price

$$p_t^m = \frac{P_t^m}{P_t} = \frac{S_t P_t^f}{P_t}.$$
(2)

7.2.4 Capital Goods and Investment

Capital is produced from domestic $(I_{d,t})$ and foreign $(I_{m,t})$ inputs. Domestic homogenous good is used as domestic input whereas Foreign input is imported.

$$I_t = \left[\gamma_I^{\frac{1}{\nu_I}} I_{d,t}^{\frac{\nu_I - 1}{\nu_I}} + (1 - \gamma_I)^{\frac{1}{\nu_I}} I_{m,t}^{\frac{\nu_I - 1}{\nu_I}}\right]^{\frac{\nu_I}{\nu_I - 1}}$$

Evolution of capital,

$$K_t = (1 - \delta) K_{t-1} + \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t.$$

7.2.5 Exports

Foreigner demand local export goods,

$$X_t = \left(\frac{P_t^x}{P_t^f}\right)^{-\eta_f} Y_t^f X_t = \left(p_t^x\right)^{-\eta_f} Y_t^f$$
(3)

 Y_t^f foreign demand shifter

 P_t^f foreign currency price of foreign good

 P_t^x foreign currency price of export good

Similar to consumption and Investment, exports are produced from intermediate export goods and imported inputs

$$X_{t} = \left[\gamma_{x}^{\frac{1}{\eta_{x}}} \left(X_{t}^{d}\right)^{\frac{\eta_{x}-1}{\eta_{x}}} + \left(1 - \gamma_{x}\right)^{\frac{1}{\eta_{x}}} \left(X_{t}^{m}\right)^{\frac{\eta_{x}-1}{\eta_{x}}}\right]^{\frac{\eta_{x}}{\eta_{x}-1}},$$

where X_t^d is a domestically produced input to exports with dollar price, $P_t^{d,x}$ and X_t^m is an imported good with dollar price, P_t^f . Price of exports defined by,

$$P_t^x = \left[\gamma_x \left(P_t^{d,x}\right)^{1-\eta_x} + (1-\gamma_x) \left(P_t^f\right)^{1-\eta_x}\right]^{\frac{1}{1-\eta_x}}.$$

In terms of the earlier versions of the model, $\gamma_x = 1$, so that $P_t^x = P_t^{d,x}$, as we would expect. It is convenient to scale this expression by $P_t^f, p_t^x = P_t^x/P_t^f$,

$$p_t^x = \left[\gamma_x \left(\frac{p_t^{d,x}}{p_t^m}\right)^{1-\eta_x} + 1 - \gamma_x\right]^{\frac{1}{1-\eta_x}} \tag{4}$$

where p_t^m is defined in equation (2) and we scale $P_t^{d,x}$ in the same way that we do other dollar variables:

$$p_t^{d,x} = \frac{S_t P_t^{d,x}}{P_t}.$$
(5)

The domestic input is produced by a competitive firm using the following production function:

$$X_t^d = \left[\int_0^1 X_{i,t}^{\frac{\varepsilon_x - 1}{\varepsilon_x}} di\right]^{\frac{\varepsilon_x}{\varepsilon_x - 1}}, \ \varepsilon_x > 1,$$
(6)

where $X_{i,t}$ is produced using domestic homogenous good by monopolists for price $P_{i,t}^x$. These monopolists face sticky prices

$$P_{i,t}^{x} = \begin{cases} \tilde{Px}_{t} & \text{with probability } 1 - \theta_{x} \\ P_{i,t-1}^{x} & \text{with probability } \theta_{x} \end{cases}$$

From Calvo we get

$$P_t^{d,x} = \left(\int_0^1 \left(P_{i,t}^{d,x}\right)^{(1-\varepsilon_x)} di\right)^{\frac{1}{1-\varepsilon_x}} = \left((1-\theta_x)\left(\tilde{P}_t^{d,x}\right)^{(1-\varepsilon_x)} + \theta_x\left(P_{t-1}^{d,x}\right)^{(1-\varepsilon_x)}\right)^{\frac{1}{1-\varepsilon_x}},$$

The marginal cost of producing $X_{i,t+j}$, after scaling by $S_t P_t^{d,x}$, is

$$s_t^x \equiv \frac{P_t}{S_t P_t^{d,x}} = \frac{1}{p_t^{d,x}}.$$
(7)

In the absence of export price stickiness ($\theta_x = 0$), monopolists will set $p_t^{d,x} = 1$. In that case, export prices will depend only on p_t^m , which is the peso price of foreign goods. Then, the export prices will be sticky in domestic currency, the model will boil down to PCP. When export prices are very sticky, the dollar price of $P_t^{d,x}$ will not move following a depreciation.

7.2.6 Aggregate Output of Homogeneous Good

Domestic homogenous good production,

$$Y_t = p_t^* K_{t-1}^\alpha \left(A_t l_t \right)^{1-\alpha}$$

where

$$p_t^* = \left[(1-\theta) \left(\frac{1-\theta \pi_t^{\varepsilon-1}}{1-\theta} \right)^{\frac{\varepsilon}{\varepsilon-1}} + \frac{\theta \pi_t^{\varepsilon}}{p_{t-1}^*} \right]^{-1}$$

Market clearing in homogeneous goods is (after scaling):

$$Y_t = I_t^d + C_t^d + X_t^d$$

Figure (17) summarizes the goods production in the model.



Figure 17: Model Goods Market

8 Results

8.1 Response of the economy following a foreign interest rate shock

Figure (18) plots impulse response of the the economy with flexible and sticky export prices to a 1% APR foreign interest rate shock. An increase in foreign interest rates pushes people to buy more dollar asset, which raises dollarization. High dollar demand depreicates the exchange rate, which in turn raises inflation due to pass through. The stark difference is when export prices are flexible ($\theta_x = 0.01$), exports go up significantly and stimulates the economy. In contrast, when export prices are sticky ($\theta_x = 0.75$), export response is muted and the economy contracts. Exchange rate depreciates more, which indicates that the comovement between the exchange rate and economic performance is negative when export prices are sticky.



Figure 18: Response of the economy following a foreign interest rate shock

9 Conclusion

In this paper, we offer the co-movement of local economic conditions and the exchange rate as a driver of average excess currency returns. In countries where the exchange rate tends to depreciate in recessions, dollar assets provide income insurance since they gain value during recessions. In these countries, residents would like to hold dollar assets and require a premium to hold local currency assets. Correlation between real GDP and real exchange rate movements appears as a significant determinant of average excess returns, even after controlling for key determinants in the literature. We build a small open economy model where the residents and the foreigners trade in FX markets for insurance as well as speculative reasons. The simple insurance view built in the model can generate key determinants of average currency returns in the data. We offer dollar invoicing of exports as a main driver of the negative comovement of output and the exchange rate as high dollar invoicing leads to a muted response of exports to exchange rate depreciations.

A Financial Depth and Currency Returns

Figure 19 plots total foreign assets and liabilities as a share of GDP, a proxy for financial depth, against excess returns. Maggiori (2012) argues that countries whose financial system is deep can intermediate large amounts of flows and carry a safety premium. Net external balance and financial depth are highly correlate, one is that the financial depth is driven mostly by assets rather than liabilities which are accumulated by giving large external surpluses



Figure 19: Excess returns vs Financial Depth

Data source: FX4Casts. Y-axis variable is the average currency return of 25 countries between 02/2003 - 11/2018. X-axis variables is the sum of foreign assets and liabilities of the banking system as a share of GDP, proxy for financial depth.

B Quarterly Returns

Here, We replicate the results in the previous section using quarterly returns. Why do We need to present quarterly results? First, my expectation data is in quarters. Second, there might be high frequency movements that are cancelled out when aggregated to quarters. Under tables 10 and 11, We show that the two principal components are present in the quarterly data as well. Similarly, S&P500 is related to the first component whereas VIX is mostly related to the second.

	Dependent variable: Excess Returns			
_	(1)	(2)	(3)	
Component 1	0.032^{*}		0.027	
	(0.018)		(0.017)	
Component 2	× /	0.012^{***}	0.011**	
		(0.004)	(0.004)	
Constant	-0.0002	0.006***	0.001	
	(0.003)	(0.001)	(0.003)	
Observations	23	23	23	
\mathbb{R}^2	0.169	0.195	0.313	
Adjusted R ²	0.130	0.157	0.245	
Residual Std. Error	0.006 (df = 21)	$0.005 \ (df = 21)$	0.005 (df = 20)	
Note:	*p<0.1; **p<0.05; ***p<0.01			

Table 10: Average excess returns vs component loadings

Data source: FX4Casts. Left hand variable is the average quarterly currency returns of 25 countries between 02/2003 - 11/2018. Right hand variables are the coefficients of each country for the two principal component of currency returns. Both components are scaled such that a positive coefficient means positive covariance with the returns.

	Dependent variable:					
	Turkey	Chile	Mexcio	Euro Area	Japan	
	(1)	(2)	(3)	(4)	(5)	
Component 1	0.259^{***}	0.197^{***}	0.172^{***}	0.189***	0.030	
	(0.029)	(0.025)	(0.028)	(0.015)	(0.057)	
Component 2	-0.195^{**}	0.082^{*}	0.076	-0.237^{***}	-0.045	
	(0.080)	(0.049)	(0.070)	(0.042)	(0.075)	
Constant	0.011^{*}	0.008^{**}	0.001	0.001	-0.001	
	(0.006)	(0.003)	(0.004)	(0.002)	(0.007)	
Observations	62	62	62	62	62	
\mathbb{R}^2	0.521	0.528	0.500	0.869	0.022	
Adjusted \mathbb{R}^2	0.505	0.512	0.483	0.864	-0.011	
Residual Std. Error $(df = 59)$	0.057	0.042	0.039	0.018	0.050	
Note:	*p<0.1; **p<0.05; ***p<0.01					

Table 11: Average excess returns vs component loadings

Data source: FX4Casts. Left hand variable is the returns of several currencies between 02/2003 - 11/2018. Right hand variables are the two principal component of currency returns. Both components are scaled such that a positive coefficient means positive covariance with the returns.

	Dependent variable:			
	S&P 500 Return	ns $\Delta \log(\text{VIX})$	$\Delta \mathrm{GFC}$	
	(1)	(2)	(3)	
Component 1	0.200***	-0.641^{***}	1.923***	
	(0.051)	(0.116)	(0.391)	
Component 2	0.091	-0.803^{***}	0.714^{*}	
-	(0.060)	(0.191)	(0.411)	
Constant	0.024**	-0.003	-0.006	
	(0.010)	(0.021)	(0.055)	
Observations	62	62	62	
\mathbb{R}^2	0.420	0.356	0.667	
Adjusted \mathbb{R}^2	0.400	0.334	0.656	
Residual Std. Error $(df = 59)$	0.053	0.212	0.304	
Note:	k	*p<0.1; **p<0.05;	***p<0.01	

Table 12: Average excess returns vs component loadings

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

	Dependen	Dependent variable:		
	Component 1	Component 2		
	(1)	(2)		
S&P 500 Returns	-1.465^{***}	-0.086		
	(0.490)	(0.358)		
$\Delta \log(\text{VIX})$	-0.009	-0.111		
	(0.051)	(0.071)		
ΔGFC	0.511***	-0.010		
	(0.054)	(0.043)		
Constant	0.038^{*}	0.002		
	(0.023)	(0.011)		
Observations	62	62		
\mathbb{R}^2	0.695	0.074		
Adjusted \mathbb{R}^2	0.679	0.026		
Residual Std. Error $(df = 58)$	0.124	0.081		
Note:	*p<0.1; **p<	*p<0.1; **p<0.05; ***p<0.01		

Table 13: Average excess returns vs component loadings

Data source: FX4Casts, Ken French dataset, CBOE. Right hand variables are the two principal components of currency returns of 25 countries between 02/2003 - 11/2018. Left hand variables are the returns of S&P500 and log change in VIX index.

C Forward Returns

Covered interest rate parity gives us an alternative measure for currency returns. Denote F_t as the price of a forward contract. No arbitrage condition requires that the return to a hedged currency position financed by USD should be equal to the return to USD returns.

$$\frac{S_t}{F_t}R_t^L = R_t^{US} \tag{8}$$

We can replace R_t^L inside the equation 1 using the equation 8,

$$R_t^{US}\left(\frac{F_t}{S_{t+1}} - 1\right) \tag{9}$$

Equation 9 allows us to overcome the problem of finding compatible interest rates across countries as well as accounting for trading costs using different ask/bid prices. One big potential issue with the forward returns is there are documented large CIP deviations. ? notes that in CIP holds most of the time in the monthly data. Still, buying forward contracts is the most straightforward strategy to invest in other currencies. Forward returns are by themselves valid returns, irrespective of whether they are a good proxy for actually borrowing in USD and investing in local currency interest rates.

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