Online Appendix to 'Financial Dollarization in Emerging Markets: Efficient Risk Sharing or Prescription for Disaster?

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A The Insurance Hypothesis

A.1 Figure 2 After Removing Controls

Here, we construct versions of Figure 2 in Subsection 3.1 after controlling for other variables. Table A1 reports the results of regressing deposit dollarization over the period 2000-2018 on our controls. The first column shows what happens when we include only the correlation term in Figure 2, and shows that that variable is highly significant. That is what we expect given the results in Figure 2. Importantly, both the numerical value and the (high) statistical significance of the coefficient on the cyclical behavior of the exchange rate remains highly significant when we also include the other controls, in columns (2)-(5). Other variables are also important for deposit dollarization. In particular, countries that experienced high inflation in the 1990s tend to have higher deposit dollarization in the 2000s. Similarly countries with 'better' institutions according to the World Bank also have lower deposit dollarization.

Table A1: Determinants of Dollarization

	Dependent variable:				
	Dollarization				
	(1)	(2)	(3)	(4)	(5)
Corr($\Delta GDP, \Delta S/P$)	-34.161^{***}	-30.287^{***}	-34.183^{***}	-33.680^{***}	-20.439^{**}
	(6.843)	(7.976)	(8.336)	(8.129)	(9.849)
Av Inflation		0.027^{***}	0.025^{***}	0.025^{***}	0.022^{***}
		(0.005)	(0.005)	(0.005)	(0.005)
Gini			0.170	0.271	0.057
			(0.195)	(0.196)	(0.270)
Fuel Export			-0.057	-0.069	-0.073
			(0.091)	(0.088)	(0.063)
Reserves/GDP			0.026	0.021	-0.003
			(0.016)	(0.016)	(0.014)
Institutions				-0.389^{**}	-0.239
				(0.189)	(0.197)
External Debt					0.253^{***}
					(0.085)
Constant	21.429^{***}	20.462^{***}	10.937	9.519	12.942
	(1.882)	(2.194)	(7.515)	(7.360)	(14.152)
Observations	121	112	94	87	58
R^2	0.168	0.232	0.325	0.392	0.362
Adjusted R^2	0.161	0.218	0.287	0.347	0.272
Residual Std. Error	19.592 (df = 119)	19.197 (df = 109)	17.924 (df = 88)	17.144 (df = 80)	16.768 (df = 50)
Note:					*p<0.1; **p<0.05; ***p<0.01

Dependent variable is the average dollarization between 2000-2018. Right hand variables are average inflation in the 90s ('Av Inflation'); average Gini index in the sample, 2000-2018, ('Gini'); fuel exports (as a share of total exports) in the sample, 2000-2018, ('Fuel Export'); Central Bank reserves (as a share of GDP) in the sample, 2000-2018, ('Reserves/GDP').
Political institutions ('Institutions') are proxied by "Constraints on the Executive Authority", 2000-2018, provided by Polity V database provided by Center for Systemic Peace ("https://www.systemicpeace.org/inscrdata.html"); External Debt (as a share of GDP), in the sample 2000-2018, ('External Debt'). Heteroskedasticity consistent standard errors appear in parentheses.

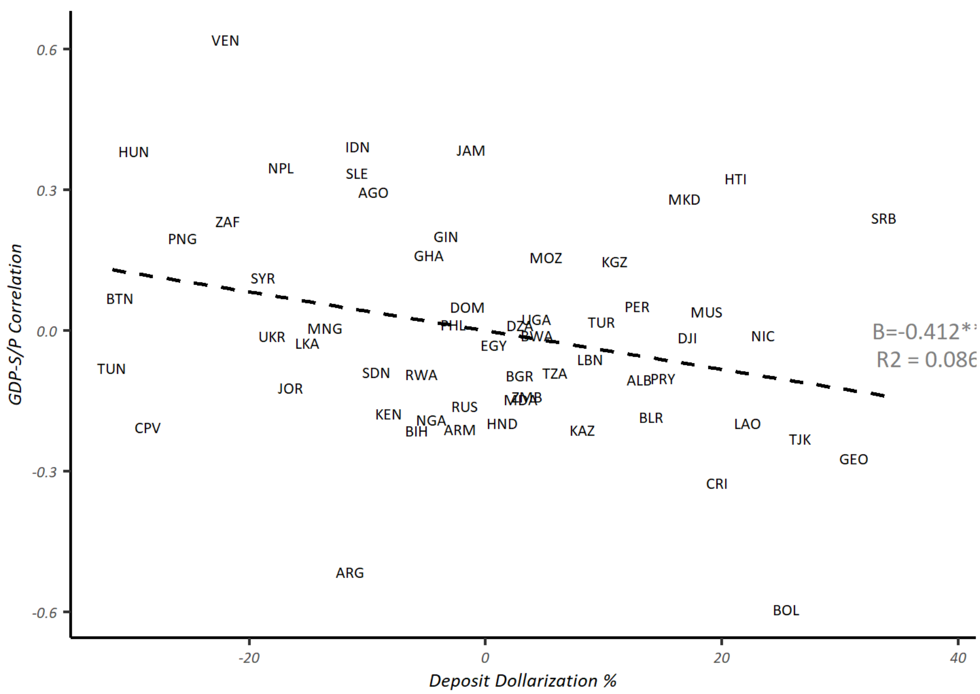
That inflation in the 1990s is important for deposit dollarization in the 2000s is not surprising. Figure A1 shows that countries which experienced high inflation in the 1990s (vertical axis) had high average levels of deposit dollarization in the 2000s (horizontal axis). It is also not surprising that countries with weak institutions would have high deposit dollarization, perhaps because these countries are more likely to turn to inflation finance in a recession.

Figure A1: Inflation vs Dollarization

We find the insignificantly-different-from zero coefficient on dollar reserves in columns (3)-(5) in Table A1 somewhat surprising. In effect, dollar reserves held by the government represents insurance for all the people in the country, households as well as the owners of firms. Governments holding a high amount of dollar reserves in countries in which the exchange rate depreciates in a recession are able to reduce spending cutbacks and tax hikes at such a time, both of which represent a form of insurance to citizens. We expect that, other things the same, households in a country with high dollar reserves would hold lower dollar deposits so that the coefficient on reserves should be negative and significant from the insurance point of view. The fact that the coefficient is insignificantly zero is also a puzzle from the point of view of the alternative hypothesis about Figure 2. That is the 'reverse causality' hypothesis associated with the balance sheet channel under which causality goes from deposit dollarization to the correlation on the vertical axis.

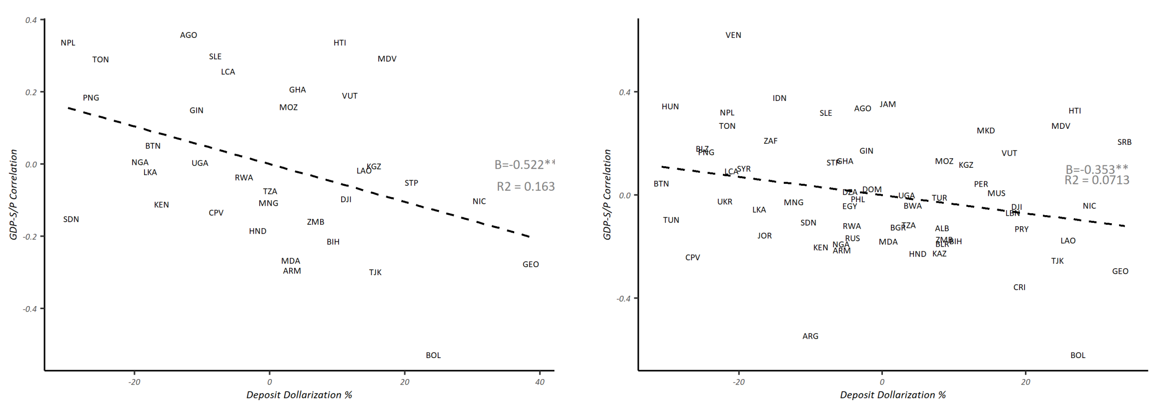
Notice in Table A1 that the number of countries for which we have evidence for all our controls is sharply limited. So, we construct three different versions of Figure 2. They differ according to which set of controls are removed from the cross-country data displayed in the figure. Figure A2 is the scatter of the error in the correlation (vertical axis) against the error in deposit dollarization (horizontal axis), after regressing on the controls in column (3) of Table A1. Note that the R^2, the slope coefficient and its significance level coincide roughly with what is reported in Figure 2. The results using the controls in columns (4) and (5) appear in the first and second panels of Figure A3, respectively. The number of countries included in the latter two data sets is sharply reduced. Still, the results display a similar pattern: the correlation on the vertical axis has a statistically significant negative relationship with deposit dollarization.

Figure A2: Countries in which the Currency Depreciates More in a Recession Have Greater Deposit Dollarization even after controlled for other determinants



Notes: x-axis and y-axis variables are the residuals from regressing the variables on the x and y axes in Figure (2) on the variables in Table A1, column 3. See figure 2 for details.

Figure A3: Countries in which the Currency Depreciates More in a Recession Have Greater Deposit Dollarization even after controlled for other determinants



Notes: x-axis and y-axis variables are the residuals from regressing the variables on the x and y axes in Figure (2) on the variables in Table A1, column 4 and 5 . See figure 2 for details.

A.2 The Interest Rate Spread, $i - i^*$, as a Tax

Here, we express $i - i^*$ in the form of a tax, τ, on dollar balances. To measure that tax, consider households' total deposit earnings:

$$i^* \overbrace{d^*}^{\text{dollar deposits in local currency units}} + i \overbrace{d}^{\text{local deposits}} . \tag{A.1}$$

On average, these earnings are less than what the household would get if it were to place all its deposits in local currency units. In that case, in would earning $(d^* + d)\, i$. The amount it loses by holding dollar deposits defines the tax:

$$(d^* + d)\, i\, (1 - \tau) = d^* i^* + di,$$

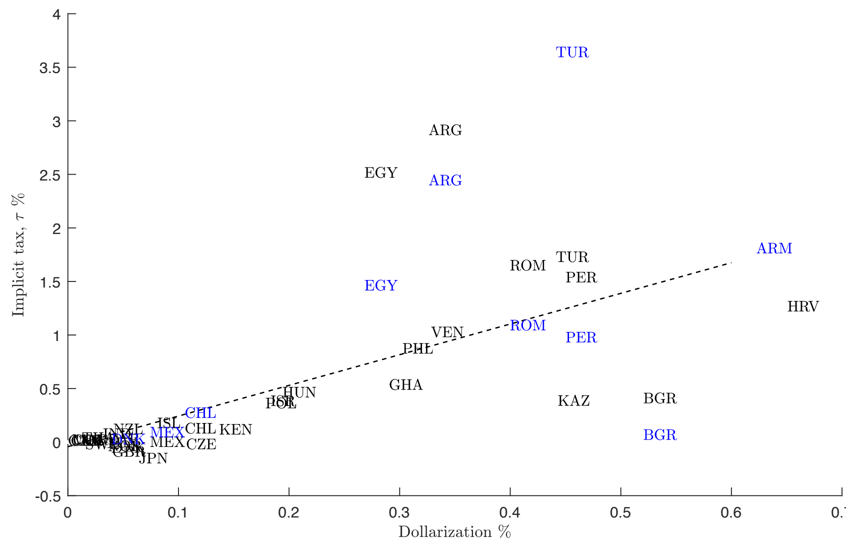
where τ denotes the tax rate. Solving,

$$\tau = \frac{i - i^*}{i} \phi, \tag{A.2}$$

where $\phi \equiv d^* / (d^* + d)$ denotes deposit dollarization (see equation (1)). Under the hedging hypothesis, τ is the 'premium' paid for the hedging services provided by dollar deposits. In countries where households want more of those services, i.e., where there is greater deposit dollarization, we expect the premium to be higher.

We display the scatter plot of τ against deposit dollarization in Figure A4.

Figure A4: Implicit Tax on Dollar Deposits versus Deposit Dollarization



Notes: τ denotes the implicit tax for denominating deposits in dollars rather than in domestic currency. See text for construction. Data on the horizontal axis correspond to $100 \times \phi$, where ϕ is defined in equation (1). For the observations marked in blue, local deposit rates were obtained from Central Bank websites. In the case of observations marked in black, the local deposit rate was inferred using covered interest parity, local and future's market exchange rates (taken from Datastream) as well as dollar risk free rates. In some cases, both measures of the domestic interest rate are available (in the case of Armenia . The line in the figure is the least squares that uses actual local dollar rates when available (blue) and uses derivative-based rates otherwise (black). The least squares line based on the black observations only is not included because it is virtually indistinguishable from the line reported.

Figure A4 suggests two things. First, the positive relationship between the price, τ, paid by households for dollarized deposits, and the quantity of those deposits suggests that variations in deposits across countries primarily reflect variations in demand by households. This is consistent with the insurance hypothesis. Second, for countries with substantial deposit dollarization (say, 40-50 percent), the price is in a range of 0.5-1.5 percent. To interpret this magnitude, it is interesting to note that the price is reasonably close to the fees earned by hedge fund managers.[72], nam. In sum, Figure A4 suggests two things. First, the positive relationship between the price, τ, paid by households for dollarized deposits, and the quantity of those deposits suggests that variations in deposits across countries primarily reflect variations in demand by households. This is consistent with the insurance hypothesis. Second, for countries with substantial deposit dollarization (say, 40-50 percent), the price is in a range of 0.5-1.5 percent. To interpret this magnitude, it is interesting to note that the price is reasonably close to the fees earned by hedge fund managers.[73]

[72] See https://www.investopedia.com/terms/t/two_and_twenty.asp .

[73] See https://www.investopedia.com/terms/t/two_and_twenty.asp .

B The Absence of Currency Mismatch in Country Banking Systems

For the details of this analysis, see the Online Technical Appendix, Section xx .zero foreign exchange (FX) risk according to the NOPFxCapital index. It reports 'net open position in foreign exchange to capital' (NOPFxCapital) for 115 countries and the results suggest that currency mismatch in banks (deposit-taking institutions) is very low.[74] We define the IMF statistic as follows. Let a and a^* denote the domestic and foreign assets of banks, respectively, each measured in local currency units. Similarly, let b and b^* denote banks' domestic and foreign liabilities. In principle, a^* and b^* should not include the portion of assets or liabilities in which exchange rate risk has been removed with the use of hedging instruments.[75] Then, NOPFxCapital corresponds to $m(s)$ for $s = 1$:

$$m(s) = \frac{(a^* - l^*)\, s}{(a^* - l^*)\, s + a - l}, \tag{B.1}$$

where the numerator, $a^* - l^*$ represents the net unhedged banks' foreign asset position and the denominator is bank net worth.[76] The statistics, for $s = 1$, are reported in the first column of Table B2. To give $m(1)$ an economic interpretation, we compute the magnitude of the depreciation, s, which would wipe out bank equity:

$$s = -\frac{a - l}{a^* - l^*} = 1 - \frac{1}{m(1)}.$$

Evidentially, when $m(1) < 0$ then $s > 1$, so it takes a depreciation to wipe out bank equity. If $1 > m(1) > 0$, so that $a > l$, then there is no depreciation that could wipe out bank equity. That is, even in the extreme case, $s = 0$, when all net foreign assets are lost, bank equity remains positive. Finally, if $m(1) > 1$ then $a < l$ and $1 > s > 0$, so that there is a

[74]For a precise definition of a 'bank' used in the data, see IMF (2006, Section 2). Data on the ratio of the net open position in foreign exchange divided by capital can be found in http://data.imf.org/regular.aspx?key=61404590. The data are an unbalanced panel. The IMF actually reports results for 119 entities. However, three - Anguilla, Macao and Montserrat - are not sovereign countries, so we do not use these data. Also, the Eastern Caribbean Currency Union (ECCU) is dropped because it includes countries included elsewhere in the dataset (ECCU also includes Anguilla).

[75]The IMF data document, IMF (FSI, Chapter 6, part (vii), 2006), Paragraph 6.37, explains NOPFxCapital. Reporting countries have the option to produce one of two versions of NOPFxCapital: a narrow one, IMF (FSI, Table 6.2, line 49, 2006) and a broader one, IMF (FSI, Table 6.2, line 50, 2006). The two versions differ according to how much detail is provided about the reporting bank's derivative operations to hedge foreign exchange risk. Obviously, the broader one includes more such information. In many cases, notes on the data provided to the IMF on their financial stability indicators are provided on the IMF website, folder labeled 'table 3', indicator S230.

[76]Details about the composition of bank assets and liabilities (including derivatives) can be found in IMF (2006, Table 4.1, page 31)). The denominator of $m(1)$ is positive for each of our observations.

appreciation that will wipe out bank equity.

Table B2: Currency Mismatch

Country	exchange depreciation, s, to wipe out bank assets	$m(1) = \frac{\text{Open FX Position}}{\text{Equity}}$
Norway	2.71	-0.37
Israel	2.99	-0.33
Switzerland	3.10	-0.32
Botswana	3.14	-0.31
Denmark	3.46	-0.28
Kazakhstan	15.15	-0.07
Central African Rep	17.81	-0.06
Bolivia	18.13	-0.06
Uganda	35.62	-0.03
Armenia	39.20	-0.02
Turkey	79.68	-0.01
Slovak Republic	96.80	-0.01
Rwanda	98.74	-0.01
Burundi	211.04	-0.00
Chad	358.86	-0.00
Nicaragua	0.01	1.00
St. Kitts and Nevis	0.34	1.50
Congo	0.38	1.61
St. Lucia	0.43	1.74
Grenada	0.50	2.00
Dominica	0.75	4.00

Notes: (i) Numbers have been rounded. Countries are ranked by NOPFxCapital, which appears in the right column. (ii) Data source: IMF.

For the 115 countries in the IMF dataset, the overwhelming majority, 93, have $0 < m(1) < 1$, and so they have zero foreign exchange (FX) risk according to the NOPFxCapital index.[77] That fact alone is an important indicator of the absence of currency mismatch in banks. The data on the remaining 22 countries are reported in Table B2. To understand the numbers in this table it is useful to look at particular cases. For example, in Nicaragua the IMF data indicate that NOPFxCapital is 1.0060 (rounded to 1). According to (B.1) with $s = 1$, Nicaraguan banks' net assets are nearly completely in dollars, i.e., $a - l$ is negative but essentially zero. If the assets were fully in dollars, bankruptcy would be impossible but given that $a - l$ is slightly negative, it would take a whopping 99% appreciation in the exchange rate for bank equity to be wiped out.

The countries in Table B2 are ordered in terms of NOPFxCapital from smallest to largest. The countries with the largest apparent exposure to foreign exchange risk (i.e., the most negative $m(1)$) are Israel, Norway, Denmark and Switzerland. In the case of Israel, notes on the IMF website indicate that the Israeli NOPFxCapital index does not fully reflect all foreign exchange hedging commercial banks. Furthermore, Bank of Israel (Statistical Bulletin, Part 1, section d, Figure 4.13, 2018) documents that once bank hedging is taken

[77] Two of the countries that we designate as having zero foreign exchange risk are Algeria and Comoros. In both cases the IMF reports zero foreign currency assets and liabilities in the years for which they report data. For the data sourse, see footnote 74.

into account, there is essentially no foreign exchange risk on commercial banks' balance sheets.[78] So, the large of NOPFxCapital in the case of Israel greatly overstates their banks' exposure to foreign exchange risk, which appears to actually be minimal. It is possible that the situation in Norway, Denmark and Switzerland is similar. The key point is that even if we take the statistics pertaining to the most risky 5 countries at face value, those countries have only a small amount of foreign exchange risk since their exchange rates would have to more than double for bank equity to be seriously at risk. The next group of 10 countries would require depreciations by factors of 10 or even over 100 for equity to be at risk. The final 6 countries have positive net foreign assets, $a^* > l^*$, with $m(1) > 1$ so that $a < l$. So, their exchange rates would have to appreciate to create a risk to the banking system. For the most part these appreciations would have to be very large.

[78]We are grateful to Nitzan Tzur-Ilan's help in this matter.

C Firms are the Source of Household Insurance

Because our panel is unbalanced, the statistics in Table C3 cover only the period 2010-2019.

(1) Country	(2) $\phi = \frac{dollar\,deposits}{total\,deposits}$	(3) $\frac{household\,(hh)\,dollar\,deposits}{total dollar\,deposits}$	(4) $\frac{firm\,dollars\,from\,banks}{firm\,dollars\,from\,everywhere}$	(5) $\frac{hh\,dollar\,borrowing\,from\,banks}{total\,dollar\,deposits}$	(6) $\frac{total\,dollar\,borrowing,\,firms}{total\,dollar\,deposits}$
Croatia	0.67		0.48	0.00	0.16
Armenia	0.59	0.74	1.00	0.31	1.07
Kazakhstan	0.52	0.66	0.42	0.15	1.93
Albania	0.51	0.86	1.00	0.15	0.47
Peru	0.48		0.77	0.17	1.01
Ukraine	0.44	0.64	0.76	0.13	1.26
Bulgaria	0.41		0.86	0.17	0.53
Uganda	0.36		1.00	0.02	0.64
Turkey	0.36	0.57	0.97	0.00	1.06
Romania	0.34	0.72	0.98	0.77	0.76
Russia	0.31	0.45	0.61	0.02	1.09
Mozambique	0.30	0.32	1.00	0.03	0.54
Honduras	0.29	0.54	1.00	0.19	0.87
Egypt	0.22	0.66	1.00	0.01	0.51
Hungary	0.21	0.38	0.83	0.43	1.43
Lithuania	0.16	0.60	0.77	0.82	1.05
Mean	0.38	0.59	0.84	0.21	0.90
Median	0.36	0.62	0.91	0.15	0.94

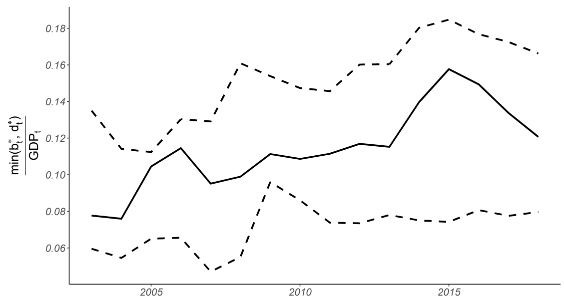
Table C3: Decomposition of Dollar Borrowing and Lending

Notes: With one exception, local residents' dollar deposits in banks and dollar credit from banks to local residents was collected from individual central bank websites. The exception is Peru, where the end-of-year data were kindly provided by Paul Castillo of the Peruvian Central Bank, for the period 2010-2019. For BIS reporting countries, dollar denominated securities issued by nonfinancial corporations are included in the column, 'NFC share'. Government share is calculated using dollar denominated securities issued in international markets for BIS reporting countries; for the remaining countries (Armenia, Albania, Honduras, Mozambique, Uganda), government share is calculated using external government debt collected from individual central bank websites. Total reserves (obtained from World Bank) is subtracted from government debt. Foreign share is 1 minus the rest combined. The data is a balanced panel covering the period 2010-2018. We begin the data in 2010 to miss the downward trend in dollar borrowing documented in Du and Schreger (2016b). In the row, 'Average for high-dollarized', we report averages for countries where deposit dollarization exceeds 0.20.

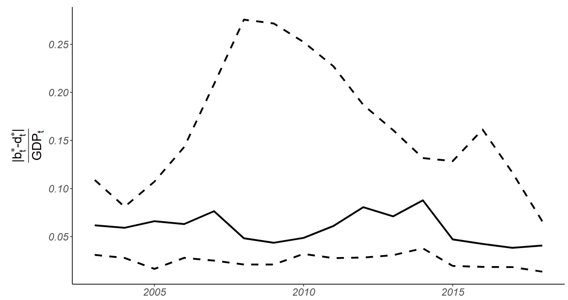
D Within vs Across Dollar Positions

Figure D5: Insider vs Across Positions

(a) Insider, $\frac{\min(b_t^*, d_t^*)}{GDP_t}$



(b) Across, $\frac{|b_t^* - d_t^*|}{GDP_t}$



Notes: Please refer to section 3.2.2 for details of the data. d_t^* and b_t^* refer to dollar deposits and loans respectively. Solid line plots the median across 16 EMEs whereas dashed lines are 25 and 75 percentiles.

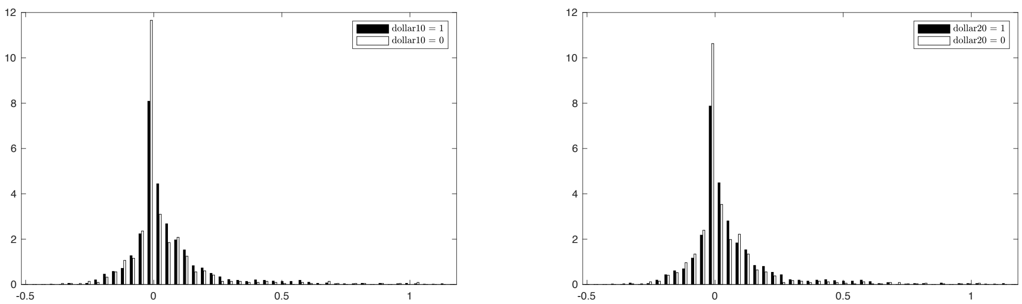
E Is High Deposit Dollarization Less or More Likely to Be Followed by Currency Depreciation in the Next Year?

We pooled all our annual data on deposit dollarization. Figure E6 displays the distribution of exchange rate depreciations, conditional on whether deposit dollarization was high or low in the previous year. Figure E6a uses a cutoff of 10% to identify high rates of deposit dollarization. Figure E6b uses a cutoff of 20%. We normalize the height of the bars, so that the product of their sum and the width of the bars is unity. Thus, the bars are an estimate of the underlying density function. In addition, to improve readability of the graphs, we dropped the smallest observation, as well as the largest 21 observations in the data.[79]

[79] The computations were done in MATLAB and the 'edges' on the horizontal axis are a grid with 50 equally-spaced points, where the first point is -0.5 and the last is 1.2. The observation 1.2 means that $S_t/S_{t-1} = 1.2$, where S_t denotes the year t exchange rate.

Figure E6: Exchange Rate Depreciations And Dollarization

(a) Average Deposit Dollarization Above 10% (b) Average Deposit Dollarization Above 20%



Note: these figures display the empirical distribution of exchange rate appreciations when deposit dollarization is above 10% and 20%, as indicated. The data correspond to our annual data and treat each observation (year, country) symmetrically.

Figure E6 examines the empirical density of exchange rate depreciations, $\Delta e_{i,t} = \ln(e_{i,t}/e_{i,t-1})$, where $e_{i,t}$ denotes the domestic currency price of a unit of foreign currency in year t and country i. The median value of $\Delta e_{i,t}$ in the entire sample is roughly zero and the mean is 0.074. The first panel, Figure E6a, reports the empirical density for all $\Delta e_{i,t}$ corresponding to t, i with low levels of dollarization, $d_{i,t-1} \leq .10$ (black bars) versus $\Delta e_{i,t}$ in which $d_{i,t-1} > .10$ (white bars).[80] The second panel is the same as the first, except that we compare i, t with $d_{i,t-1} \leq 0.20$ against $d_{i,t-1} > .20$. The key thing to note is that, if anything, there is a slight shift towards larger depreciations, $\Delta e_{i,t} > 0$, when dollarization is high. If deposit dollarization made balance sheet effects important, we might expect monetary authorities to see this and to respond by reducing the likelihood of large depreciations. In fact, the depreciations are slightly skewed to the right, consistent with the idea that deposit dollarization does not magnify balance effects.

[80] See equation (1) for the definition of $d_{i,t}$. We use $d_{i,t-1}$ rather than $d_{i,t}$ to minimize potential distortions from an 'automatic' effect of exchange rate depreciation that raises deposit dollarization, holding the quantity of dollar deposits and domestic deposits fixed. This effect is at best marginal because it only matters for the (presumably) small number of countries which jump deposit dollarization bins when the exchange changes. In any case, we repeated the histogram for $\Delta e_{i,t}$ and $d_{i,t}$ and found little difference in the results. That is, we find that the empirical density does not reveal a systematic pattern of fewer depreciations in deposit dollarized economies.

F Dataset: Country-year availability and crises

Table F4: Country-year availability and years of crises

Country	Crisis1	Crisis2	Crisis3	First Year	Last Year
Albania				1995	2017
Algeria				2000	2017
Angola				1996	2017
Anguilla				2001	2017
Antigua and Barbuda				1995	2017
Argentina	1995	2001		1995	2017
Armenia				1995	2017
Aruba				2005	2017
Austria	2008			1999	2017
Bahamas				1995	2017
Bahrain				1995	2017
Barbados				1995	2017
Belarus	1995			1995	2017
Belgium	2008			2000	2017
Belize				1995	2017
Bhutan				1995	2017
Bolivia				1995	2017
Bosnia and Herzegovina				1998	2017
Botswana				1996	2017
Bulgaria	1996			1995	2017
Burundi				2009	2017
Cambodia				1995	2017
Canada				1995	2017
Cape Verde				1995	2015
Chile				1995	2017
Congo Dem Rep				1995	2017
Costa Rica				1995	2017
Croatia	1998			1995	2017
Cyprus	2011			1995	2017
Czech Republic	1996			1995	2017
Denmark	2008			1995	2017
Djibouti				1995	2017
Dominica				1995	2017
Dominican Republic	2003			1997	2017
Egypt				1995	2017
Estonia				1995	2017
Finland				1997	2017
France	2008			2000	2017
Georgia				1997	2017
Germany	2008			2000	2017
Ghana				1996	2017
Greece	2008			1995	2017
Grenada				1995	2017
Guatemala				1998	2017
Guinea				1995	2017
Haiti				1997	2017
Honduras				1995	2017
Hungary	2008			1995	2017
Iceland	2008			1995	2017
Indonesia	1997			1995	2016
Ireland	2008			2003	2017
Israel				1995	2017
Italy	2008			2000	2017
Jamaica	1996			1995	2017
Japan				1999	2017
Jordan				1995	2017
Kazakhstan	2008			1999	2017
Kenya				1996	2017
Korea	1997			1995	2017
Kosovo				2005	2017
Kuwait				1995	2017
Kyrgyz Republic				1997	2017
Lao PDR				1995	2017
Latvia	1995	2008		1995	2017
Lebanon				1995	2017
Lithuania	1995			1995	2017
[illegible]	[illegible]			[illegible]	[illegible]

Country	Crisis1	Crisis2	Crisis3	First Year	Last
Malawi				1995	20
Malaysia	1997			1997	20
Maldives				1995	20
Malta				2004	20
Mauritius				1995	20
Mexico				1995	20
Moldova	2014			1995	20
Mongolia	2008			1995	20
Montserrat				2001	20
Morocco				2002	20
Mozambique				1995	20
Namibia				2004	20
Nepal				1995	20
Netherlands	2008			1995	20
Netherlands Antilles				1995	20
Nicaragua	2000			1995	20
Nigeria	2009			1995	20
Norway				1997	20
Oman				1995	20
Pakistan				1995	20
Papua New Guinea				1995	20
Paraguay	1995			1995	20
Peru				1995	20
Philippines	1997			1995	20
Poland				1995	20
Portugal	2008			1995	20
Qatar				1995	20
Romania	1998			1995	20
Russia	1998	2008		1995	20
Rwanda				1995	20
Samoa				2001	20
Sao Tome and Principe				1996	20
Saudi Arabia				1995	20
Serbia				2000	20
Seychelles				2004	20
Sierra Leone				1995	20
Singapore				1995	20
Slovak Republic	1998			1995	20
Slovenia	2008			1995	20
South Africa				1995	20
Spain	2008			1995	20
Sri Lanka				1996	20
St. Kitts and Nevis				1995	20
St. Lucia				1995	20
St. Vincent and the Grenadines				1995	20
Sudan				1995	20
Suriname				1999	20
Sweden	2008			1995	20
Switzerland	2008			1997	20
Syria				1995	20
Taiwan				1995	20
Tajikistan				1997	20
Tanzania				1995	20
Thailand	1997			1995	20
Tonga				1995	20
Trinidad and Tobago				1995	20
Tunisia				1995	20
Turkey	2000			1995	20
Uganda				1995	20
Ukraine	1998	2008	2014	1995	20
United Arab Emirates				1995	20
United Kingdom	2007			1995	20
Uruguay	2002			1995	20
Uzbekistan				1998	20
Vanuatu				1995	20
Venezuela				1995	20
[illegible]	[illegible]			[illegible]	[illegible]

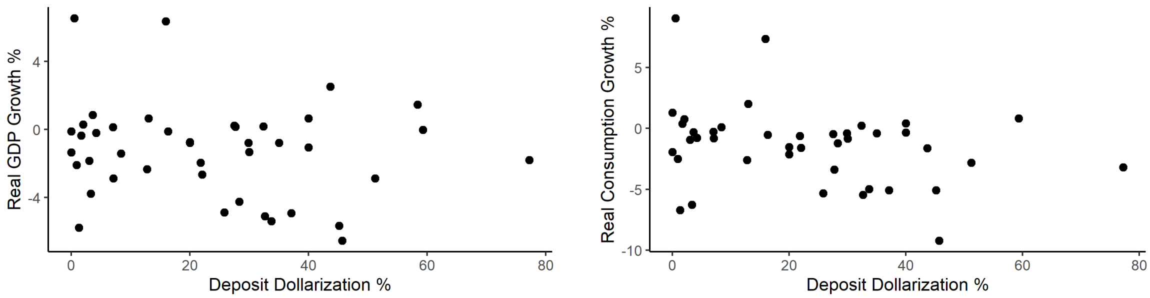
G Bivariate Analysis: Sudden Stops

To investigate the robustness of (i) and (ii), we use the Eichengreen and Gupta (2018) data on sudden stops. There are 34 countries that intersect with the 66 countries in the Eichengreen and Gupta (2018) data set and the 124 countries in our data set on deposit dollarization. There are 43 sudden stops in the data that we analyze. Figure G7 indicates that there is little relationship between the probability of a sudden stop and deposit dollarization. Figure G8 shows that there is little relationship between the cost of a sudden stop (measured in a decline of GDP growth or consumption growth) and deposit dollarization. Again, with this different measure of crisis we come a way with the same conclusion: there does not seem to be a systematic relationship the probability of a crisis, or its cost if there is one, and deposit dollarization.

Figure G7: Eichengreen and Gupta (2018) Frequency of Sudden Stops versus Dollarization

Note: Based 34 countries' data, the intersection of 66 Eichengreen and Gupta (2018) countries with the 124 Levy-Yeyati (2006) countries. Each point corresponds to a country. There are 43 sudden stops in the period 1990-2014.

Figure G8: Cost of Eichengreen and Gupta (2018) Severity of Sudden Stop and Deposit Dollarization



Note: See note to Figure G7 for data on sudden stops. Real GDP and consumption growth is calculated by taking the difference between average growth rate during the sudden stop and the decade average around the sudden stop.

We conclude that both data sets analyzed above indicate very little relationship between deposit dollarization and the likelihood or cost of crisis.

H Bootstrap Analysis of Logistic Regression

Table H5 provides more direct evidence on the relationship between crisis and dollarization, allowing for the possible role of exchange rates. First, the overall frequency of Laeven and Valencia (2018) crises, unconditional on the level of dollarization, is 1.8 percent in our sample of 2,281 observations. Second, if we consider just the subset of 1,690 observations in which $d_{i,t} > 0.10$, the probability of Laeven and Valencia (2018) crisis is 2.01 percent. Even for the 1,340 observations in which $d_{i,t} > 0.20$ the probability of crisis is 1.87 percent.[81] These observations are consistent with our bivariate analysis in Section (4.1), though here it is based on data at a more temporally disaggregated level.

Table H5 also allows us to focus a question that involves trivariate relationships. The table arranges our data in a way that we can ask, using minimal econometric structure, the following question. 'Is a big exchange rate depreciation more likely to lead to a crisis when the level of deposit dollarization is high?' The answer is 'no', according to the results in the table.

The table organizes the data according to six exchange rate depreciation intervals (see columns (1) and (2)). The first and sixth intervals are 'very large' appreciations and depreciations. The second and fifth intervals are 'large', and so on. The lower bound on the first interval and the upper bound on the sixth interval are the smallest depreciation and largest depreciation, respectively, in the dataset. The depreciations, -6.0 and 20.8 are the 10^{th} and

[81] With a little work, the 2 percent results can be recovered from Table H5 from the entries in columns (3), (4) and (5). In each of the six panels, take the product of the probability (the number not in brackets or parentheses) and the number of observations (the number in parentheses) and sum across all six panels.

90^{th} percentiles of the depreciation rates. The mean depreciation rate is 7.4 and we also include 7.4/2 as boundaries for our six depreciation intervals. There are 365 observations on the median exchange rate depreciation, which is zero. All these observations are included in the third depreciation interval.

Each of the six panels corresponding to a depreciation range is composed of two rows. The first row of each panel in column (3) indicates the frequency of Laeven and Valencia (2018) crises, conditional on depreciation being in the interval defined in columns (1) and (2).[82] The first row of each panel in Columns (4)-(6) report the frequency of crisis conditional on that panel's depreciation interval, and conditional on the level of dollarization indicated in the column's header. The numbers in parentheses in columns (3), (5) and (6) indicate the quantity of observations in which the depreciation rate lies in the range specified in columns (1) and (2) and the deposit dollarization rate lies in the range indicated in the column heading.[83] Our depreciation intervals were designed in part to ensure roughly similar-sized samples in each interval.[84] The numbers in square brackets in columns (5) and (6) indicate the fraction of observations in the associated depreciation range that have deposit dollarization rates in excess of 10 percent and 20 percent, respectively.[85] Consistent with the evidence in Figure 1, the numbers in square brackets in columns (5) and (6) indicate that the fraction of our sample with deposit dollarization 10 (20) percent and higher is around 70 percent (60 percent). Moreover, the results indicate that these fractions rise with the exchange rate.

The numbers in the second row of each of the six panels in Table H5 are p-values. In columns (3) and (4) the p-value is the probability that the frequency estimator exceeds its estimated value in the first row, under our null hypothesis: (a) the Laeven and Valencia (2018) crisis indicator is independent of both the depreciation rate and the level of deposit dollarization and (b) the joint density of deposit dollarization and the exchange rate is what we see in the data.[86] Note that the p-values are all well above the usual 1 and 5 percent cutoff values, 0.01 and 0.05. The table provides no evidence against the null hypothesis.

The p-values in columns 5 and 6 go directly to the question raised above: whether a crisis is more likely if an exchange rate depreciation occurs when deposit dollarization is high. We find no such evidence. Specifically, the p-value in column j reports the probability, under

[82] The frequency in column (3) unconditional, in that does not condition on any particular value of deposit dollarization.

[83] There is no number in parentheses in column (4), because the number of observations in that category is just the number in parentheses in column (3), minus the number in parentheses in column (5).

[84] The relatively large number of observations associated with the 0-3.7 interval reflects that we include the 365 zero observations in that interval.

[85] There is no square bracketed number in column (4), because that would just be unity minus the number in square brackets in column (5).

[86] For details of the bootstrap procedure we use to compute the p-values, see the notes to Table H5.

Table H5: Relation Between Exchange Rate Depreciation and Crisis, Conditional on Dollarization

Depreciation (%) bins		Frequency (%) of crisis conditional on:			
lower bound	upper bound	unconditional	dep. doll. < 10%	dep. doll. > 10%	dep. doll. > 20%
(1)	(2)	(3)	(4)	(5)	(6)%
-274.3	-6.0	1.3, (228)	0.0	1.9, (159), [0.70]	0.0, (120), [0.53]
		0.69	1.00	0.16	0.99
-6.0	-0.0	2.0, (346)	3.3	1.6, (254), [0.73]	1.5, (206), [0.60]
		0.36	0.15	0.85	0.65
-0.0	3.7	1.4, (763)	0.8	1.8, (507), [0.66]	1.8, (379), [0.50]
		0.76	0.90	0.16	0.44
3.7	7.4	1.1, (281)	0.0	1.3, (235), [0.84]	1.6, (189), [0.67]
		0.82	1.00	0.33	0.25
7.4	20.8	3.0, (435)	2.0	3.3, (335), [0.77]	3.0, (264), [0.61]
		0.04	0.41	0.20	0.77
20.8	359.0	1.8, (228)	0.0	2.0, (200), [0.88]	2.2, (182), [0.80]
		0.49	1.00	0.24	0.22

Note: Analysis is based on 2,281 annual observations on Laeven and Valencia (2018) crisis indicators, exchange rate changes and indices of deposit dollarization drawn from an unbalanced panel of emerging market economies. For a detailed discussion of the structure of the table, see the text. To understand our bootstrap procedure for computing the p-values, let X denote the 2281 by 4 matrix, where the first column contains the data on x_i and the other three columns contain 0,1 dummies: one that indicates a Laeven and Valencia crisis, and two which indicate whether deposit dollarization is above 10 percent, or 20 percent, respectively. To do the bootstrap we constructed 1 million artificial datasets, X(1),....,X(1,000,000). For the jth data set we randomly draw two sets of integers of length 2281, with replacement, from [1,...,2281]. Then, X(j) was constructed by reordering the rows of the first column of X using the first set of random indices and reordering the rows in columns (2)-(4) with the second set of indices. In this way, we capture the null hypothesis that crises are independent of exchange rates and deposit dollarization. At the same time, our bootstrapped data preserve the empirical covariation between exchange rates and deposit dollarization. For each artificial data set, we compute the statistics discussed in the text. The p-value for a given estimated statistic is the fraction of simulated statistics that exceed its corresponding empirical analog.

the null hypothesis, that the estimated jump in frequency, from column $j-1$ to column j, is larger than its estimated value, for $j = 5, 6$. For example, given the third depreciation range, $0 - 3.7$, the jump in crisis frequency for observations with $d_{t,i} < 0.10$ (column (4)) to what that frequency is for observations with $d_{t,i} > 0.10$ (column (5)) is 1.8-0.8, or 1 percentage point. Bootstrap simulations indicate that under the null hypothesis, (a) and (b) stated above, the probability of getting an even higher jump is 16 percent. As noted above, that probability would have to be 1 or 5 percent to reject the null hypothesis in standard practice. Note that 16 percent is the minimum p-value in columns (5) and (6).

In sum, the simple frequency analysis in Table H5 provides no evidence that deposit dollarization makes a country vulnerable to a Laeven and Valencia (2018) crisis.

I Appendix Logistic Regression Tables

I.1 Different Measures of Uncertainty

Table I6: Different Measures of Uncertainty

	(1)	(2)	(3)	(4)	(5)	(6)
Crisis						
Dollar (20)	-0.734	-0.641	-0.627	-0.615	-0.730	-0.590
	(-0.75)	(-0.70)	(-0.67)	(-0.70)	(-0.75)	(-0.66)
Δer	-0.283	-0.417	0.512	0.136	-0.622	-0.249
	(-0.08)	(-0.08)	(0.20)	(0.04)	(-0.16)	(-0.05)
Dollar(20)*Δer	-2.811	-3.892	-3.285	-3.588	-2.933	-3.949
	(-0.55)	(-0.72)	(-0.81)	(-0.80)	(-0.55)	(-0.72)
High FL/FA	1.544	1.590	1.629	1.621	1.547	1.499
	(1.27)	(1.36)	(1.36)	(1.37)	(1.29)	(1.34)
High FL/FA * Low Reserves	-1.252	-1.354	-1.224	-1.307	-1.282	-1.259
	(-0.97)	(-1.07)	(-1.00)	(-1.07)	(-1.00)	(-1.03)
Dollar(20) * Low Reserves	1.538	1.402	1.550	1.425	1.573	1.513
	(1.30)	(1.23)	(1.34)	(1.22)	(1.35)	(1.29)
Reserves/GDP	-1.033	-1.705	-0.288	-1.282	-1.019	-0.795
	(-0.45)	(-0.66)	(-0.15)	(-0.49)	(-0.44)	(-0.40)
Real GDP Growth	0.0404	0.0706	0.0253	0.0560	0.0552	0.0618
	(0.53)	(0.98)	(0.35)	(0.82)	(0.74)	(0.90)
External Debt	0.332***	0.371***	0.280***	0.339***	0.351***	0.348***
	(5.84)	(3.98)	(5.75)	(4.85)	(5.43)	(3.69)
VIX	0.126***					
	(2.77)					
Global Factor		-0.408				
		(-0.89)				
Financial Stress			1.155**			
			(1.96)			
Mon Pol Uncertainty				0.00850		
				(0.61)		
Financial Uncertainty					4.368**	
					(2.52)	
ExcangeRate Market Vol						1.048*
						(1.81)
Constant	-8.281***	-5.396***	-122.7**	-6.307***	-9.731***	-6.060***
	(-5.80)	(-9.14)	(-2.04)	(-4.05)	(-4.72)	(-8.58)
N	1186	1186	1126	1186	1186	1186
Years	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Countries	EMEs	EMEs	EMEs	EMEs	EMEs	EMEs
Pseudo R2	0.0537	0.0198	0.0576	0.0207	0.0457	0.0218

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: Global Factor is taken from Miranda-Agrippino and Rey (2020). The rest of the uncertainty measures are downloaded from Economic Policy Uncertainty https://www.policyuncertainty.com. Financial Stress measures financial stress based on major US newspapers (Puttmann (2018)). Monetary Policy Uncertainty and Economic Policy Uncertainty measure policy uncertainty in the US (Baker et al. (2016)). Similarly, Exchange Rate Market Volatility tracks volatility in exchange rate markets (Baker et al. (2019)). Financial Uncertainty is from Jurado et al. (2015)

I.2 Adding Second lag

Table I7: Probability of Banking Crises

	(1)	(2)	(3)	(4)	(5)
	Crisis	Crisis	Crisis	Crisis	Crisis
Crisis					
Dollar (20)	-0.587	-0.534	-0.423	-1.147	-0.828
	(-0.67)	(-0.30)	(-0.39)	(-0.71)	(-0.46)
Δer	-0.910*	-3.284	0.470	0.470	-0.0846
	(-1.85)	(-0.84)	(0.69)	(0.21)	(-0.02)
Dollar(20)*Δer	3.085**	4.300	1.612	1.255	1.444
	(2.54)	(1.04)	(1.00)	(0.46)	(0.41)
High FL/FA		2.001*		1.296**	1.373
		(1.80)		(2.19)	(1.30)
Dollar(t-2) (20)	0.180	1.055	0.776	1.453	1.507
	(0.28)	(0.70)	(0.72)	(0.88)	(0.80)
Dollar(20)(t-1)*(t-2)*Δer	-1.921*	-2.052	-1.917	-2.897	-3.979
	(-1.72)	(-0.90)	(-1.52)	(-1.26)	(-1.36)
VIX	0.169**	0.166***	0.0787*	0.130***	0.125***
	(2.56)	(2.92)	(1.92)	(2.87)	(2.60)
High FL/FA * Dollar (20)		-0.858			-0.818
		(-0.84)			(-0.82)
Reserves/GDP		-3.371**		-2.281	-1.674
		(-2.04)		(-1.08)	(-0.86)
Real GDP Growth		0.0193		0.0131	0.0515
		(0.24)		(0.16)	(0.61)
External Debt					0.320***
					(3.76)
Constant	-7.614***	-8.857***	-6.137***	-7.908***	-8.561***
	(-5.22)	(-4.40)	(-5.51)	(-5.76)	(-4.79)
N	2255	1521	1891	1427	1185
Years	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Countries	All	All	EMEs	EMEs	EMEs
Pseudo R2	0.119	0.173	0.0378	0.118	0.130

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

I.3 Adding Interaction Terms

Table I8: Probability of Banking Crises

	(1) Crisis	(2) Crisis	(3) Crisis	(4) Crisis
Crisis				
Dollar (20)	0.177	0.0895	1.620	1.698
	(0.32)	(0.14)	(0.74)	(0.79)
Δer	-0.0278	-0.0563	-0.0947	-0.103
	(-0.01)	(-0.02)	(-0.04)	(-0.05)
Dollar(20)*Δer	-0.983	-0.948	-1.090	-1.011
	(-0.27)	(-0.26)	(-0.35)	(-0.32)
High FL/FA	1.330*	-0.242	1.295**	-0.234
	(1.95)	(-0.15)	(2.11)	(-0.15)
VIX	0.133***	0.0956**	0.172**	0.135*
	(2.84)	(1.97)	(2.56)	(1.89)
FL/FA * Dollar (20)	-0.0440			-0.0404
	(-0.45)			(-0.41)
Reserves/GDP	-2.191	-2.277	-2.235	-2.260
	(-1.09)	(-1.13)	(-1.11)	(-1.10)
Real GDP Growth	0.0137	0.0103	0.0128	0.0126
	(0.16)	(0.12)	(0.16)	(0.15)
VIX * High FL/FA		0.0608		0.0631
		(1.00)		(1.06)
VIX * Dollar (20)			-0.0596	-0.0610
			(-0.83)	(-0.83)
Constant	-7.840***	-6.850***	-8.796***	-7.909***
	(-5.53)	(-5.59)	(-4.26)	(-3.85)
N	1429	1429	1429	1429
Years	1995-2017	1995-2017	1995-2017	1995-2017
Countries	EMEs	EMEs	EMEs	EMEs
Pseudo R2	0.110	0.113	0.112	0.116

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

I.4 10% Cutoff

Table I9: Probability of Banking Crises

	(1)	(2)	(3)	(4)	(5)	(6)
Dollar (10)	-0.164	0.452	0.452	0.540	0.899	1.469
	(-0.37)	(0.75)	(0.75)	(0.94)	(0.87)	(1.36)
Δer	-0.775*	-4.902	-4.902	0.533	0.461	-2.007
	(-1.82)	(-1.15)	(-1.15)	(1.01)	(0.46)	(-1.18)
Dollar(10)*Δer	1.198*	3.264	3.264	0.108	-1.414	-0.191
	(1.73)	(0.77)	(0.77)	(0.11)	(-0.97)	(-0.10)
High FL/FA		1.521**	1.521**		1.257**	0.764
		(2.28)	(2.28)		(2.07)	(1.26)
VIX	0.165**	0.164***	0.164***	0.0750*	0.131***	0.126***
	(2.48)	(2.95)	(2.95)	(1.77)	(3.00)	(2.82)
Reserves/GDP		-3.617**	-3.617**		-2.352	-1.815
		(-2.22)	(-2.22)		(-1.17)	(-0.95)
Real GDP Growth		0.00563	0.00563		0.00762	0.0316
		(0.08)	(0.08)		(0.10)	(0.45)
External Debt						0.289***
						(4.41)
Constant	-7.583***	-8.680***	-8.680***	-6.283***	-8.375***	-9.108***
	(-5.28)	(-5.58)	(-5.58)	(-4.62)	(-5.11)	(-5.60)
N	2262	1524	1524	1919	1445	1186
Years	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Countries	All	All	All	EMEs	EMEs	EMEs
Pseudo R2	0.0405	0.0626	0.0626	0.00506	0.0259	0.0411

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

I.5 Level of Dollarization

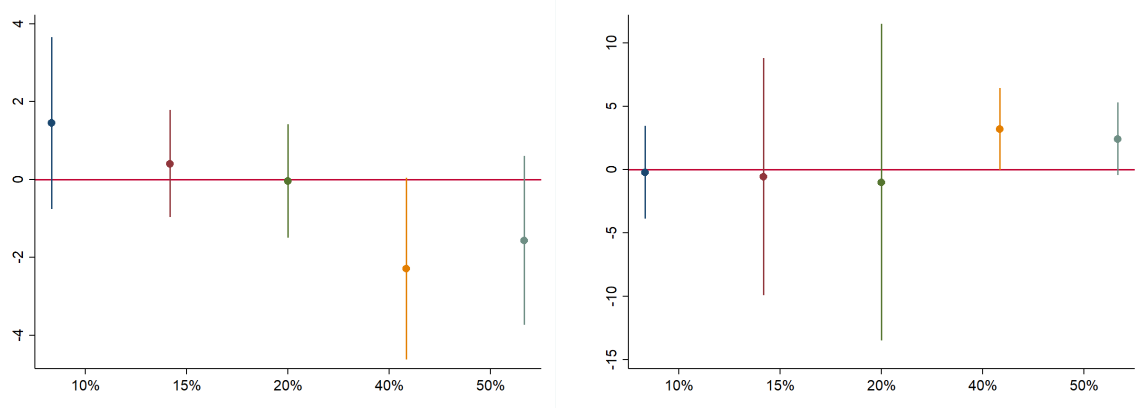
Table I10: Level of Dollarization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crisis							
Δer	-0.795	-4.424	-4.424	0.681*	-1.660	-1.961	0.283
	(-1.39)	(-1.55)	(-1.55)	(1.67)	(-0.81)	(-0.68)	(0.46)
High FL/FA		1.542**	1.543*		1.544*	1.138	
		(2.19)	(1.71)		(1.79)	(1.26)	
Dollar	-0.0104	-0.00981	-0.00981	0.000471	-0.00710	-0.0113	-0.00143
	(-0.85)	(-0.77)	(-0.75)	(0.06)	(-0.59)	(-0.92)	(-0.15)
Dollar*Δer	0.0246*	0.0723	0.0723	-0.000323	0.0287	0.0111	0.000949
	(1.87)	(1.40)	(1.40)	(-0.03)	(0.79)	(0.16)	(0.08)
VIX	0.164**	0.167***	0.167***	0.0758*	0.133***	0.127***	0.103**
	(2.49)	(3.01)	(3.01)	(1.78)	(2.94)	(2.68)	(2.02)
Reserves/GDP		-3.142**	-3.148		-3.168	-2.203	-2.919
		(-2.27)	(-1.11)		(-1.04)	(-0.89)	(-1.62)
Real GDP Growth		0.0272	0.0272		0.0242	0.0606	-0.0335
		(0.38)	(0.38)		(0.31)	(0.86)	(-0.78)
High FL/FA * Low Reserves			-0.00218		-0.468	-0.453	
			(-0.00)		(-0.70)	(-0.55)	
External Debt						0.288***	0.313***
						(4.14)	(4.18)
Constant	-7.413***	-8.358***	-8.357***	-5.876***	-7.492***	-7.761***	-6.518***
	(-5.16)	(-5.26)	(-5.28)	(-5.36)	(-5.81)	(-5.77)	(-5.68)
$\overline{\text{Dollar}}$ (20)							
Dollar(20)*Δer							
N	2262	1524	1524	1919	1445	1186	1542
Years	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Countries	All	All	All	EMEs	EMEs	EMEs	EMEs
Pseudo R2	0.0473	0.0811	0.0811	0.00358	0.0283	0.0425	0.00895

t statistics in parentheses
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

I.6 Different Cutoffs

In Table I11, we plot dollarization and exchange rate interaction coefficients for different dollarization cutoffs. As the cutoff increases, dollarization coefficient becomes more negative whereas the interaction term becomes more positive, while they are still not statistically significant at 5% level. In Figure I9 we plot AUC-ROC curves for 40% cutoff. Dollarization itself has poor prediction and it does not contribute much to the performance on top of VIX and External Debt.

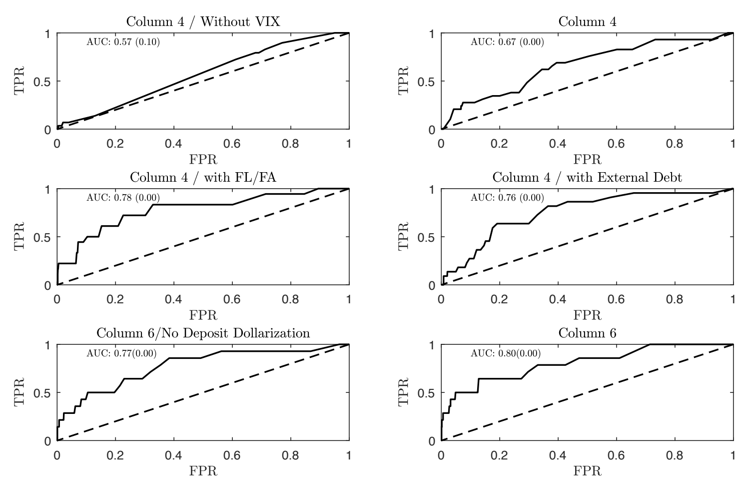


Dollarization coefficients $\qquad$ Dollarization$\times ER$ coefficients

Table I11: Coefficients of logistic regression for different dollarization cutoffs, lines represent 95% confidence interval

Coefficients are obtained by running the logistic regression in Table 1, column 6. The results based on other columns are similar.

Figure I9: The Information Content For Financial Crises in Deposit Dollarization, the VIX and External Debt



Note: The solid lines correspond to the function, g, defined in equation (I.1). The title of each panel defines the logit regression underlying the g function in each panel. Column 4 and 6 refer to columns in Table (**??**). In Panel A, g is based on an estimated logit regression that corresponds to the one in column 4 in which the VIX has been removed. Panel B uses the logit function reported in column 4. In Panel C, g is based on an estimated logit regression that corresponds to the one in column 4 in which the External Debt has been included. Panel D uses the logit function reported in column 6. In Panel E, g is based on an estimated logit regression that corresponds to the one in column 6 in which the deposit dollarization variables (variables 1 and 3 in Table (**??**)). See the text for the definition of AUC and for a discussion of the $p-$ values in parentheses.

I.7 Levy-Yeyati (2006) Evidence

Levy-Yeyati (2006) is an influential paper often citing by authors that consider deposit dollarization asa source of financial fragility. Using his own dataset, we replicate his results and show that they are highly fragile. Column 1 of I12 replicates table 5, column 6 in Levy-Yeyati (2006). Column 2, employs country-year cluster as discussed in Petersen (2009). Columns 3 and 4 uses 15% and 20% dollarization cutoffs respectively. Finally, column 5 uses post 1990 data. Note that the dollarization loses significance at 5% when the correct standard errors are used. In all other columns, dollarization variables are not statistically significant.

Table I12: Levy-Yeyati (2006) Replication

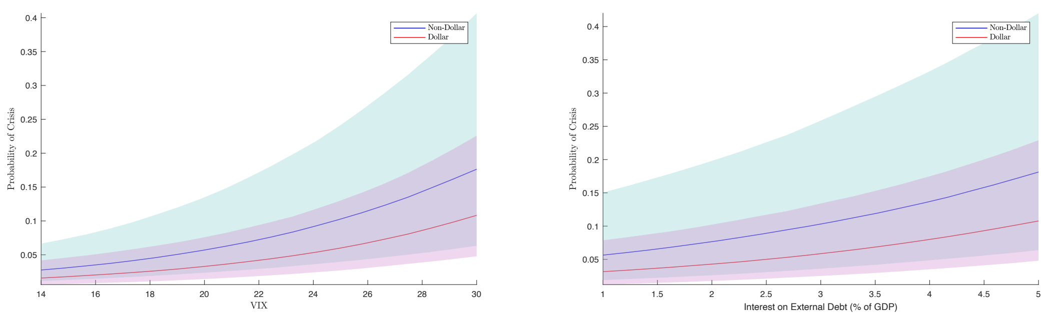
	(1)	(2)	(3)	(4)	(5)
Crisis					
Dollar(10)	0.411	0.411			0.794
	(0.92)	(0.63)			(0.99)
Dollar(10)*Δer	3.196**	3.196*			2.274
	(2.39)	(1.69)			(0.90)
Dollar(15)			0.234		
			(0.47)		
Dollar(15)*Δer			1.208		
			(1.22)		
Dollar(20)				0.0388	
				(0.08)	
Dollar(20)*Δer				1.436	
				(1.46)	
Δer	-2.321	-2.321	-0.567	-0.730	-1.084
	(-1.50)	(-1.02)	(-0.44)	(-0.51)	(-0.46)
FL/FA	0.00698	0.00698	0.00444	0.00479	0.00332
	(1.42)	(1.47)	(1.64)	(1.34)	(1.62)
FL/FA * Δer	0.146	0.146	0.0963*	0.104	0.0709
	(1.53)	(1.57)	(1.77)	(1.48)	(1.44)
Δp	-1.092	-1.092	-0.628	-0.648	-1.490
	(-0.93)	(-0.81)	(-0.50)	(-0.52)	(-1.18)
Δtt	0.0112	0.0112	0.0106	0.0112	0.00556
	(0.86)	(0.73)	(0.66)	(0.69)	(0.27)
realint	-0.000000817**	-0.000000817	-0.000000782**	-0.000000774**	-0.000000672*
	(-2.40)	(-1.62)	(-2.37)	(-2.30)	(-1.71)
M2/reserves	-0.00600	-0.00600	-0.00595	-0.00623	-0.0171
	(-0.36)	(-0.38)	(-0.38)	(-0.41)	(-0.93)
gdppc_i	0.000000564**	0.000000564*	0.000000504	0.000000510	0.000000539
	(2.25)	(1.85)	(1.62)	(1.61)	(1.42)
Δ gdp	-0.00105	-0.00105	-0.00000944	-0.0000249	0.0338
	(-0.03)	(-0.03)	(-0.00)	(-0.00)	(0.68)
private credit/gdp	0.795	0.795	0.896	0.959	1.000
	(0.59)	(0.45)	(0.53)	(0.60)	(0.43)
cash/assets	-0.922	-0.922	-0.962	-0.979	-0.276
	(-0.69)	(-0.80)	(-0.74)	(-0.75)	(-0.23)
capital flows/gdp	-0.575	-0.575	-0.501	-0.570	-1.233
	(-0.37)	(-0.44)	(-0.36)	(-0.41)	(-0.59)
composite_avg	-0.671*	-0.671	-0.692*	-0.723**	-0.711
	(-1.93)	(-1.59)	(-1.78)	(-1.99)	(-1.40)
sudden stop	-0.243	-0.243	-0.217	-0.206	-0.208
	(-0.27)	(-0.26)	(-0.22)	(-0.21)	(-0.23)
currency crisis	1.109*	1.109*	0.924	0.936	0.825
	(1.80)	(1.81)	(1.40)	(1.40)	(1.57)
Constant	-2.912***	-2.912***	-2.847***	-2.749***	-3.264***
	(-5.87)	(-6.76)	(-5.78)	(-5.85)	(-6.00)
N	483	483	483	483	343
Years	1976-2003	1976-2003	1976-2003	1976-2003	1990-2003
StDev Cluster	Country	Country-year	Country-year	Country-year	Country-year
Cutoff	10%	10%	15%	20%	10%

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

I.8 Implied Probabilities from the Logistic Regression

Figure I10 plots the implied probability of a banking crises using the results under the column 6 of table 1 along with one standard deviation confidence intervals. In a relatively calm period (VIX=14), a country with high external debt has a probability of a systemic banking crises around 2% while the probability rises to around 10% when there is high global uncertainty (VIX=30). Similarly, a country with low external debt has a probability of a systemic banking crises around 5% when VIX is very high; this probability rises to 10% when the interest on external debt rises to 5% of GDP.

Figure I10: Implied Probability of Systemic Banking Crisis



(a) Variations in VIX, for Country with Relatively High External Debt Burden

(b) Variations in External Debt Burden, Holding VIX fixed at High Value

Note: Vertical axis shows the response of the systemic crisis probability to variations in the variable in figure title. In each panel probabilities are reported for the case in which the deposit dollarization dummy is unity ("Dollar") and zero ("Non-Dollar"). In first panel, external debt interest costs are fixed at 5 percent of GDP. In the second panel the VIX is held fixed at 30. In both panels the other variables are fixed at roughly their average values: $\Delta er = 0$, $FL/FA = 1$, $\Delta GDP = 0$, $Reserve/GDP = 0.1$. Computations for the graphs are based on regression results in column 6 of table 1.

I.9 Diagnostics for the Logit Regression

The logit regression results suggest that deposit dollarization does not increase vulnerability to crisis, while the VIX and external debt does. Our conclusions rest on the validity of the (classic) statistical inference that we use, as well as on the validity of the linearity assumption about the log odds of crisis. The fact that crises are low probability events makes us particularly concerned, and so here we turn to some standard informal diagnostics as a check on our analysis. These diagnostic provide support for the idea that our logit specification provides a useful device for forecasting crisis and also support or our inference about the role of deposit dollarization, the VIX and external debt.

The diagnostic device that we use takes into account the two desiderata when forecasting a binary event. We want to maximize the frequency of true positives and minimize the frequency of false negatives. We apply a procedure designed to take these desiderata into account (see, e.g., Fuster et al. (2017); Suss and Treitel (2019)). We define the True Positive Rate (TPR) as follows:

$$TPR(\overline{p}) = \frac{\text{Number of crises correctly predicted}}{\text{Number of all crisis observations}},$$

where $\overline{p}$ denotes a cutoff such that if $p\left(x_{i,t};\hat{\beta}\right) > \overline{p}$, we say that a crisis is predicted. Obviously, the true positive rate can be set to its highest possible value of unity, simply by setting $\overline{p} = 0$. This is why we also measure the False Positive Rate (FPR):

$$FPR(\overline{p}) = \frac{\text{Number of false crisis predictions}}{\text{Number of all non-crisis observations}}.$$

Here, we see the problem with $\overline{p} = 0$. That would give us a 100 percent false positive rate. We compute $TPR(\overline{p})$ and $FPR(\overline{p})$ for a grid of values of $\overline{p}$ over the unit interval. Our results are presented in Figure I11, where each point on the solid line is $g(\overline{p})$, where

$$g(\overline{p}) \equiv (TPR(\overline{p}), FPR(\overline{p})), \ \overline{p} \in [0,1]. \tag{I.1}$$

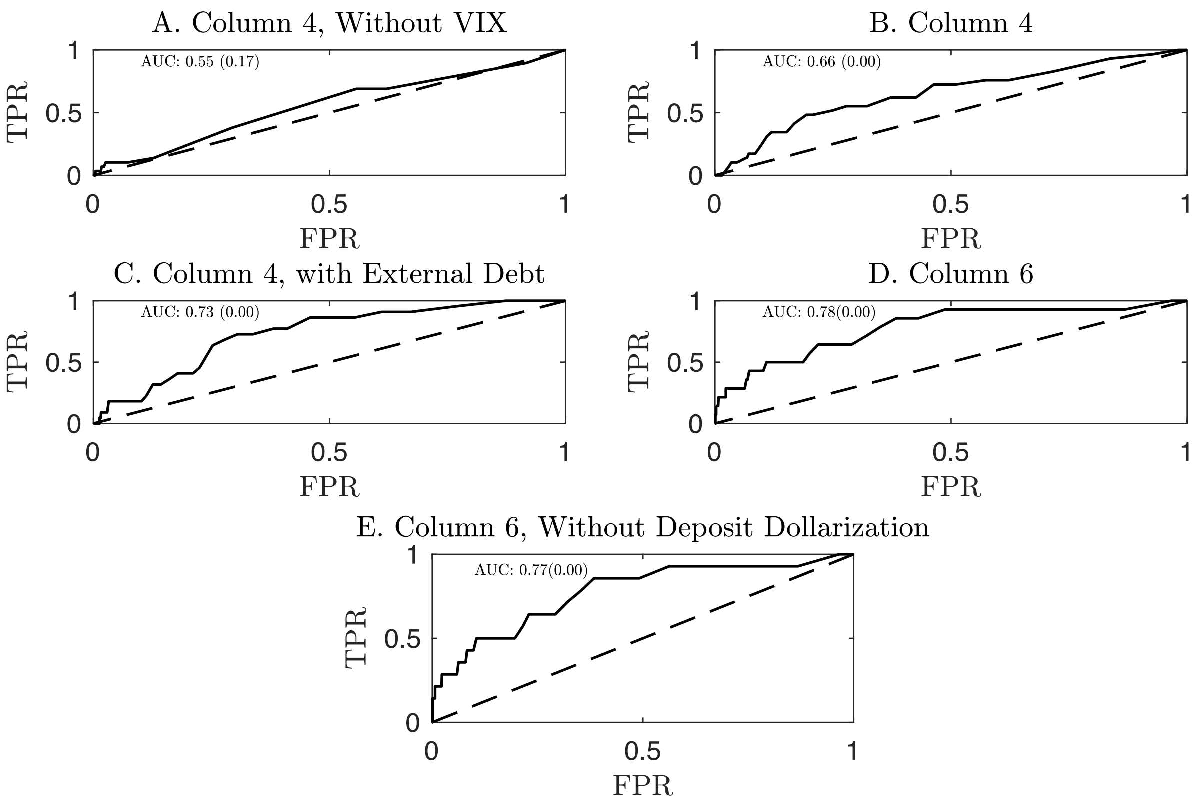
The graph of $g(\overline{p})$ is referred to as the Receiver Operating Characteristics (ROC) (see Hosmer et al. (2013, Chapter 5)). The 45 degree line is a benchmark which represents what the ROC curve, g, would look like if $p\left(x_{i,t};\hat{\beta}\right)$ were simply drawn independently over all i and t from a uniform distribution and the sample were infinite. There is a different g function corresponding to different specifications of $p\left(x_{i,t};\hat{\beta}\right)$. We do not include this dependence of g on the specification of p in order to keep the notation simple.

Panel A of Figure I11 graphs $g(\overline{p})$ for the specification of p underlying the results in column 4 of Table 1, except that the VIX is not included in the logit regression when it is estimated. This is a forecasting model that only uses exchange rate depreciations, deposit dollarization and the interaction between the two variables to forecast systemic banking crises. Note that $g(\overline{p})$ is very close to the 45 degree line. The integral of g over $\overline{p} \in (0,1)$ is referred to as the Area Under the ROC curve (AUC). is reported to be 0.55, slightly higher than what it would be if g were exactly the 45 degree line. In fact, g is not statistically significantly different from the 45 degree line. We determined this based on a particular bootstrap exercise. First, we computed the integral underneath the solid line, AUC=0.55. We then computed an artificial AUC by replacing the crisis probabilities, $p\left(x_{i,t};\hat{\beta}\right)$, for each i,t with an independent draw from a uniform distribution. We repeated the latter exercise 5,000 times. The number in parentheses in Panel A of Figure I11 displays the fraction of times that artificial AUC's exceed the empirical AUC=0.55. The result $p-$value is 0.17 and is indicated in Panel A. That is, the simple logit crisis forecasting model underlying Panel A is not significantly better than a random forecasting model. This is consistent with our conclusion that deposit dollarization is not helpful for forecasting crises.

Panel B of Figure I11 graphs the ROC, $g(\bar{p})$, when the underlying forecasting model is exactly the one in column 4 of Table 1, so that it includes the VIX. Note that now the $p-$value now is zero. So, comparing Panels A and B we see that the VIX does help significantly in crises. Still, according to Hosmer et al. (2013, page 177) and AUC of 0.66 is really only a little better than a random forecasting model. Panel C works with a version of the logit model in column 4 which is estimated with External Debt also included. Adding this variable improves the forecasting model as shown by the fact that the AUC jumps to 0.73. Hosmer et al. (2013, page 177) argues that this value of AUC constitutes an 'acceptable' forecasting model. In panel D we report the ROC when the underlying forecasting model is the estimated one in column 6. The AUC increases with the additional variables, but not very much. For example, Hosmer et al. (2013, page 177) argues that with this value for AUC the model is still only 'acceptable' and not 'excellent'. Finally, Panel E shows the ROC when we re-estimate the column 6 model, leaving out variables pertaining to deposit dollarization. Panel E reports that dropping deposit dollarization leave the AUC of the model virtually unchanged.

In sum, we find that out logit model is in a sense an 'acceptable' model for forecasting crises. The analysis here suggests that the important variables for forecasting crises are the VIX and external debt. Deposit dollarization is not related to crises.

Figure I11: The Information Content For Financial Crises in Deposit Dollarization, the VIX and External Debt



Note: The solid lines correspond to the function, g, defined in equation (I.1). The title of each panel defines the logit regression underlying the g function in each panel. Column 4 and 6 refer to columns in Table (**??**). In Panel A, g is based on an estimated logit regression that corresponds to the one in column 4 in which the VIX has been removed. Panel B uses the logit function reported in column 4. In Panel C, g is based on an estimated logit regression that corresponds to the one in column 4 in which the External Debt has been included. Panel D uses the logit function reported in column 6. In Panel E, g is based on an estimated logit regression that corresponds to the one in column 6 in which the deposit dollarization variables (variables 1 and 3 in Table (**??**)). See the text for the definition of AUC and for a discussion of the $p-$ values in parentheses.

J Balance Sheet Effects

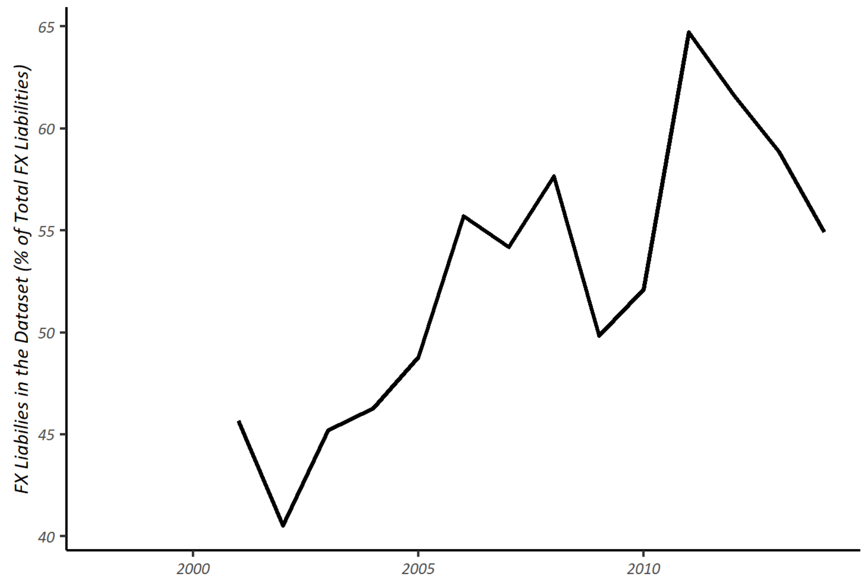
J.1 Analysis of Firm-Level Data in Peru and Armenia

This subsection provides the analysis summarized in Section 5 of the paper. We first describe our analysis of two Peruvian data sets. We then discuss the Armenian dataset.

J.1.1 The Ramírez-Rondán (2019) Dataset

We use the Ramírez-Rondán (2019) data to investigate investment effects of an exchange rate depreciation. After 2006, these data account for well over 50% of all dollar borrowing by non-financial firms in Peru (see Figure J12).

Figure J12: Total Dollar Borrowing in Panel Data Set, Divided by Total Dollar Borrowing by All Non-financial Firms



Note: ratio, total dollar liabilities in Ramírez-Rondán (2019) data set to total dollar borrowing by Peruvian nonfinancial firms, as reported in the Central Bank of Peru online data and by the BIS. For further discussion, see text.

Table J13 displays our ordinary least squares regression results. The evidence suggests that sales growth and GDP growth are the main drivers of investment and currency mismatch on firm balance sheets is relatively unimportant. Figure J17 shows that total borrowing in the Ramírez-Rondán (2019) dataset encompasses the majority of borrowing by non-financial firms in Peru, at least beginning in 2006.

The left hand variable in our regression is the i^{th} firm's investment in year t. We measure investment by the change in the log of the i^{th} firm's fixed assets.[87] In addition to a constant term, there are two types of right-hand variables: those that pertain to the i^{th} firm as well that those that pertain to the economy as a whole. Firm-level variables include sales/total assets, leverage, and log assets. The last column in Table J13 also uses the firm-level dummy variable, $Large$. That variable is unity for firm i in year t if the i^{th} firm's assets are in the top quartile of firm assets in year t. We also include the dummy variable, $Mismatch$. This variable takes on a value of unity for firm i in year t if the firm's net dollar assets, scaled by its total assets, are less than the median value of that ratio across all firms in year t.[88] We also include a dummy variable, $Exporter$, which is unity for firms whose exports are on

[87] The Ramírez-Rondán (2019) dataset also includes a variable, expenditures on fixed assets, which could be used to measure investment. When we used this variable as the left-side variable in our regressions we obtained results very similar to what is reported in Table J13. These results can be provided on request by the authors.

[88] The median cutoff is negative in each year. Our data on firms' net dollar asset position does not include derivatives.

average more than 20 percent of sales, and zero for the other firms. The firm-level dummy variable, *Non-Exporter* is simply 1-*Exporter*. We differentiate between exporters and non-exporters to help us identify balance sheet effects, if they exist. Assuming non-exporters cannot easily hedge currency mismatch balance sheet effects of exchange depreciations should be most evident for firms like this. All firm-level variables are lagged by one year to minimize simultaneity bias.

The aggregate variables in our regression are not lagged and they include GDP growth, inflation, the VIX and exchange rate depreciation. We include the VIX here because of the importance of that variable in explaining financial crises, in Table 1. As it turns out, the VIX plays no significant role in explaining firm-level investment. Standard errors are reported in parentheses and we take into account clustering in $\epsilon_{i,t}$ by firm and by year (see Petersen (2009)).

Consider column 1 in Table J13. The coefficient on ΔER indicates that when there is a nominal depreciation, firms tend to cut back on investment in the subsequent year. The second row of column 1 indicates that the subset of firms with currency mismatch cut back on investment a little more, in the wake of a depreciation. Critically, the coefficients in both cases are not significantly different from zero. Comparing the results in the third and second rows of column 1 allows us to focus just on firms with currency mismatch. Among these firms we find that the non-exporters invest relatively more after a depreciation than all firms with currency mismatch. So, the point estimates suggest the balance sheet channel is negligible. The standard errors also indicate this.

Column 2 adds additional aggregate variables. Here, two things are worth noting. First, coefficients on variables also included in column 1 are essentially unchanged in column 2. Second, note that sales and GDP growth are the only significant explanatory variables for investment.

Columns 3, 4 and 5 include additional controls and do not significantly change the picture that emerges in column 2. Interestingly, column 5 shows that the coefficient on *Large* is positive and modestly significant, while the coefficient on $\log(Assets)$ is negative, though not significant. This suggests that investment is not strongly related to firm size over most of the range of sizes, but is increasing for very large firms.

Table J13: Balance Sheet Effects in Peru

	(1)	(2)	(3)	(4)
Mismatch	4.540	2.705	1.481	2.671
	(3.428)	(3.221)	(2.387)	(2.733)
Mismatch * ΔER	-0.0386	-0.0736	-0.0837	-0.114
	(0.202)	(0.192)	(1.580)	(1.582)
ΔER		0.224	0.545	0.525
		(0.438)	(0.525)	(0.568)
log(Assets)	-11.00	2.164	-0.274	-1.939
	(7.098)	(4.460)	(0.870)	(1.379)
Leverage	0.457	0.240	0.148	0.154
	(0.458)	(0.453)	(0.532)	(0.496)
Sales/Assets	19.72**	30.12***	5.941**	5.884**
	(9.723)	(9.695)	(2.902)	(2.955)
GDP		1.464*	2.103**	2.109*
		(0.807)	(1.019)	(1.082)
Mismatch * Non Exporter * ΔER			-0.0425	0.0608
			(1.743)	(1.722)
VIX			0.417	0.404
			(0.293)	(0.310)
Exporter			-0.866	-0.502
			(3.136)	(3.062)
Exporter * ΔER			-0.302	-0.253
			(0.834)	(0.819)
Large				8.456
				(5.196)
Large * Mismatch				-1.355
				(4.936)
Large * Mismatch * ΔER				-0.102
				(0.851)
N	1316	1316	1275	1275
R2	0.174	0.128	0.0256	0.0299
firm fe	yes	yes	no	no
year fe	yes	no	no	no

Standard errors in parentheses
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Note: Left hand variable is firm-level investment; data are provided by Ramírez-Rondán (2019) and Paul Castillo; data covers 118 firms over 1999-2014.

For our purposes the critical finding in Table J13 is that balance sheet effects on non-financial firm investment appear to be negligible in this data set. This is so, even for firms which we might expect ex ante to exhibit substantial balance sheet effects: the firms that have substantial currency mismatch and are not exporters.

How can it be that the balance sheet effects of exchange rate depreciations are so small for these firms? A direct examination of the balance sheets suggests that foreign exchange exposure is concentrated among firms that have the capacity to withstand large depreciations. To see this let $NetFX$ denote the local currency value of a firm's net foreign exchange position:

$$NetFX = Assets^{\$} - Liabilities^{\$},$$

where $Assets^{\$}$ and $Liabilities^{\$}$ denote dollar assets and liabilities, respectively. Let S denote the actual exchange rate and let S' denote a counterfactual exchange rate. If the exchange rate were S' rather S, a firm's net assets, $NetAssets$, would, in domestic currency units, be:

$$NetAssets + \Delta S \left(Assets^{\$} - Liabilities^{\$} \right),$$

where $\Delta S = S'/S - 1$. The value of ΔS for which the above expression is zero is the depreciation that, if it occurred, would bankrupt the firm. Let $\chi_i(\Delta S)$ denote the function indicating whether firm i is bankrupt, or not:

$$\chi_i(\Delta S) = \begin{cases} 1 & NetAssets_i + \Delta S \times NetFX_i < 0 \\ 0 & \text{Otherwise} \end{cases}$$

The fraction of firms (weighted by net assets) that would be bankrupt if the exchange rate depreciated by ΔS is:

$$Default(\Delta S) = 100 \frac{\sum_i \chi_i(\Delta S) \times NetAssets_i}{\sum_i NetAssets_i}.$$

Figure J13 plots the fraction of defaulting firm net worth, $Default$, against counterfactual exchange rate depreciations for three years. Note that even with a 200% exchange rate deprecation, less than 10% of the total firm equity goes bankrupt.

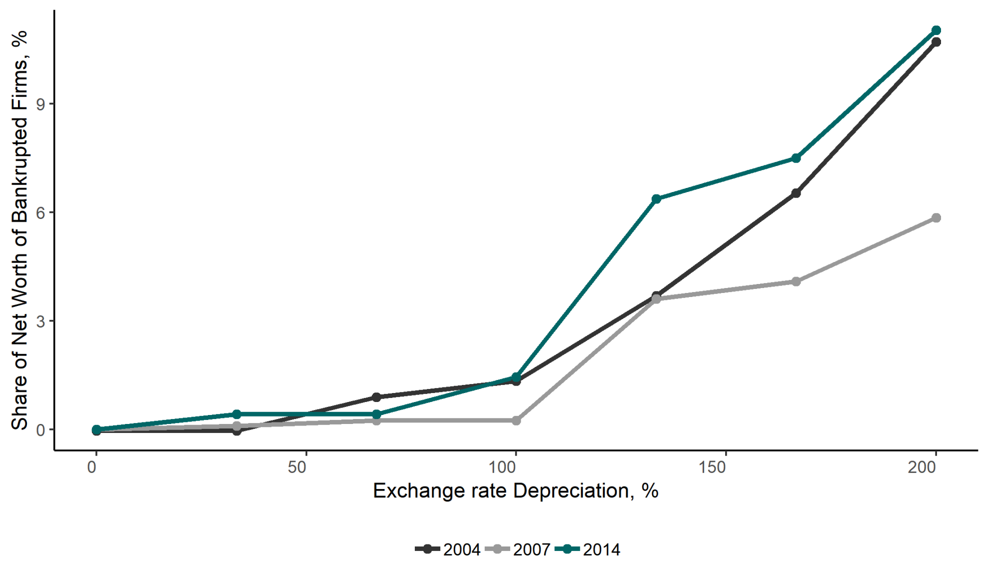


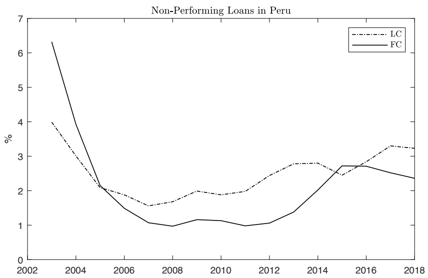
Figure J13: Fraction of Defaulting Firm Net Worth

Our measure attempts to isolate the balance sheet effects of a currency depreciation *per se*. Of course, the effect of a depreciation on a firm's balance will in part reflect the shock that caused the depreciation in the first place. Our results suggest that whatever that shock is, balance sheet effects do not play an important role in its propagation. So, if the depreciation is due to an expansion action by the central bank, then we expect the expenditure switching effects to dominate the balance sheet effects. Similarly, if the depreciation is due to a decline in the demand for exports we expect that balance sheet effects will not amplify the effects of that that shock.

It is possible that the data analysis above is distorted by a kind of survival bias. One piece of evidence which suggests this is not the case can be found in data on non-performing loans for Peru and Turkey (see Figure J14). The figures distinguish between foreign currency and domestic currency loans to non-financial business and households. In Peru, the thing to note is that these rates are roughly the same. One period that is of particular interest to us is 2013-2015, when the large depreciation occurred. Note that the non-performance rate on foreign currency loans did rise then. However, it simply rose up to the rate on domestic currency loans. We view this evidence as complementary to the other evidence displayed in this section which suggests that the balance sheet effects on non-financial firms of exchange rate depreciation are not large. In Turkey, FX non-performance is virtually nonexistent. Anecdotal evidence suggests the reason is the high collateral requirements on firms which borrow in dollars. One cautionary evidence is from Armenia, where the FX non-performance rose significantly following the depreciation in late 2014.[89]

[89]Shalva Mkhatrishvili brought to our attention that in Georgia the situation is similar to Armenia

Figure J14: Non-performing Loans



Source: Respective Central Bank Websites. Here, LC denotes Local Currency loans and FC denotes Foreign Currency loans. Non-Performance is measured as Non-performing FC (LC) Loans / Total FC (LC) Loans

J.1.2 The Humala (2019) Dataset

Following a period of relative calm, Peru experienced a sharp, three-year depreciation starting in 2013. The PEN depreciated around 30%. We use the quarterly balance sheet data from 28 largest firms in Peru studied in Humala (2019) to see what sort of foreign exchange losses they experienced and how their investment responded.[90]

Figure J15a plots cumulative foreign exchange losses during the period covered by the two vertical lines in Figure J16d against currency mismatch in 2012Q4.[91] Each observation has a number attached, so that it is possible to compare observations across figures. The losses and mismatch in Figure J15a are expressed as a ratio of their 2014Q2 equity.[92] The data set does not include information about whether a firm has 'natural hedges' in the form of revenues from exports. Figure J16d shows a positive relationship between currency mismatch and foreign exchange losses. Interestingly, there are two firms, 7 and 20, that are outliers in terms of the magnitude of their foreign exchange losses. There is one firm, 10, that is an outlier in terms of initial currency mismatch.

Figure J15b displays total investment for each firm during the period of the depreciation, against currency mismatch on the eve of the depreciation. A firm's total investment is the log of the ratio of total assets in 2016Q4 to total assets in 2012Q4. The key finding is that investment is not significantly related to mismatch at the start of the depreciation. Firm 10, which had the most mismatch in the initial period, also had the lowest level of investment. That single observation suggests a link between the two variables. However, ta

[90] The raw data source is the Superintendency of the Securities Markets in Peru.

[91] Our cumulative data go one year beyond the period over which the depreciation occurred, in order to capture its full effects.

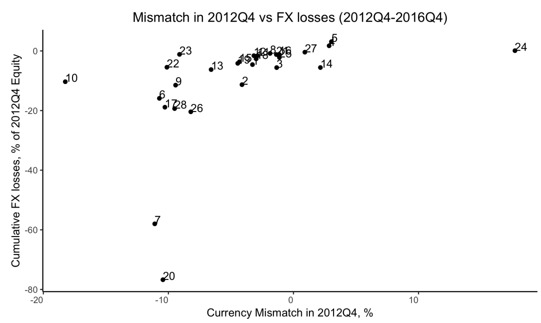
[92] Currency mismatch is defined as the (Dollar Assets - Dollar Liabilities + Net Derivative Position)/Total Assets. Equity is total assets minus total liabilities. All these data, plus the foreign exchange losses analyzed below, are reported by the firms to the Peruvian government agency, the Superintendency of the Securities Markets, which in turn is the data source for the dataset constructed in Humala (2019).

king into account all 28 observations there does not appear to be a link. Figure J15b displays two regression lines, one that uses the firm 10 observation and the other that does not. Both of those lines are roughly the same and essentially flat.

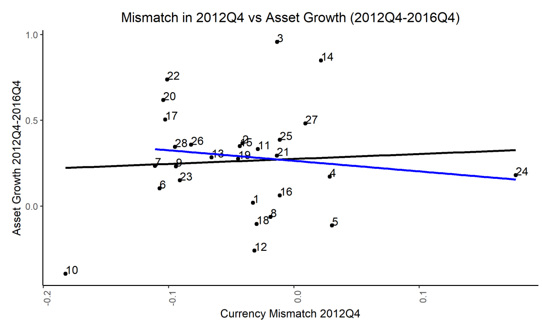
The channel by which currency mismatch might affect investment should operate through foreign exchange losses. So, Figure J16c plots investment against foreign exchange losses. The two outliers in Figure J15a, firms 7 and 20, are apparent in this figure. Note that their levels of investment are at the mean or above the mean of the other firms. The figure displays two least squares regression lines, one with and one without the outliers. In both cases, the point estimates indicate, if anything that investment is higher the bigger are the foreign exchange currency losses.

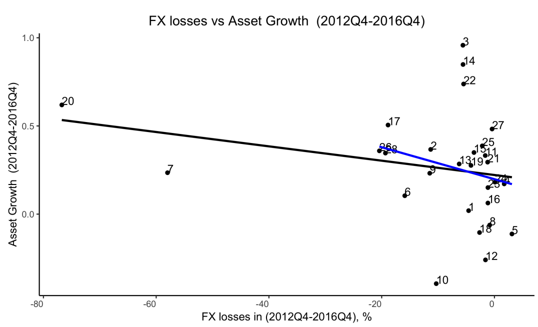
Figure J15: Currency Mismatch, Foreign Exchange Losses and Credit Growth 2012Q2-2016Q4

(a) Currency Mismatch, Foreign Exchange Losses

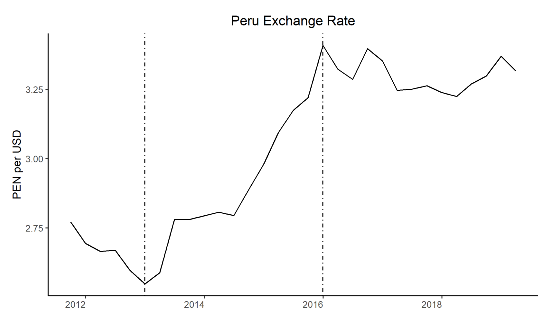


(b) Credit Dollarization vs Asset Growth 2012Q2-2016Q4





(c) FX Losses and Credit Growth 2012Q2-2016Q4



(d) Nominal Exchange Rate in Peru

Note: tick marks refer to exchange rate in the 4^{th} quarter of the preceding year. First and second vertical lines correspond to 2012Q4 and 2015Q4, respectively. Source: average of bid and ask exchange rates used in Humala (2019).

We take the evidence in the figures as indicating that there is no substantial relationship between currency mismatch and investment during the period in which Peru experienced a substantial depreciation. This complements the evidence in Subsection J.1.1 which suggests that exchange rate depreciations, even for firms with currency mismatch little exports have a statistically negligible impact on firm investment.

J.1.3 Armenia Dataset

Armenia experienced a substantial 17% depreciation between early November 2014 and the end of February 2015 (see figureJ16). We study how non-financial firm investment in 2015, 2016 and 2017 is associated with the level of a firm's dollar debt before the depreciation. Our data are annual and end-of-year. We obtain end-of-2013 firm-level data on dollar debt from the Credit Registry of the Central Bank of Armenia.[93] Our results are based on two different ways of scaling a firm's dollar debt: one is by its total credit and the other is by its total assets (financial and fixed), both at end of 2013. In both cases, the scaled dollar credit measure is expressed in percent by multiplying by 100. Asset data were obtained from Armenia's State Revenue Committee and matched with the corresponding credit registry data.[94] Our measure of investment is 100 times $\Delta Capital_t$ the log level of the firm's fixed assets (e.g., structures and equipment) at the end of year t minus that level at the end of year $t-1$, for $t = 2015, 2016, 2017$.

Table J14 displays the results of regressing firm-level investment on our measures of the firm's dollar debt before the depreciation, as well as on other controls. Consider first the case in which credit is measured relative to total credit (see row (1) in the table). In this case, firms with large and small shares of credit in dollars before the depreciation invested about the same amount after the depreciation. This can be seen from the fact that the parameter estimates in row (1) are small and statistically insignificant. In addition, in the 2015 result the sign of the parameter is even 'wrong' from the perspective of the balance sheet effect. Row (2), where dollar credit is measured relative to total assets, yields generally the same results. However, the measure of dollar credit used in row (2) is marginally significant and has the 'right' sign in 2015. On the face of it, this appears to be a small piece of evidence that balance sheet effects in fact did play some role in the aftermath of the Armenian depreciation. However, the results are driven by a small number of firms that have dollar credit that exceeds by a substantial margin their total assets. So, before drawing a firm conclusion from row (2) about dollarization, we would need to have a better understanding about the circumstances of these firms.[95]

[93] This dataset contains the universe of all loans in Armenia.

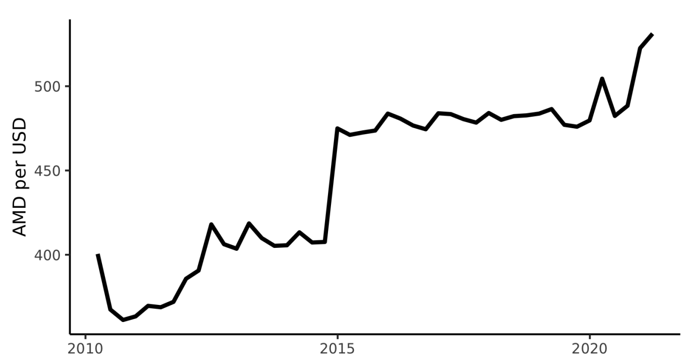
[94] This dataset contains asset and investment information the firms which file corporate tax reports. This tends to be larger firms in Armenia. Smaller companies in Armenia file tax reports which are not required to include asset and investment information.

[95] It is possible that there are measurement problems with assets. In some cases, for example, intangible assets (goodwill, technical know-how) are important, but hard to value and perhaps not reported. Or, the technically bankrupt firms in our data set may represent a prudential problem because they are simply able borrow too much, rather than example of why dollarization per se is bad. We also did the regressions in Table J14 using log investment as the left hand variable (these data are obtained from the State Revenue Committee). The results were all insignificant. However, we lose 60-75% of the observations when we use the investment variable and so lack of significance may reflect lack of power. Still, the fact that coefficients in these regressions are always insignificant causes us to downplay somewhat the already marginally significant

The parameter, N, in the bottom row of Table J14 indicates the number of firms in the dataset. Note that the value of N declines as we go from 2015 to 2016 and 2017. Also, we have fewer firms for our regressions with the row (2) measure of credit. This is because we do not have total asset data for all firms in our dataset. We investigated whether the decline in N might have been caused by firms experiencing severe balance sheet effects because of the depreciation. If that were true, then our results for 2016 and 2017 in Table J14 would be distorted by selection effects. In fact, each firm that 'disappear' from our 2016 and 2017 did so not because they exited, but rather because they chose to file a different tax form which does not require that they report assset and investment data. In addition, we found that the pre-depreciation level of dollar credit of firms that do not appear in the 2016 and 2017 tax data does not differ substantially from the firms that do remain in the dataset.[96]

We also included a dummy variable that indicates whether a firm is an exporter or not. We interacted the dummy variable with the credit variable and found that the resulting coefficient is not significantly different from zero, although we lose a substantial number of observations when want to know if a firm is an exporter or not.[97] This finding is similar to the one reported above for Peru as well as the one found in Bleakley and Cowan (2008). A firm with substantial dollar debt appear to have the same investment response to a depreciation shock whether the firm is an exporter or not.

Figure J16: Nominal Exchange Rate in Armenia



Source: IMF International Financial Statistics. Each observation denotes the end of quarter value of the nominal exchange rate.

result reported in the 2015 column of row (2) in Table J14.

[96]We compared the average of our end-of 2013 credit dollarization measures for firms that appear in the 2016 and 2017 data with the average for firms that disappear from either or both of those two years and these averages are not significantly different.

[97]The number of firms for which the export status is reported is about 1/6 of the number of firms in our dataset.

Table J14: Balance Sheet Effects in Armenia

		2015	2016	2017	2015	2016	2017
$\frac{\text{Dollar Credit}}{\text{Total Credit 2013}}$	(1)	0.0329	-0.0299	-0.0104			
		(0.76)	(-0.87)	(-0.15)			
$\frac{\text{Dollar Credit}}{\text{Total Assets 2013}}$	(2)				-0.0667*	-0.0321	-0.0393
					(-1.95)	(-0.98)	(-0.46)
Age	(3)	0.0754	-0.0120	-0.364	0.206	0.192	0.170
		(0.20)	(-0.04)	(-0.66)	(0.47)	(0.54)	(0.31)
Employees	(4)	0.00726	0.00453	0.00158	0.00304	0.00367	0.00224
		(1.64)	(1.23)	(0.30)	(1.34)	(1.32)	(1.23)
Constant	(5)	1.221	-2.555	13.92	5.072	-6.213	1.443
		(0.23)	(-0.59)	(1.57)	(0.90)	(-1.15)	(0.16)
N		679	609	327	440	352	198

Notes: ; t statistics in parentheses

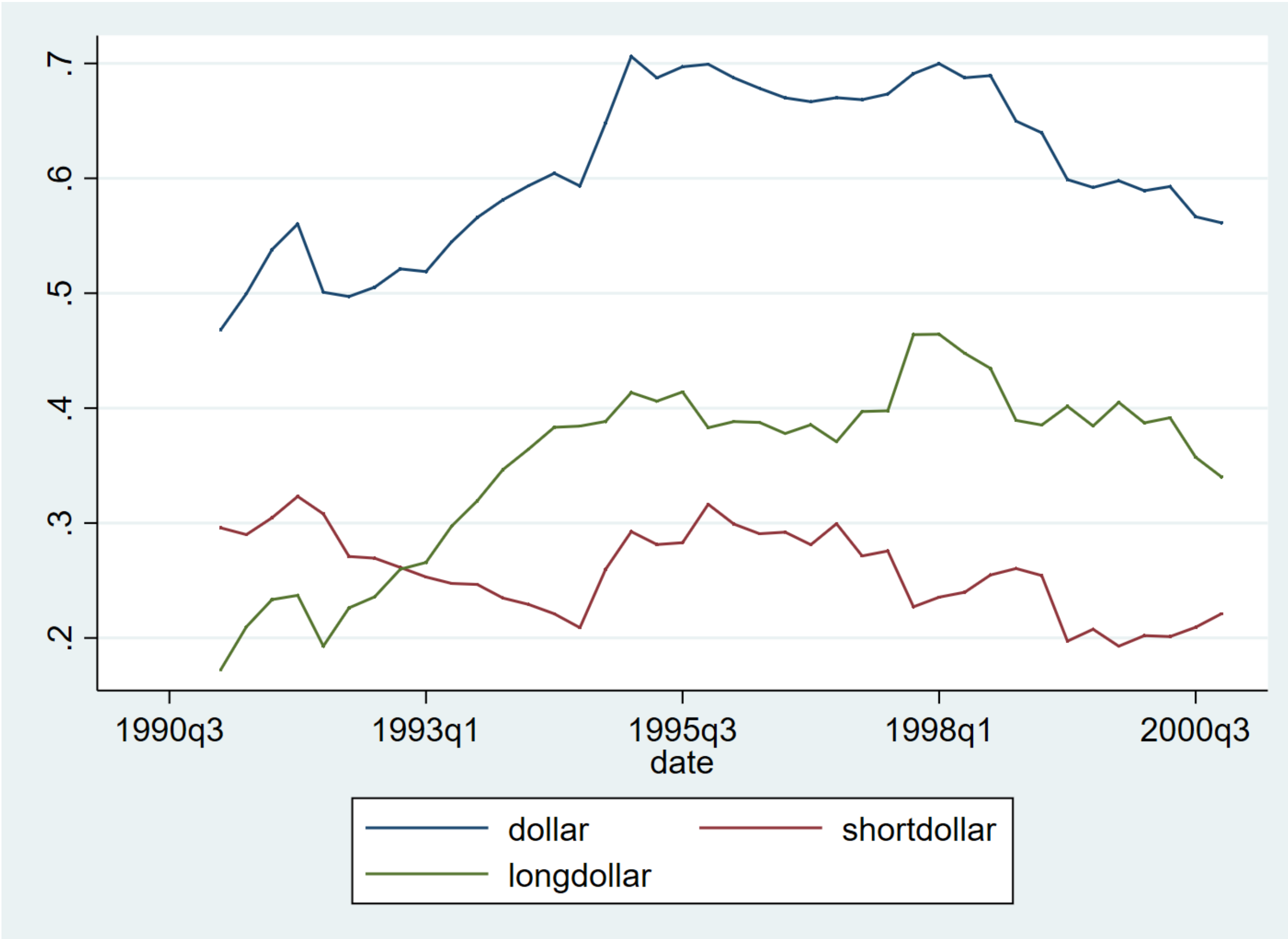
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Notes: left-hand variable is $100 \times \Delta Capital$; sources: Armenian credit registry and corporate tax reports.

J.2 Dollar Borrowing in Mexico

Figure J17 shows total dollar credit as well as short term and long term credit to non-financial firms in Mexico. The data are scaled by total firm credit. So, the total dollar credit data are the sum of the short-term and long-term data. Note that most dollar credit is long-term.

Figure J17: Dollar Credit to Non-Financial Firms, by Currency, in Mexico



Notes: Here, 'dollar' denotes the ratio of dollar credit to total credit; 'shortdollar' denotes the ratio of short term dollar credit to total credit; 'longdollar' denotes the ratio of long-term dollar credit to total credit. Data used in Aguiar (2005) and kindly provided to us by Mark Aguiar.

K Model Analysis

The first section below describes our model. The second section shows that the model provides a reasonable framework for organizing our empirical results. That section also relates our model to other analyses. Section K.2.2 relates the results of our model to the empirical findings in Miranda-Agrippino and Rey (2020). We show that an exogenous increase in the dollar rate of interest leads to an appreciation of the dollar, a reduction of capital flows in 'the rest of the world', which we assume is composed of small open economies like our model. Although we imagine those economies are somewhat different from each other, they are not sufficiently different to represent a diversifiable risk to our foreign financiers. In addition, we show that the variance of the rate of return on assets (all rates of return are converted into dollar units) increase when the dollar rate increases, suggesting that a measure of the VIX rises in our model after an increase in the dollar interest rate. These results are consistent with the results reported in Miranda-Agrippino and Rey (2020). Our results also can be compared with Ilzetzki and Jin (2020). They report, using 1990-2009 data, that a rise in the dollar interest rate leads to a depreciation in the exchange rate and a rise in foreign output. Ilzetzki and Jin (2020) conjecture that a simultaneous change in risk aversion can account for these results. We explore the impact of changing the risk aversion parameter for foreign financiers in section K.2.2. We show (see Figure K.2.2) that with a decline in risk aversion, foreign (US) financiers make more loans in foreign currency in order to take advantage of the interest premium in the domestic economy. As they acquire foreign currency to lend in the local currency market, the exchange value of the dollar depreciates. In addition, the local interest rate premium falls and local firms borrow more. This borrowing finances investment and higher GDP in the next period. These effects are consistent with the conjectures in Ilzetzki and Jin (2020) about the effects of risk averse

K.1 The Model

The first, second and third subsections below describe our households, firms and foreign financiers, respectively. The final subsections describe the production of final period 2 consumption goods, as well as the economy-wide aggregate conditions. The latter include the market clearing conditions, the balance of payments and domestic GDP. Finally, we define the equilibrium, and summarize the equations and unknowns.

K.1.1 Worker-Households

Household Deposit Decision Households are endowed Y units of *domestic good*, in period 1. They sell all the goods in a period 1 domestic goods market and deposit the corresponding credits in a bank. The bank offers two types of deposits, d and d^*, both denominated in units of the period 1 domestic good. The first type of deposit, d, offers a state non-contingent claim on dr period 2 final domestic consumption goods. The second type of deposit, d^* offers a state non-contingent claim on d^*r^* period 2 foreign goods. We refer to d as 'peso deposits' and d^* as 'dollar deposits'. The household's financial constraint in period 1 is:

$$d + d^* = Y. \tag{K.1}$$

The household's period 2 budget constraint is:

$$c_2^{house} = dr + d^*r^*e_2 + w_2l_2, \tag{K.2}$$

where c_2^{house} and w_2 are denominated in terms of the period 2 final consumption good and wage rate of the household in period 2. The subscript, 2, on a variable indicates that it is contingent on the realization of period 2 shocks. All the variables in (K.3) are denominated in period 2 final consumption goods. In (K.3), e_2 denotes the real exchange rate in period 2. That is, one unit of period 2 foreign goods can be exchanged for e_2 units of period 2 final consumption good. It is useful to substitute out for d in (K.2) using (K.1):

$$c_2^{house} = (e_2 r^* - r)\, d^* + w_2 + Yr. \tag{K.3}$$

Thus, c_2^{house} is the level of consumption the household enjoys if all of Y is deposited into peso accounts, plus the adjustment to consumption that occurs if $d^* \neq 0$. Technically, there is an upper bound on d^* implied by the non-negativity constraint on c_2^{house} . That upper bound can be backed out of equation (K.6) by setting e_2 to the lower bound of its support. In practice, we ignore this constraint.

The problem of the household is to choose d, d^* subject to (K.1) to solve

$$\max_{d^*} Ec_2^{house} - \frac{\lambda}{2} var\left(c_2^{house}\right), \tag{K.4}$$

subject to (K.3) and $0 < l_2 \leq 1, c_2^{house} \geq 0$. With a little algebra it is easy to establish that[98]

$$\begin{aligned} var\left(c_2^w\right) &= \left[d^* - \frac{-Cov\left(r^* e_2, w_2\right)}{var\left(r^* e_2\right)}\right]^2 var\left(r^* e_2\right) \\ &+ \left(1-\rho^2\right) var\left(w_2\right), \end{aligned} \tag{K.5}$$

where

$$\rho = \frac{Cov\left(e_2, w_2\right)}{\sqrt{var\left(e_2\right) var\left(w_2\right)}}.$$

In the special case, $\lambda = \infty$, the household seeks only to use dollars to hedge (or, acquire insurance on) its period 2 income, $w_2 + Yr$. It is clear from (K.5) that with only a hedging

[98]Taking into account that Yr and d^* are not random, we have, $var\left(c_2^w\right) = var\left[d^* e_2 r^* + w_2\right]$. Denoting $s \equiv e_2 r^*, Q = w_2$,

$$\begin{aligned} var\left[d^* s + Q\right] &= E\left[d^*\left(s - Es\right) + Q - EQ\right]^2 \\ &= \left(d^*\right)^2 var\left(s\right) + 2d^* Cov\left(s, Q\right) + var\left(Q\right) \\ &= \left(d^*\right)^2 a + b\left(d^*\right)^2 + c = a\left[\left(d^*\right)^2 - \frac{-b}{2a}\right]^2 + c - \frac{b^2}{4a}. \end{aligned}$$

where

$$a = var\left(s\right), b = 2Cov\left(s, Q\right), c = var\left(Q\right).$$

Equation (K.5) follows by simple rearrangement.

motive, the household chooses d^* to set the object in square brackets in (K.5) to zero. In that case, the variance of c_2^w is

$$\left(1-\rho^2\right) var\left(w_2\right) \geq 0,$$

because $\rho \in [-1,1]$. If $E\left(e_2 r^* - r\right) \neq 0$ and the household's risk aversion is finite $(\lambda < \infty)$ then it has a speculative motive in addition to the hedging motive for choosing d_1^*. So, for dollar deposits to provide 'perfect' consumption insurance it must be that the correlation between the exchange rate and period 2 is exactly ± 1. The solution to (K.4) is:

$$d^* = -\overbrace{\frac{E\left(r - e_2 r^*\right)}{\lambda var\left(r^* e_2\right)}}^{\text{speculative motive}} - \overbrace{\frac{cov\left(r^* e_2, w_2\right)}{var\left(r^* e_2\right)}}^{\text{hedging motive}}. \tag{K.6}$$

The first term reflects the household's *speculative motive* for holding deposits and the second term reflects the worker-household's *hedging motive*. If e_2 depreciates in a recession, when w_2 is low, then dollar deposits are a hedge against income uncertainty. Other things the same, the household would want $d^* > 0$. Of course, if there is a big enough premium on the domestic rate of interest, $r > Ee_2 r^*$, this would drive the household to want to hold less d^*. Note that equation K.6 exhibits a standard feature of mean-variance preferences, namely that a marginal increase in initial wealth (here, Y_1) is allocated totally to the risk free asset, d. This is considered an unrealistic implication of this type of preferences.

The Household Deposit Decision as a Futures Contract In the previous section, we obtained a linear decomposition of the household deposit decision into a speculative and a hedging component. Our use of this language reflects that there is a isomorphism between forward contracts and dollar deposits, which we explain formally in this subsection.

Suppose that in period 1 the household purchases L long contracts to buy dollars with pesos in period 2. The price, F, which specifies the number of pesos the household must pay per dollar in period 2 is determined in period 1 by the requirement that the number of long contracts must equal the number of short contracts. Under the contract, the household receives a payment of $\left(e_2 - F\right) L$ pesos from the exchange in period 2. (If this quantity is negative, then the payment goes from the household to the exchange.) So, now the household's period 2 budget constraint is

$$c_2^{house} = \left(e_2 - F\right) L + w_2 + Yr. \tag{K.7}$$

We assume that F must be consistent with covered interest parity, so that

$$r = Fr^*. \tag{K.8}$$

There is no current exchange rate in this expression because our definition of r^* is the number of claims on foreign goods in period 2 per domestic goods in period 1 (recall the discussion before equation (K.1)). Using equation (K.8) to substitute out for F in equation (K.7) and rearranging, we obtain:

$$c_2^{house} = (e_2 r^* - r)\frac{L}{r^*} + w_2 + Yr. \tag{K.9}$$

Comparing the latter expression with equation (K.7), we see that with

$$\frac{L}{r^*} = d^* \tag{K.10}$$

the two equations are identical. This establishes that dollar deposits, d^*, in our previous discussion, can be interpreted as long forward contracts on dollars, with $d^* = L/r^*$. Division by r^* converts the future L dollars into period 1 pesos (recall, d^* is measured in pesos). In equation (K.9) the lower bound on the support on e_2 places an upper on L and the upper bound on the support of e_2 places a lower bound on L. The value, $L = 0$, is always feasible but the household can choose L positive or negative, subject to satisfying the budget constraint and $c_2^{house} \geq 0$ with probability 1. The household could guarantee payment to the exchange by putting up claims against its period 2 income as collateral.

In principle, the discussion in this section draws attention to one way that we could be misinterpreting observed dollar deposits. We interpret countries with low dollar deposits as having a low demand for income insurance that derives from covariation of the exchange rate and income. That would not be correct if in those countries, households had access to forward markets. In fact, very few emerging markets appear to have well-developed forward markets in their own exchange rates, and even where those markets are available we assume that households do not have easy access to them.

K.1.2 Firm-Households and Period 2 Domestic Output

The Firms' Decision in the Model Identical, competitive firms are on the other side of the period 1 lending market. Such a firm needs period 1 resources to invest in capital, K. Capital is used, in combination with the labor of the household, to produce domestic output in period 2.

The firm builds K in period 1 using domestic, k_h, and foreign, k_f, inputs using the following production function:

$$K = k_h^{\omega} k_f^{1-\omega}. \tag{K.11}$$

For a given amount of K, the firm's cost minimization problem solves

$$\min_{k_h,k_f} e_1 k_f + k_h + p^K \left[K - k_h^{\omega} k_f^{1-\omega}\right], \tag{K.12}$$

where p^K denotes the Lagrange multiplier on the constraint. Also, e_1 denotes the period 1 real exchange rate: it is the amount of the domestic period 1 good required to purchase 1 unit of the period 1 foreign good. The solution to the firm's cost minimization problem is:

$$k_f = \left(\frac{\omega}{1-\omega} e_1\right)^{-\omega} K,\ k_h = \left(\frac{\omega}{1-\omega} e_1\right)^{1-\omega} K,\ p^K = \left(\frac{\omega}{1-\omega} e_1\right)^{1-\omega} \frac{1}{\omega}, \tag{K.13}$$

where the multiplier, p^K, is the firm's (shadow) marginal cost of building K.

The firm has no resources of its own in period 1, so on net it issues debt, b, b^*, into the period 1 domestic financial market. Here, b and b^* denote borrowing in pesos and dollars, respectively, in period 1. The interest rates on the two assets, r and r^*, are the same rates faced by the household. The firm uses the resources borrowed in period 1 to purchase domestic goods, k_h, and foreign goods, k_f, subject to the financing constraint, $e_1 k_f + k_h = b + b^*$. Substituting out for k_f and k_h in the last expression using (K.13), the financing constraint reduces to:

$$p^K K = b + b^*, \tag{K.14}$$

where the firm treats p^K as an exogenous (shadow) price (see equation (K.13)).[99]

Capital, K, is used by the firm to produce the period 2 domestic good, Y_2^h, using labor:

$$Y_2^h = (AK)^{\alpha}\, l_2^{1-\alpha}, \tag{K.15}$$

where l_2 denotes labor hired in period 2 and A denotes a technology shock realized in period

[99] A simple envelope argument establishes p^K is the marginal cost to the firm of K. An interior solution to the minimization problem sets the first order optimality conditions for k_h and k_f to zero and satisfies the complementary slackness conditions: $p^K \left[K - k_h^{\omega} k_f^{1-\omega}\right] = 0$ and $p^K \geq 0, K - k_h^{\omega} k_f^{1-\omega} \leq 0$. Because the prices of k_f and k_h are positive, we know that the constraint is binding, so that $K - k_h^{\omega} k_f^{1-\omega} = 0$ is part of the solution. At the optimum, the inputs are functions, $k_f(K), k_h(K)$ of K. Thus the minimized cost, $C(K)$, is $C(K) = e_1 k_f(K) + k_h(K) + p^K \left[K - (k_h(K))^{\omega} (k_f(K))^{1-\omega}\right]$. Differentiating with respect to K, we obtain

$$C'(K) = \left[e_1 - p^K (1-\omega)(k_h(K))^{\omega} (k_f(K))^{-\omega}\right] k_f'(K) + \left[p^K \omega (k_h(K))^{\omega-1} (k_f(K))^{1-\omega}\right] k_h'(K) + p^K + p^{K'} \left[K - (k_h(K))^{\omega} (k_f(K))^{1-\omega}\right] = 0$$

so that $C'(K) = p^K$ because all other terms disappear by the first order optimality conditions, including the complementarity conditions assuming the constraint is binding.

2. Optimization leads to

$$p_2^h Y_2^h - w_2 l_2 = r_2^K K, \tag{K.16}$$

where

$$r_2^K = \alpha p_2^h A \left[\frac{1-\alpha}{w_2/p_2^h} \right]^{\frac{1-\alpha}{\alpha}}, \; w_2 = (1-\alpha) \, p_2^h \, (AK)^\alpha \, ,$$

so that

$$r_2^K = \alpha p_2^h A \left[\frac{1-\alpha}{(1-\alpha)\,(AK)^\alpha} \right]^{\frac{1-\alpha}{\alpha}} = \alpha p_2^h A^\alpha K^{\alpha-1} = \alpha \frac{p_2^h Y_2^h}{K}.$$

Here, we have used the fact that in equilibrium, $l_2 = 1$. Also, w_2 denotes (K.15) the competitive wage rate in units of the final consumption good. Finally, p_2^h denotes number of period 2 final consumption goods needed to purchase a unit of the domestic period 2 output good.

The firm's consumption of final period 2 consumption goods, c_2^{firm}, must satisfy its budget constraint,

$$c_2^{firm} = r_2^K K - (br + b^* e_2 r^*) \, ,$$

and its financing constraint, (K.14). Using the financing constraint, equation (K.14), to substitute out for b, the firm's period 2 consumption is given by:

$$c_2^{firm} = \left(r_2^K - p^K r \right) K - b^* \left(e_2 r^* - r \right). \tag{K.17}$$

According to this expression, the marginal return to the firm of a unit of capital is given by $r_2^K - p^K r$ in case all the firm's borrowing in period 1 is in pesos. The expression also shows how consumption is affected in case $b^* \neq 0$.

We define the rate of return on capital in the usual way (payoff on one unit of K, divided by the price of one unit of K:

$$R_2^K = \frac{r_2^K}{p^K}. \tag{K.18}$$

We assume that the firm chooses K and b^* to maximize the following mean variance objective:

$$\max_{b^*, K} E(c_2^{firm}) - \frac{\lambda}{2} var(c_2^{firm}), \tag{K.19}$$

subject to (K.17). Optimization of b^* implies (as in the discussion of section (K.1.1)):

$$b^* = \frac{E\,(r - e_2 r^*)}{var\,(e_2 r^*)\,\lambda} + \frac{cov\left(e_2 r^*, r_2^K\right)}{var\,(e_2 r^*)} K \tag{K.20}$$

The key thing to note is that the hedging term in (K.20) has the opposite sign from what it is in (K.6). If the exchange rate depreciates when the firm's income is low then, other things the same, the firm does not want to borrow in dollars. Of course, the speculative motive could induce the firm to borrow in dollars after all, even if the exchange rate depreciates in a recession. That would require that there be a premium on the peso interest rate. Finally, optimization of K leads to the following solution:

$$p_1^K K = \frac{E\left(R_2^K - r\right)}{var\left(R_2^K\right)\lambda} + \frac{cov\left(e_2 r^*, R_2^K\right)}{var\left(R_2^K\right)} b^*. \tag{K.21}$$

Again, this has the standard structure of a decision that optimizes a mean-variance objective. Since the firm is a borrower, its hedging incentive goes in the opposite direction from the household's incentive. In particular, if the exchange rate depreciates when their income is low, then their hedging motive drives them to reduce b^*. It is important to note that the solution to this problem has the classic mean-variance property that the risky investment is a function only of variables that are exogenous to the decision maker (in this case, the firm). Equations (K.20) and (K.21) jointly determine the entrepreneur's risky decisions as a function of market prices alone. It is important for our analysis that $c_2^{firm} \geq 0$ in all states of nature. For a computed equilibrium to be an actual equilibrium requires verifying this non-negativity constraint.

Firm Dollar Loans Interpreted as Futures Contracts Suppose that when the firm borrows, it borrows only in pesos. It can participate in futures markets for currency on an exchange. In particular, the firm purchases S short contracts on dollars in an exchange in period 2. It agrees to sell dollars in period 2 at a price of F pesos per contract, i.e., FS. Under the contract, the firm receives $(F - e_2)S$ pesos from the exchange in period 2. If $F < e_2$ then the firm receives a negative amount, i.e., it must make a payment to the exchange. The firm's period 2 budget constraint is:

$$c_2^{firm} = \overbrace{\left(r_2^K - p^K r\right)K}^{\text{revenues net of borrowing costs}} + \overbrace{(F - e_2)S}^{\text{revenues from future's exchange}}$$

$$c_2^{firm} = r_2^K K + (F - e_2)S - p^K r K$$

Under $\delta = 1$ we have the following (mysterious!) equilibrium condition

$$p_2^h = e_2^{\frac{\omega_c}{\omega_c - 1}}$$

$$r_2^K = \alpha p_2^h A \left[\frac{1-\alpha}{(1-\alpha)(AK)^\alpha}\right]^{\frac{1-\alpha}{\alpha}} = \alpha p_2^h A^\alpha K^{\alpha-1} = \alpha e_2^{\frac{\omega_c}{\omega_c-1}} A^\alpha K^{\alpha-1}$$

$$c_2^{firm} = \left(r_2^K - p^K r\right) K + (F - e_2)\left(s + \frac{r_2^K}{e_2} K\right)$$

$$r_2^K K = e_2 S$$

Using the arbitrage constraint in equation (K.8), $r = Fr^*$

$$c_2^{firm} = \left(r_2^K - p^K r\right) K + (r - e_2 r^*) \frac{S}{r^*}.$$

This budget constraint is identical to the firm's budget constraint when has access to loan markets in dollars as well as pesos, as long as we interpret

$$b^* = \frac{S}{r^*}. \tag{K.22}$$

Since we can expect $cov\left(e_2 r^*, r_2^K\right) < 0$, equation (K.20) suggests that firms' hedging motive wants them to go long, not short. To be induced to go long, a premium will be required on the peso interest rate, r. [XXneed discussion of natural constraint on S. They can't afford too big a depreciation if $S > 0$.]

K.1.3 Foreign Financiers

The Financiers' Decision A third category of participants in domestic financial markets is foreign financiers. These are foreigners who also have mean-variance preferences and who have the ability to borrow and lend in the domestic financial market. In period 1 the representative foreigner financier borrows b^f in the foreign financial market, where b^f is denominated in foreign goods. The financier must pay back $b^f r^\$$ in period 2, where $r^\$$ is period 2 foreign goods per period 1 foreign good borrowed. The equilibrium has the following property:

$$e_1 r^* = r^\$, \tag{K.23}$$

for otherwise the financier would have an arbitrage opportunity. The financier uses the borrowed 'dollars' to make loans in the domestic credit market. Of these loans, $x^\$$ is the quantity of dollar loans and x^D is the quantity of peso loans. Both $x^\$$ and x^D are in units of foreign goods, so that the foreign financiers' financial constraint is:

$$x^\$ + x^D = b^f. \tag{K.24}$$

The foreign financier has other exogenous income, Y_2^f, in period 2, in foreign goods. This other income is imperfectly correlated with the period 2 foreign demand shifter, which we denote by Y_2^*. In particular,

$$Y_2^* = \xi + \nu, \tag{K.25}$$

where ξ and ν are independent random variables which are realized in period 2. We assume that the financier's period 2 other income has the following form:

$$Y_2^f = s\nu,$$

where s is a parameter that is known in period 1 before the financier solves its problem. Thus,

$$Cov\left(Y_2^f, Y_2^*\right) = s \times \sigma_\nu^2. \tag{K.26}$$

Both Y_2^f and Y_2^* are expressed in units of foreign goods.

The financier's consumption is the foreign consumption good value of its period 2 earnings:

$$x^\$ e_1 r^* + \frac{x^D e_1 r}{e_2} - b^f e_1 r^* + Y_2^f, \tag{K.27}$$

where we have substituted out $r^\$$ using the arbitrage condition. After substituting out for b^f from K.24, the financier's consumption of period 2 foreign goods is, after rearranging:

$$\left(\frac{r}{e_2} - r^*\right) x^D e_1 + Y_2^f. \tag{K.28}$$

The objective of the foreign financier is:

$$\max_{x^D} E\left(x^D e_1\left(\frac{r}{e_2} - r^*\right) + Y_2^f\right) - \frac{\lambda^f}{2} var\left(x^D e_1\left(\frac{r}{e_2} - r^*\right) + Y_2^f\right). \tag{K.29}$$

The solution to this problem is:

$$x^D = \frac{E\left(\frac{e_1}{e_2} r - r^\$\right)}{var\left(\frac{e_1}{e_2} r\right)\lambda^f} - \frac{Cov\left(\frac{e_1}{e_2} r, Y_2^f\right)}{var\left(\frac{e_1}{e_2} r\right)}. \tag{K.30}$$

Consider the hedging motive here. If the exchange rate depreciates when Y^f is low then the covariance term is positive and the foreign financier does not want to lend pesos in the domestic currency market. Note that if this covariance is sufficiently large then foreigners would still not lend pesos, even if there were a premium on r.

Note also that there is no solution for $x^\$$ and b^f in the foreign financier's problem. Dollars lent and dollars borrowed by the financier exactly cancel in their budget constraint. So, all choices of $x^\$$ and b^f that are consistent with (K.30), (K.24) are welfare-maximizing for the financier. Market clearing will provide the additional restriction needed to pin down the decision of the financier.

Foreign Financiers Participation in Futures Markets We assume that in period 1 foreign financiers have access to the same futures exchange that firms and households participate in. Similarly, we assume there is no period 1 market in dollar deposits. The foreign financiers buy H long contracts on period 2 dollars. In period 1 they commit to pay FH pesos in period 2 for H dollars. So, in period 2 they receive $H(e_2 - F)$ pesos from the exchange in case $e_2 > F$ and they pay in case $e_2 > F$. So, their period 2 profits, in dollar units, of buying H long contracts is:

$$\frac{H(e_2 - F)}{e_2}.$$

Because there is no local dollar lending market in period 1, we have that $x^{\$} = 0$, so that $x^{D,F} = b^{f,F}$. We use a different notation for peso loans and dollar borrowing by the financier when there are futures markets, because their participation in the local peso market will change when the dollar lending market is replaced by a dollar futures market.

The period 2 profits that financiers make by lending in the period 1 peso market are:

$$\frac{\overbrace{\overbrace{b^{f,F} e_1}^{\text{loans, in peso terms}} \times r}^{\text{dollar revenues}}}{e_2} - b^{f,F} r^{\$} = x^{D,F} e_1 \left(\frac{r}{e_2} - \frac{r^{\$}}{e_1} \right),$$

using the financial constraint, (K.24). Even though a local dollar lending market does not exist, we can still define r^* using arbitrage. In particular the sure dollar return on one peso is

$$r^* = \frac{r^{\$}}{e_1}.$$

So, in period 2 the foreign financiers have the following resources for consumption of the foreign good:

$$\frac{H(e_2 - F)}{e_2} + Y_2^f + x^{D,F} e_1 \left(\frac{r}{e_2} - r^* \right).$$

Then, using the arbitrage restriction on futures market, equation (K.8), we obtain that period 2 consumption for the foreign financier is:

$$\begin{aligned} \frac{H}{r^*}\left(r^* - \frac{r}{e_2}\right) + Y_2^f + x^{D,F} e_1 \left(\frac{r}{e_2} - r^*\right) &= \left(\frac{H}{r^*} - x^{D,F} e_1\right)\left(r^* - \frac{r}{e_2}\right) + Y_2^f \\ &= \tilde{x}\left(\frac{r}{e_2} - r^*\right) + Y_2^f, \end{aligned} \tag{K.31}$$

where

$$\tilde{x} \equiv \frac{H}{r^*} - x^{D,F} e_1. \tag{K.32}$$

Note that $\tilde{x}$ in effect is a choice variable of the financier because H and $x^{D,F}$ are, while the financier treats r^* and e_1 as beyond its control. In the futures market, the foreign financier has the same problem as in equation (K.29). Comparing equation (K.31) with equation (K.28) we see that the financier's budget equation is the same whether it participates in dollar and peso loan markets, or just peso loan markets and a futures market in which dollars and pesos are traded. The only difference is that in the former, the choice variables are x^D and $x^{\$}$ (hence, b^f, by equation (K.24)) and in the latter the choice variables are $x^{D,F}$ and H (equation (K.24) then implies $b^{f,F} = x^{D,F}$).

Given the equivalence, the solution to the financier problem can be inferred from equation (K.30):

$$\tilde{x} = \frac{E\left(\frac{r}{e_2} - r^*\right)}{var\left(\frac{r}{e_2}\right)\lambda^f} - \frac{Cov\left(\frac{r}{e_2}, Y_2^f\right)}{var\left(\frac{r}{e_2}\right)}, \tag{K.33}$$

That is,

$$\tilde{x} = x^D e_1. \tag{K.34}$$

Any choice of H and $x^{D,F}$ consistent with (K.32) and (K.32) is welfare-maximizing for the financier.

K.1.4 Final Consumption Good Production in Period 2

The final good is produced in period 2 by combining the domestically produced period 2 good, c_2^h, with an imported period 2 foreign good, c_2^f. We model this as being accomplished by a zero-profit, representative competitive good firm. The firm's CES production function is:

$$c_2 = \mathbb{A}\left[\omega_c^{\frac{1}{\delta}}\left(c_2^h\right)^{\frac{\delta-1}{\delta}} + (1-\omega_c)^{\frac{1}{\delta}}\left(c_2^f\right)^{\frac{\delta-1}{\delta}}\right]^{\frac{\delta}{\delta-1}}, \quad \mathbb{A} = \omega_c^{\omega_c}(1-\omega_c)^{1-\omega_c}\ 0 < \delta \leq 1. \tag{K.35}$$

The firm solves

$$\max_{c_2, c_2^h, c_2^f} c_2 - p_2^h c_2^h - e_2 c_2^f, \tag{K.36}$$

subject to the production function. Here, p_2^h denotes the value, in units of the final period 2 consumption good, of c_2^h. The first order conditions, expressed in Marshallian demand form, are:

$$c_2^h = c_2 \omega_c \mathbb{A}^{\delta-1}\left(p_2^h\right)^{-\delta},\ c_2^f = c_2(1-\omega_c)\mathbb{A}^{\delta-1}e_2^{-\delta}. \tag{K.37}$$

Note that when $\delta \to 0$ we obtain the Leontief result that the ratio of the home to foreign good in production is a constant, $\omega_c/(1-\omega_c)$, independent of relative prices. Also, in the Cobb-Douglas case, $\delta \to 1$, it is the ratio of expenditures on the two inputs that is constant,

$\omega_c / (1-\omega_c)$.[100]

It is is well known that with linear homogeneity in production and perfect competition, equilibrium requires that the factor prices (expressed in units of the output good) satisfy a simple relation. We obtain this by substituting (K.37) into the production function and rearranging, to obtain:

$$p_2^h = \begin{cases} \left[\frac{A^{1-\delta}-(1-\omega_c)(e_2)^{1-\delta}}{\omega_c}\right]^{\frac{1}{1-\delta}} & 0<\delta<1 \\ \left(\frac{e_2}{}\right)^{-\frac{1-\omega_c}{\omega_c}} & \delta=1 \end{cases}.$$

K.1.5 Market Clearing, Balance of Payments and GDP

This section describes the goods and financial market clearing conditions in periods 1 and 2.

Period 1 The market clearing condition in the period 1 goods market is given by

$$c_1^* + k_h = Y. \tag{K.38}$$

Here, Y is the period 1 endowment of domestic goods which households supply to the goods market. The credit they receive for these sales are deposited in the local banks.

Period 1 Gross Domestic Product (GDP) corresponds to Y. The demand for domestic period 1 goods is the sum of the demand by firms, k_h, and the demand by foreigners, c_1^*. We assume that foreigners' demand for domestic goods is given by:

$$c_1^* = \omega e_1^\eta Y^*,\ \eta > 0, \tag{K.39}$$

where η denotes the elasticity of demand for exports and Y^* denotes the foreign demand shifter, in units of foreign goods.

There are clearing conditions in each of the two local financial markets in period 1. The supply of peso loans is $d + x^D e_1$ and the demand for those loans is b. Clearing requires:

$$d + x^D e_1 = b. \tag{K.40}$$

Similarly, clearing in the period 1 market for dollar loans requires

$$d^* + x^\$ e_1 = b^*. \tag{K.41}$$

The balance of payments in period 1 requires that net exports, $c_1^* - e_1 k_f$, equals assets

[100] In the Cobb-Douglas case, the production function converges to $c_2 = \left(c_2^h\right)^{\omega_c}\left(c_2^f\right)^{1-\omega_c}$,by the presence of $\mathbb{A}$ in equation (K.35).

acquired by domestic residents, $d+d^*$, net of liabilities issued by domestic residents, $b+b^*$:

$$c_1^* - e_1 k_f = d + d^* - (b + b^*) . \tag{K.42}$$

Period 2 The market clearing condition in the period 2 domestic goods market is given by

$$Y_2^h = c_2^h + c_2^*, \tag{K.43}$$

where c_2^* denotes exports. This is assumed to be determined by the following demand curve:

$$c_2^* = \left(\frac{e_2}{p_2^h}\right)^\eta Y_2^*, \tag{K.44}$$

after scaling the prices. Here, Y_2^* denotes foreign GDP in period 2, defined in (K.25). It is a function of e_2/p_2^h, the relative price of foreign versus domestic period 2 goods. The market clearing condition for period 2 final consumption goods is given by:

$$c_2 = c_2^{house} + c_2^{firm}.$$

Domestic GDP in period 2 measured by spending is the sum of consumption and exports net of imports:

$$GDP_2 = c_2 + p_2^h c_2^* - e_2 c_2^f. \tag{K.45}$$

Using the zero profit condition for final good producers, (K.36), as well as market clearing, (K.43), we find that the value-added representation of GDP is as follows:

$$GDP_2 = p_2^h Y_2^h. \tag{K.46}$$

Finally, the income representation of GDP is give by combining (K.46) with (K.16):

$$GDP_2 = w_2 + r_2^K K. \tag{K.47}$$

The balance of payments in period 2 requires that the receipts for net exports, $p_2^h c_2^* - e_2 c_2^f$, must equal net foreign asset accumulation. We express the period 2 balance of payments in units of period 2 final consumption. Because period 2 is the last period, net asset accumulation in period 2 results in a zero stock of net assets at the end of period 2. For example, if the net asset position at the end of period 1 were positive, then net asset accumulation in period 2 would be negative and the trade surplus would be negative as well.

On the asset side, recall that net asset accumulation by domestic residents in period 1 is $d + d^* - (b + b^*)$, in units of period 1 domestic goods. The period 2 net earnings on those assets, in period 2 final consumption units, is

$$dr + d^* r^* e_2 - (br + b^* r^* e_2) \,.$$

So, the balance of payments requires:

$$p_2^h c_2^* - e_2 c_2^f = br + b^* r^* e_2 - (dr + d^* r^* e_2) \,. \tag{K.48}$$

That is, net exports must be positive in period 2 if interest obligations to foreigners exceed their obligations to domestic residents.

K.1.6 Futures Market

We now consider the adjustments required for the case in which there is no local lending market for dollars, and there is instead a futures market. First, we consider market clearing in the period 1 futures market:

$$L + H = S,$$

or, after diving by r^*, and using equations (K.10), (K.32) and (K.22):

$$d^* - \tilde{x} + b^{f,F} e_1 = b^*,$$

so that clearing in the futures market requires

$$b^{f,F} e_1 = b^* + \tilde{x} - d^*.$$

It is interesting to observe that the total participation of foreign financiers in the domestic financial market, measured by b^f, is not affected whether local dollar lending markets are replaced by futures markets. To see this, use equation (K.34) and equation (K.24) to obtain:

$$b^{f,F} e_1 = \overbrace{b^* - d^*}^{x^{\$} e_1} + x^D e_1 = b^f e_1. \tag{K.49}$$

Since we have an algorithm for computing the equilibrium in the version of the model with a loan market and having a futures market is equivalent, we can infer quantities in the futures market from the solution of the loan market version of the model. The formulas for b^*, d^* are unchanged, e.g., they correspond to equations (K.20) and (K.6), respectively. In addition, $\tilde{x}$ corresponds to $x^D e_1$ in the model with only loan markets. We conclude,

$$x^{D,F} e_1 = b^* + x^D e_1 - d^*, \tag{K.50}$$

where the values of the variables on the right of the equality correspond to their value in the baseline version of the model in which there are only loan markets. From equation (K.50) we consider several cases. First, if $b^* = d^*$ so that foreign financiers are not participating in the local dollar market, then the extent of their participation in a futures will not be affected since by equation (K.49) their overall participation is not affected by the markets. If $b^* > d^*$ then foreigners are supplying a positive amount of dollars in the local lending market, so that when that market is shut down they shift their financing into the peso lending market. We can see this simply by rewriting equation (K.50):

$$x^{D,F} e_1 - x^D e_1 = b^* - d^*$$

Obviously if they were borrowing in the dollar market then when that market is shut down, they reduce their lending in the peso market.

K.1.7 Equilibrium

An equilibrium for the model is a set of values of the following 24 objects which satisfy 24 equilibrium conditions:

$$K, r, r^*, e_1, e_2, p_2^h, p^K, r^K, b, b^*, k_h, k_f, w_2, d, d^*, c_2^{house}, c_2^{firm}, c_2, c_2^h, c_2^f, c_1^*, c_2^*, x^D, x^\$,$$

with the understanding that variables with a subscript, 2, are vectors with length equal to the number of possible realizations of the exogenous shocks.[101] The shocks to foreign demand and foreign financier income, ξ, ν, and the shock to domestic productivity A, in equation (15).

K.1.8 Futures Markets and Insurance Flows

In our model we have only one type of outsider, the foreign financier. We denote the quantity of long contracts for dollars by that agent by H. Suppose there are two types of foreigners. The number of dollars purchased long is denoted H^l and the number of dollars purchased short is H^s. Open interest, oi, is the sum of the long contracts or the sum of the shorts. Both sums are the same by market clearing in the futures market. Thus,

$$oi = L + H^l = S + H^s. \tag{K.51}$$

[101] We solve the model by reducing it to four equations in the four unknowns, K, r, e_1, e_2. The four equations are (K.21), (K.38), (K.40), and (K.48). We proceed by fixing values for K, r, e_1, e_2 and then using the other equations to determine the 20 other variables above.

Also, we can define nff, net financial flows, as the net quantity of long contracts purchased by the foreign financier:

$$nff = H^l - H^s = S - L. \tag{K.52}$$

If $nff > 0$ then foreigners gain in the event of a jump in e_2, because on net, they are long on dollars. Presumably, the idea of exorbitant privilege/duty suggests that $nff < 0$ so that in fact foreigns provide insurance and lose when there is a depreciation in local currency, with a jump in e_2. The following identity is useful:

$$\overbrace{min\,[L,S]}^{\text{amount of insurance provided between domestic residence insidurs}} + \overbrace{min\left[H^l, H^s\right]}^{\text{amount of insurance provide between foreigners}} + |nff| = oi \tag{K.53}$$

To verify this identify, consider the two possible scenarios, $L > S$ and $L < S$. Suppose (i) $L > S$. In this case $H^s > H^l$ according to equation (K.51). Then, $min\,[L,S] = S$, and equation (K.52) implies $min\left[H^l, H^s\right] = H^l$ and $|nff| = H^s - H^l$. Then,

$$min\,[L,S] + min\left[H^l, H^s\right] + |nff| = S + H^l + H^s - H^l = oi.$$

Now, suppose (ii) $S > L$. In that case, (K.51) implies $H^l > H^s$, so that $|nff| = H^l - H^s$, so that

$$min\,[L,S] + min\left[H^l, H^s\right] + |nff| = L + H^s + H^l - H^s = oi.$$

The case, $L = S$ is trivial so that equation This establishes equation (K.53). Rewriting, we have

$$\frac{min\,[L,S]}{oi} + \frac{min\left[H^l, H^s\right]}{oi} + \frac{|nff|}{oi} = 1,$$

which is displayed in section 3.3.1 in Chari and Christiano (2019).

K.1.9 Interest rate Spread

In this section, we consider the special case of our model $b^* = d^*$. Equating d^* from (K.6) with b^* from (K.20) and rearranging:

$$E\left(r - e_2 r^*\right) = -\frac{\lambda}{2} cov\left(r^* e_2, w_2 + r_2^K K\right) = -\frac{\lambda}{2} cov\left(r^* e_2, GDP_2\right). \tag{K.54}$$

Here, the second equality uses (K.47). According to this expression, there is a positive premium on peso deposits if the exchange rate depreciates when GDP is low. This expression is consistent with the very simple intuition in the introduction, in which we disregarded the role of foreigners in domestic credit markets.

It is interest to see what equation (K.54) implies for the forward premium. Using the arbitrage restriction, equation (K.8), (K.54)can be written:

$$E\left(e_2 - F\right) = \frac{\lambda}{2} cov\left(e_2, GDP_2\right), \tag{K.55}$$

after dividing both sides by r^*. From equation (K.55) we have the F is bigger than Ee_2 when the exchange rate depreciates (i.e., e_2 jumps) in a recession. The reason for this is that when households obtain income insurance by buying dollars in the futures market, they bid up the price, F, of those dollars. They must do so, so that the people taking the other side of the deal earn a reward on average. So, we can think of the price of insurance being the money lost on average by the household, per dollar bought in the futures market, $E\left(e_2 - F\right)$. This money is transferred to the people who go short, firms and foreigners.

K.1.10 Equilibrium

The 24 unknowns in the model are:

$$K, r, r^*, e_1, e_2, p_2^h, p^K, r^K, b, b^*, k_h, k_f, w_2, d, d^*, c_2^{house}, c_2^{firm}, c_2, c_2^h, c_2^f, c_1^*, c_2^*, x^D, x^\$,$$

with the understanding that variables with a subscript, 2, are vectors with length equal to the number of possible realizations of the exogenous shocks. We solve the model by reducing it to four equations in the four unknowns, K, r, e_1, e_2. The four equations are (K.21), (K.38), (K.40), and (K.48). We proceed by fixing values for K, r, e_1, e_2 and then using the other equations to determine the 20 other variables above.

K.2 Results

The section below describes the calibration of the model, which uses data from Peru. We then discuss the ability of our model to reproduce the key features of the Peruvian data.

K.2.1 Calibration

Data from the Central Bank of Peru (CBP) website suggests $d^*/\left(d + d^*\right) \simeq .44$. Data from the CBP and the Bank for International Settlements (BIS) suggests that $b^*/\left(b + b^*\right) \simeq 0.40$. To address the relative magnitude of foreign and domestic finance, we consider two ratios. The first is $\left(b - d\right)/b$. The logic of this ratio is that the firm 'naturally' wants to borrow in soles, $b > 0$. We draw this inference from the observation that domestic currency interest rates command a premium. Then, $\left(b - d\right)/b = x^D e_1/b$. This is the share of domestic currency

Table K15: Calibrated Model Parameter Values

Parameter	Description	Value
α	Capital Share, (15)	0.42
λ	Risk aversion, domestic residents (9), (19)	7.34
λ^F	Risk aversion, foreign financiers (29)	7.34
η	Elasticity of demand for exports, (34), (K.44)	6.61
δ	Elasticity of substitution (domestic final goods in period 2), (30)	1.00
$r^{\$}$	USD real interest rate, (22)	1
Y^*	Period 1 trade demand, (34)	0.53
s	Covariance parameter, financiers, (26)	7.39
ω	Investment home-bias, (11)	0.71
ω_c	Consumption home-bias, (30)	0.74
Y	Period 1 GDP, (7)	1.80
μ_A	Mean productivity, (15)	8.80
μ_ξ	Mean, ξ shock to foreign demand, (24)	5.79
μ_ν	Mean, ν shock to foreign demand, (24)	1.73
σ_A	Std dev productivity, (15)	$0.13\mu_A$
σ_ξ	Std dev ξ shock to foreign demand, (24)	$0.63\mu_\xi$
σ_ν	Std dev ν shock to foreign demand, (24)	$0.14\mu_\nu$

Note: model parameters selected to optimize a penalty function based on discrepancy between the entries in the 'Peru' and 'Value' columns in Table K16. Numbers in parentheses correspond to equations where the associated parameter is first used.

borrowing provided by foreigners. Using BIS and CBP data we infer that this ratio is roughly 0.02: roughly 2% of domestic soles borrowing is financed by foreigners. The second ratio we examine is $(d^* - b^*)/d^*$. The logic of this ratio is that the household 'naturally' wants to make dollar deposits, so that $d^* > 0$. The question then is, how much of $d^* > 0$ is borrowed (lent, if $d^* - b^* < 0$) by foreigners. Using BIS and CBP data we infer that this ratio is roughly $-.37$. This means that firms want to borrow more dollars than households supply, a gap made up by foreign dollar lending, $x^{\$} > 0$.

All three shocks are iid with the given standard deviations. For simplicity we assumed each random variable can take 2 values with equal probability. Overall, we have 8 possible realizations of the three shocks in period 2.

Calibration parameters: $\sigma_z, \sigma_\xi, \sigma_\nu, \alpha, \eta, \mu_A, \mu_\xi, \mu_\nu, Y_1^*, Y_1, s, \omega, \omega_c, \lambda$. Here, μ_x denotes the mean of the shock, $x = z, \xi, \nu$. Calibration targets are displayed in Table K16.

K.2.2 Model Results

Exercise - Increase in Volatility Foreigners' Demand for Exports Figure K18 shows how the equilibrium changes as the standard deviation of the two foreign demand shocks, (ξ and ν in equation K.39) increases from 10 percent below their calibrated values to 10 percent

Table K16: Endogenous Variables and Corresponding Values for Peru

Variable	Description	Value	Peru
$\frac{p^K K}{Y} = \frac{b+b^*}{d+d^*}$ (1)	Capital-output ratio	1.02	
$100 \times (r-1)$	Domestic Rate	-0.3%	-0.3%
$E(e_2 r^*)$	Expected Dollar Rate	0.974	
$100 \times E(r - e_2 r^*)$	Spread (domestic agents)	2.25%	2.20%$^{(6)}$
$100 \times E(\frac{r}{e_2} - r^*)$	Spread (financier)	2.36%	
$d^* / (d^* + d)$	Deposit Dollarization	0.59	0.44$^{(2)}$
$\frac{b-d}{b}$	Foreign Source of Peso Credit	-0.00	0.01$^{(3)}$
$\frac{d^*-b^*}{d^*}$	Foreign Absorption of Dollar Deposits	-0.04	-0.37$^{(3)}$
$b^* / (b + b^*)$	Credit Dollarization	0.60	0.40$^{(3)}$
$\frac{c_1^* - e_1 k_f}{Y}$	Trade Surplus (share of GDP)	-0.02	-0.02$^{(4)}$
$100 \times \frac{E(r - r^* e_2)}{r} \frac{d^*}{d^* + d}$	Implicit tax on dollar deposits	1.3%	1.5%$^{(5)}$
ρ	Correlation, e_2, GDP	-0.21	-0.20$^{(7)}$

Notes: (1) it is easy to verify, using equations (7) and (37), that the trade surplus as a share of GDP, is $1 - \frac{b+b^*}{d+d^*}$; (2) d^* denotes the foreign currency deposits of residents, measured in soles and d denotes the domestic currency deposits of residents, and the ratio is an average over 2000-2016 (source: CBP); (3) b (b^*) is the sum of soles (dollars) borrowing by non-financial firms from Peruvian banks (source: CBP) plus international securities issued by nonfinancial corporations in soles (dollars) (source: BIS); ratios are averages over the period, 2000-2016; (4) average, over 2000-2017 (source: World Bank, World Development Indicators); (5) the implicit tax is based on the domestic interest rate inferred by covered interest parity and US/soles forward rates (see text for details); (6) here, r and $r^* e_2$ are measured as the real return, in units of Peruvian CPI goods, associated with soles deposits (r) and dollar deposits ($r^* e_2$) in Peruvian banks over 2004-2014 (source: CBP); (7) correlation based on S/P (S denotes soles per dollar, P denotes Peruvian CPI) and Peruvian real GDP, where both variables were log, first differenced, covering the period 2000-2018.

above their calibrated value. A negative realization in that shock creates a recession in period 2 when demand by foreigners for the domestic good drops (see equation K.44). When that happens, the exchange rate, e_2, jumps (depreciates) and the wage rate, w_2,falls (see panel 2,1). This is why the hedging benefit of dollar deposits to the household of increasing dollar deposits increases with the rise in the volatility of the foreign demand shock (see the solid line with dots in panel 1,1). Households respond by increasing their dollar deposits, which appear as the solid like in panel 1,1 of Figure K18. Deposits have been scaled by a constant, Y_1, which is total deposits, $d + d^*$, according to equation K.1. Dollar deposits vary from 0.34 to 1.58 as the volatility of the demand shock varies from smallest to largest. Evidently, the demand for d^* is so high at the upper bound of the variance, that $d < 0$. That is, households borrow in local currency units in order to increase their dollar deposits above Y_1. Other things the same, the decrease in the supply of deposits denominated in local goods drives up the interest rate premium on domestic deposits (see panel 3,1). This moderates the household's incentive to increase its dollar deposits via a fall in the speculative motive. This motive, defined in equation (K.6), can be seen in the dot-dash line in panel 1,1, which shows that the speculative motive alone motivates households to set $d^* < 0$ because borrowing dollars from banks and lending the proceeds in the form of domestic currency on average makes money for the household when there is a premium on peso deposits. The speculative motive is quite strong and varies from -3.12 to -4.45 across the range of variation in Figure K18.

Although the speculative motive makes households averse to dollar deposits when there is a premium on the peso interest rate, the hedging motive is stronger. If households were infinitely risk averse (i.e., $\lambda = \infty$) then the hedging motive would be the only motive operating on households. Across the range of variation in Figure K18 households would want to hold 3.30-5.33 in (scaled) deposits. That is, despite the premium on peso deposits, they want to borrow those deposits, $d < 0$, in order to make d^* very large. is the only pulls the household in the other direction, the hedging motive dominates and d^* rises with the greater volatility in export demand shocks. Operating through the speculative motive of the household, the relative increase in the domestic rate of interest partially offsets the household's greater hedging motive stronger hedging motive when foreign demand shocks are more volatile. The hedging motive alone makes the demand for dollar deposits rise from 0.34 to 1.58 over the range of volatilities displayed in Figure K18. The 1,1 panel in K18 The premium on the domestic rate of interest Note how the speculative motive (see the dot-dashed line) dictates that households borrow in dollars, $d^* < 0$, and lend in local currency. Total deposits is 1.58, so then the standard rises by 10 percent, deposits are almost entirely in dollars.

For firms, the hedging motive leads to the opposite response in the market for loans. Hedging considerations dictate reducing dollar borrowing when the exchange rate depreciates more in a recession, which is a time when they have low income (see the solid line with dots in panel 1,2). Other things the same, firms' desire to shift borrowing from dollars to local currency adds to the upward pressure on the premium on local currency (see 3,1). With dollar borrowing less attractive and rates on domestic borrowing going up, firms reduce borrowing overall (see panel 3,3). With less borrowing, firms' financial constraint, equation (K.14), implies less investment. With reduced investment, the demand for foreign inputs decreases, leading to a jump (depreciation) in the period 1 exchange rate, e_1. This raises firms' shadow cost of capital, p^K (see equation (K.13)), amplifying the fall in capital investment, K (see panel 2,2).

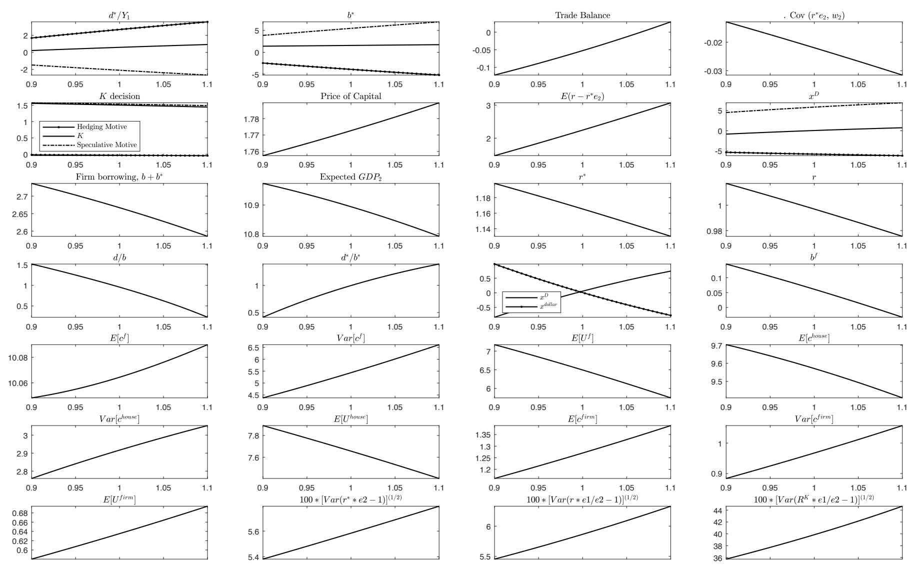
Evidently, net acquisition of assets by domestic residents, $d + d^* - (b + b^*)$, rises with the volatility in the foreign demand shock.[102] The balance of payments, equation (K.42), requires that the trade surplus increase. This is accomplished in part by the stimulus to exports, c_1^*, occasioned by the depreciation in the period 1 exchange rate (see equation (K.39)).

It is interesting to see what the model has to say about the role of foreign financiers, especially given the premium on the domestic rate of interest rises (see panel 3,1). Foreign financiers' speculative motive (the dot-dash line) suggests that they should borrow dollars,

[102] Recall, from equation (K.1), that $d + d^* = Y$, which is pre-determined. So, the conclusion in the text about net asset accumulation reflects the fall in $b + b^*$ observed in panel 3,3 of Figure K18.

convert them into domestic currency and lend the proceeds, x^D, in the domestic financial market. Given the premium on the domestic interest rate this would, in expected value, earn them a profit. They don't exploit this opportunity because with the higher volatility of export demand in period 2, lending in domestic currency units is a bad hedge for foreign financiers. Their other sources of income tend to drop when the demand for exports drop (see equation (K.26)). With the bigger depreciation in the domestic currency when this happens, this strategy hits financiers with losses in their own currency units just when their other sources of income are low.

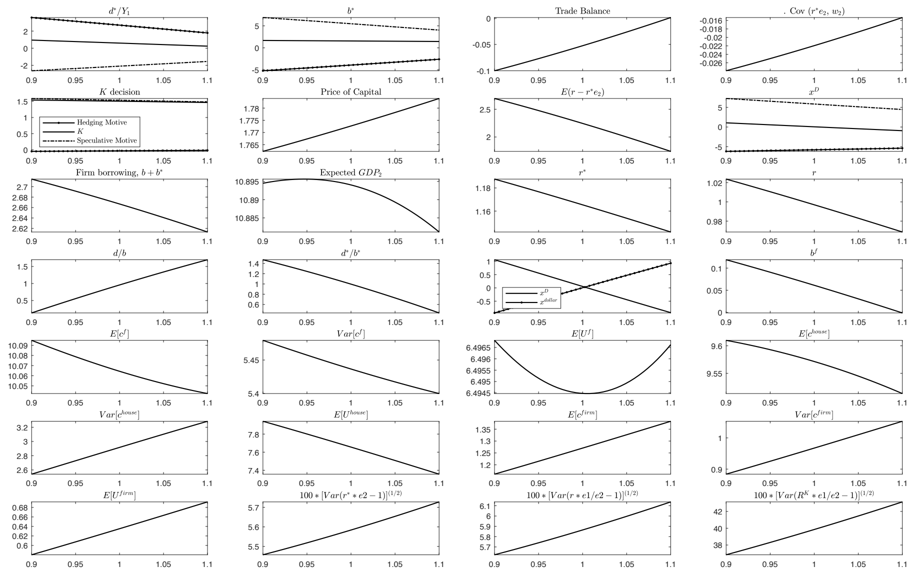
Figure K18: Increase in volatility of trade shock, ξ and ν



Note: horizontal axis displays $x \in [0.9, 1.1]$ and vertical axis is value of indicated variable(s) when the values of σ_ξ and σ_ν in Table (K15) are replaced by $x\sigma_\xi$ and $x\sigma_\nu$. Here, ν and ξ are the shocks to period 2 foreign demand for domestic period 2 tradable goods (see equation (K.25)). The legend in the panels with three graphs correspond to the legend in the 2,2 panel.

Figure K19 displays the impact on equilibrium of increasing the standard deviation of the technology shock, A, in equation (K.15). When this shock increases in importance, then the depreciation that occurs in a recession is reduced (see panel 1,2). With the hedging value of dollar deposits reduced, households shift from dollar deposits into local currency deposits (see panel 1,1). With the supply of local currency deposits in local lending markets increased, the premium on the domestic interest rate is reduced (see panel 2,2).

Figure K19: Increase in volatility of productivity shock



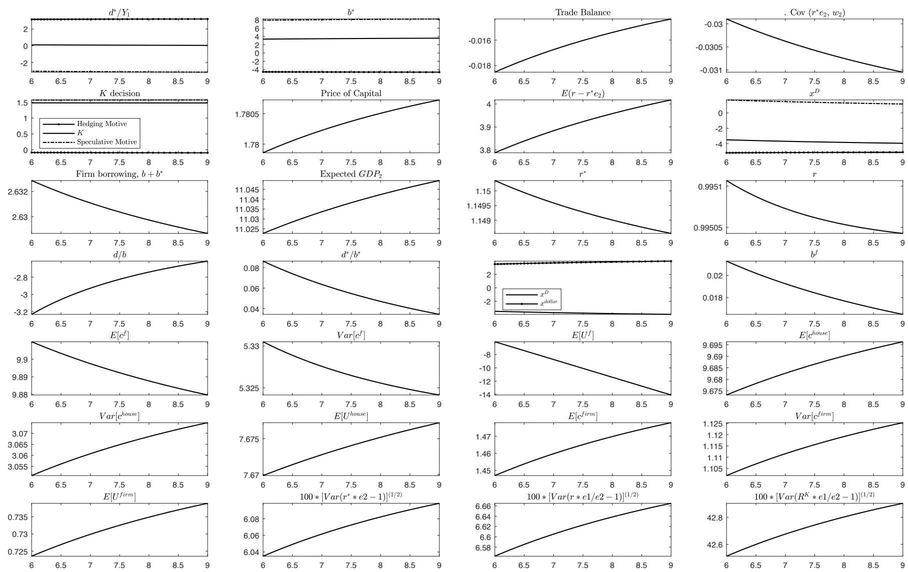
Note: horizontal displays $x \in [0.9, 1.3]$ and vertical axis is value of indicated variable when the value ofσ_A in Table (K15) is replaced by $x\sigma_A$. Here, A is the technology shock experienced by domestic firms in period 2 (see equation (K.15)).

Exercise - Risk Aversion of Foreign Financiers Figure (K20) shows what happens when we increase the risk aversion of the foreign financiers (see λ^F in equation (K.29)). When foreign financiers become more risk averse they are more reluctant to lend in local currency. With the fall in demand for local currency by foreign financiers, the exchange rate, e_1, depreciates (see the definition of p^K in (K.13) and panel 2,2 of Figure (K20)). The fact that foreign financiers lend less in the local currency market, we see that the interest premium on local currency rises (see panel 2,3). (Foreigners substitute so much into dollar lending that they actually finance this in part by borrowing in local currency to lend in dollars (see how x^D becomes negative in panels 2,4 and 4,3).) Households respond by substituting a little towards peso deposits (panel 1,1). But, overall there is a reduction in local deposits, so that the domestic interest rate premium rises (see panel 2,3). Firms are pushed into borrowing in dollars, but they don't like this so overall borrowing by firms, $b + b^*$, decreases (see panel 3,1). Net foreign asset accumulation goes up because $d + d^*$ is constant. By the balance of payments, this means the trade surplus must rise. The rise in e_1 increases period 1 exports (that e_1 rises can be seen in the fact that p^K rises, according to equation (K.13)). The reduced demand for imports by firms because they cut back on production, also helps increase the trade surplus (see 'sudden stop' in panel 1,3).

Note from the 3,3 panel that r^* falls. This has to be, because $r^\$ = e_1 r^*$, and $r^\$$ is being held constant. But, if r^* goes down then so does r, even though the premium on r goes up.

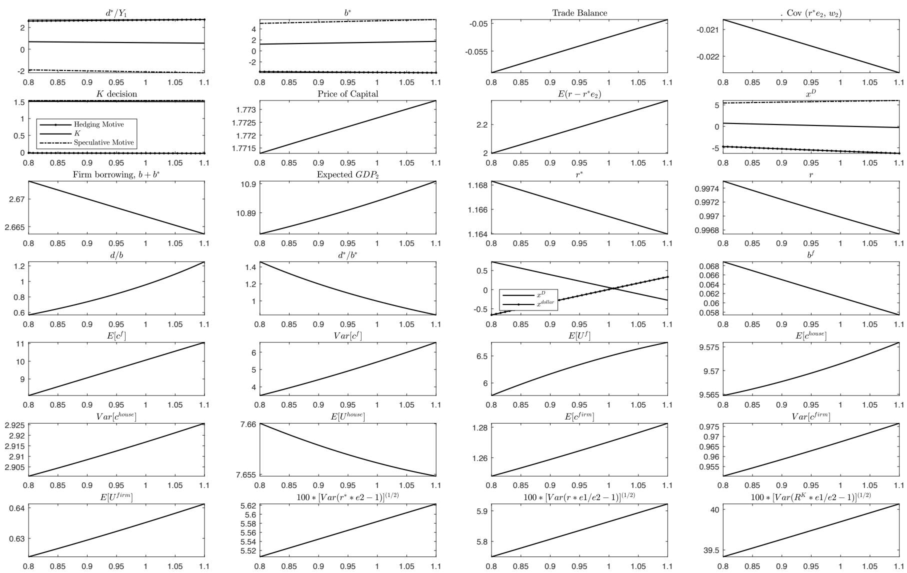
Not surprisingly, because there is less borrowing by firms in the first period, the expected period 2 GDP declines (see panel 3,2).

Figure K20: Increase in foreign financier risk aversion



Exercise - Income comovement of Foreign Financiers Figure K21 shows what happens when we increase the degree of comovement between the trade shock and the income of foreign financiers by increasing the value of s in (K.26). This change makes domestic currency loans a bad hedge, and the effects resemble those in Figure K20.

Figure K21: Increase in comovement between foreign financier income and trade shock

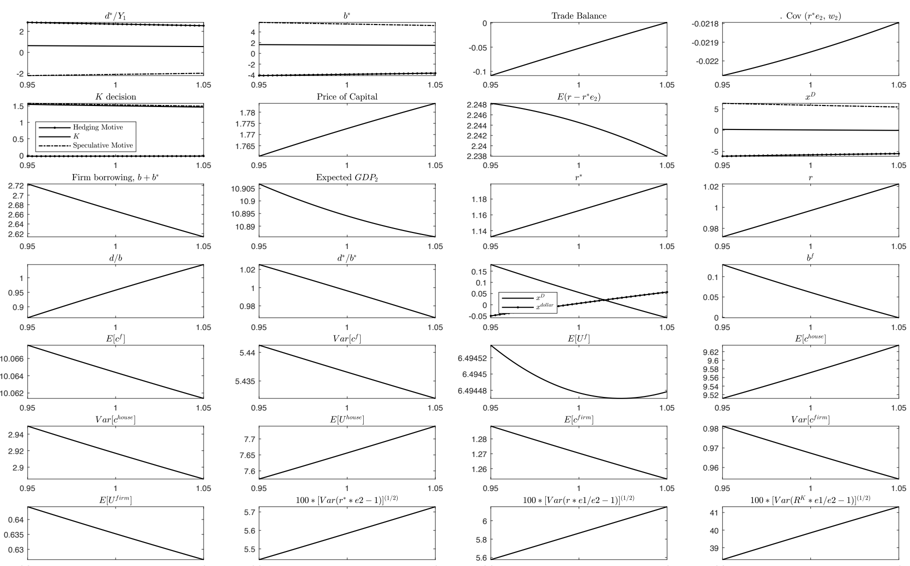


Exercise - Increase in $r^\$$ Figure K22 displays the impact of increasing $r^\$$. Obviously, that makes dollar assets more attractive. This means that the foreign financier prefers to lend in the dollar market (see panel 4,3). The reduction in the demand for local currency by the foreign financier leads to a depreciation in the exchange rate (see p^K in panel 2,2 and recall equation (K.13)). The reduced supply of funds to the domestic peso market implies that there is an increase in the local currency premium (see panel 2,3). This forces local firms to substitute away from local currency borrowing and into dollar borrowing, which they don't naturally like to do for hedging reasons. So, total firm borrowing, $b + b^*$, goes down (see panel 3,1). So, there is a fall in foreign capital inflows. By the balance of payments (see (K.42)), this implies that the trade balance must increase (see panel 1,3). Holding quantities fixed in K.42, a depreciation makes the trade balance go down (the 'J' curve effect). But, the increase in exports occasioned by the depreciation (see equation K.39), as well as the decline in imports, k_f, ensures that the trade balance actually goes up so that the balance of payments is satisfied. The 4,4 panel indicates that the total amount of dollars borrowed by the foreign financiers, to lend into the local market (either as dollars or pesos) goes down. The fact that capital flows to the domestic economy go down is consistent with evidence in Figure 7 of Miranda-Agrippino and Rey (2020).

Interestingly, the rise in $r^\$$ leads in the next period to a fall in domestic GDP. This looks marginally like it contradicts the results in the 1,1 panel of Figure 7 of Miranda-Agrippino and Rey (2020). They do show that there is an initial drop in foreign GDP after a rise in

$r^{\$}$, but that drop is not statistically significant. Eventually, foreign GDP rises after a rise in $r^{\$}$, but that is just barely significantly different from zero. Finally, note that the variance of e_2 goes up (see 7,2 panel of Figure K22). In addition, the variance of the rate of return (in dollars) on investments abroad go up too. In panel 7,3 of Figure K22 we see that the variance on the return, $re_1/e_2 - 1$, of local currency investments expressed in dollars, goes up. The variance, in dollars, on the rate of return to capital, $R^k e_1/e_2 - 1$, also goes up. The overall rise in variability of returns, seems consistent with results reported in the results in Figure 6 (middle panel) of Miranda-Agrippino and Rey (2020). There, they show that a rise in $r^{\$}$ leads to a fall in the Global Factor, which looks like (the inverse of) the VIX (see panel (a) in their Figure 2). We have not yet investigated how to compute their Global Factor in our model (the only asset price we have is p^K), or their measure of Global Risk Aversion.

Figure K22: Increase in $r^{\$}$



K.3 Conclusion, Model

In sum, these calculations show that the model can be used to articulate a narrative which summarize our empirical findings. We suppose that the configuration of shockss the consequence that the exchange rate depreciates in a recession. In this case, households have an incentive to denominate their deposits in dollars. In addition, the resulting scarcity of local currency in local currency markets will create the premium on the domestic interest rate observed in many emerging market countries. In our model, foreigners do not trade away that premium by lending in local currency because their position resembles that of domestic households. Lending for foreigners, as for domestic households, is a bad hedge when the exchange rate depreciates in a recession. In this case, dollar deposits represent an insurance mechanism, by with firms provide income insurance to households. Firms are compensated for borrowing in dollars by being charged a low rate on average. Households pay for the insurance by the opportunity cost of not earning the higher average rate on deposits denominated in domestic currency units.

L Appendix Material on Domestic Household

This appendix explores alternative interpretations of the household's mean-variance utility function. This reinterpretation would also apply to the other mean-variance agents in the model.

L.1 Low Probability of Disaster Restriction

We explored an alternative to the household problem in which it maximizes expected utility subject to a lower bound on the risk of disaster, defined as $c_2^{house} \leq c_l$, where c_l is a 'disaster' level of consumption. In the end, we did not succeed, but there may yet be some approximate sense in which this is similar to our statement of the household problem. The problem is

$$\max_{d^*} Ec_2^{house}$$

subject to

$$\text{prob}\{(e_2 r^* - r)\, d^* + w_2 + Yr < c_l\} \leq p.$$

Put differently, we want to choose d^* to maximize expected utility subject to $CDF\,(c_l; d^*) \leq p$. Setting this up as a Lagrangian problem, we have that d^* solves

$$\max_{d^*} E\left[(e_2 r^* - r)\, d^* + w_2 + Yr\right] + \lambda\left[p - CDF\,(c_l; d^*)\right].$$

Under the assumption of normality (which underlies the utility specification in equation (K.4)) we have

$$CDF\,(c_l; d^*) = \frac{1}{2}\left[1 + erf\left(\frac{c_l - E\left[(e_2 r^* - r)\, d^* + w_2 + Yr\right]}{\sqrt{2Var\left((e_2 r^* - r)\, d^* + w_2 + Yr\right)}}\right)\right],$$

where, for any y,

$$erf\,(y) = \frac{2}{\sqrt{\pi}} \int_0^y e^{-t^2}.$$

By Leibniz's rule we have

$$erf'(y) = \frac{2}{\sqrt{\pi}} e^{-y^2}.$$

The simplicity of this expression will be useful. The first order condition of the household's problem is:

$$E(e_2 r^* - r) = \lambda CDF_{d^*}(c_l; d^*) = \lambda \frac{1}{2} \frac{2}{\sqrt{\pi}} e^{-\left(\frac{c_l - E[(e_2 r^* - r)d^* + w_2 + Yr]}{\sqrt{2Var((e_2 r^* - r)d^* + w_2 + Yr)}}\right)^2} \times \frac{d}{dd^*}\left(\frac{c_l - E[(e_2 r^* - r)d^* + w_2 + Yr]}{\sqrt{2Var((e_2 r^* - r)d^* + w_2 + Yr)}}\right)$$

Differentiating the last term,

$$\frac{d}{dd^*} \frac{c_l - \mu(d^*)}{(2\sigma^2(d^*))^{1/2}}$$

where

$$\mu(d^*) \equiv E[(e_2 r^* - r)d^* + w_2 + Yr]$$
$$\sigma^2(d^*) \equiv Var((e_2 r^* - r)d^* + w_2 + Yr),$$

so that

$$\mu'(d^*) = E(e_2 r^* - r).$$

Also,

$$\frac{d}{dd^*} \frac{c_l - \mu(d^*)}{(2\sigma^2(d^*))^{1/2}} = -\frac{\mu'(d^*)}{(2\sigma^2(d^*))^{1/2}} - \frac{1}{2} \frac{c_l - \mu(d^*)}{\sqrt{2}(\sigma^2(d^*))^{3/2}} \frac{d}{dd^*}\sigma^2(d^*)$$

Then,

$$\begin{aligned} \frac{d}{dd^*}\sigma^2(d^*) &= \frac{d}{dd^*} E[(e_2 - Ee_2)d^* r^* + w_2 - Ew_2]^2 \\ &= 2E[(e_2 - Ee_2)d^* r^* + w_2 - Ew_2][(e_2 - Ee_2)r^*] \\ &= 2var(e_2)d^*(r^*)^2 + 2r^* cov(w_2, e_2). \end{aligned} \tag{L.1}$$

Substituting,

$$\begin{aligned} \frac{d}{dd^*} \frac{c_l - \mu(d^*)}{(2\sigma^2(d^*))^{1/2}} = &-\frac{E(e_2 r^* - r)}{(2\sigma^2(d^*))^{1/2}} \\ &- \frac{1}{2} \frac{c_l - \mu(d^*)}{\sqrt{2}(\sigma^2(d^*))^{3/2}} \left[2var(e_2)d^*(r^*)^2 + 2r^* cov(w_2, e_2)\right]. \end{aligned}$$

This expression does not look like our mean-variance problem.

For what it's worth, we verified that our formula for the derivative of the CDF, using the error function 'works' in the case that we differentiate the CDF with respect to c_l. Then, we should get the Normal density function.

$$CDF\left(c_l; d^*\right) = \frac{1}{\sqrt{2\pi\sigma^2}} \int_{-\infty}^{c_l} e^{-\frac{1}{2}\left(\frac{c-\mu(c;d^*)}{\sigma_C(d^*)}\right)^2} dc$$

We know that if we differentiate this w.r.t. c_l then the derivative of CDF is the Normal pdf evaluated at c_l.

Consider the CDF of a Normal variable with mean μ and variance, σ^2. For given x, the CDF with the error formula is:

$$CDF\left(x\right) = \frac{1}{2}\left[1 + erf\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)\right]$$

Differentiating with respect to x,

$$CDF'\left(x\right) = \frac{1}{2} erf'\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)\frac{1}{\sigma\sqrt{2}}$$

But,

$$erf'\left(y\right) = \frac{2}{\sqrt{\pi}} e^{-y^2}$$

so, as expected:

$$CDF'\left(x\right) = \frac{1}{2}\frac{2}{\sqrt{\pi}} e^{-\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)^2}\frac{1}{\sigma\sqrt{2}} = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)^2},$$

verify the expression of the $CDF\left(x\right)$ in terms of the error function.

L.2 Risk Neutrality With Variance Constraint

Now, suppose the household maximizes expected utility subject to an upper bound constraint on the variance of consumption:

$$\max_{d^*} E c_2^{house}$$

subject to

$$var\left(c_2^{house}\right) \leq \alpha V^h.$$

In Lagrangian form,

$$E c_2^{house} + \nu\left[\alpha V^h - var\left(c_2^{house}\right)\right],$$

where $\nu > 0$ is the multiplier. To see this, suppose $\nu = 0$. Then the solution when there is a premium on r, is to set $d^* = -\infty$ which makes the variance $+\infty$. To avoid violating the constraint, ν must be positive.

It is useful to simplify the variance term:

$$
\begin{aligned}
var\left[\left(e_2 r^* - r\right) d^* + w_2 + Yr\right] &= E\left[\left(e_2 r^* - r\right) d^* + w_2 + Yr - E\left(\left(e_2 r^* - r\right) d^* + w_2 + Yr\right)\right]^2 \\
&= E\left[e_2 r^* d^* + w_2 - E\left(e_2 r^* d^* + w_2\right)\right]^2 \\
&= E\left[\left(e_2 - Ee_2\right) r^* d^* + w_2 - Ew_2\right]^2 \\
&= var\left(r^* e_2\right)\left(d^*\right)^2 + var\left(w_2\right) + 2d^* cov\left(r^* e_2, w_2\right) \qquad \text{(L.2)}
\end{aligned}
$$

Writing the problem explicitly and in Lagrangian form, we have

$$
E\left[\left(e_2 r^* - r\right) d^* + w_2 + Yr\right] + \nu\left[\alpha V^h - E\left(\left(e_2 - Ee_2\right) d^* r^* + w_2 - Ew_2\right)^2\right]
$$

The first order condition is:

$$
\begin{aligned}
E\left(e_2 r^* - r\right) &= \nu 2E\left[\left(\left(e_2 - Ee_2\right) d^* \left(r^*\right)^2 + w_2 - Ew_2\right)\left(e_2 - Ee_2\right) r^*\right] \\
&= \nu 2 var\left(e_2\right) d^* \left(r^*\right)^2 + \nu 2 r^* cov\left(w_2, e_2\right)
\end{aligned}
$$

So,

$$
d^* = \frac{E\left(e_2 r^* - r\right)}{\nu 2 var\left(e_2 r^*\right)} - \frac{cov\left(w_2, r^* e_2\right)}{var\left(r^* e_2\right)}. \qquad \text{(L.3)}
$$

It is useful to make the functional dependence of ν on V^h explicit. By risk neutrality and assuming

$$
E\left(e_2 r^* - r\right) \neq 0,
$$

then the complementarity condition implies:

$$
var\left(c_2^{house}\right) = \alpha V^h. \qquad \text{(L.4)}
$$

Equations (L.3) and (L.4) represent two equations in our two unknowns, d^* and ν. Substituting from equation (L.2):

$$
var\left(r^* e_2\right)\left(d^*\right)^2 + var\left(w_2\right) + 2d^* cov\left(r^* e_2, w_2\right) = \alpha V^h. \qquad \text{(L.5)}
$$

(L.3) and (L.5) can be solved as one nonlinear equation in ν. In particular, fix ν and compute d^*. Then, evaluate (L.5). Adjust ν until (L.5) is satisfied. Problem is that the solution is not analytic, and not apparently very similar to the problem in section (K.1.1).

In any case, this is not what the VaR people, like Danielsson et al. (2010), are talking about since they assume w_2 is non-random so that $var\left(w_2\right) = cov\left(r^* e_2, w_2\right) = 0$. In that case,

$$var\left(r^{*}e_{2}\right)\left(d^{*}\right)^{2}=\alpha V^{h}$$

so using equation (L.3) we get nonsense:

$$d^{*}=1.$$

This is probably why Danielsson et al. (2010) make the constraint on the standard deviation, $\left(var\left(c_{2}^{house}\right)\right)^{1/2}$, instead of on $var\left(c_{2}^{house}\right)$. We look at the latter case in the following subsection.

L.3 Risk Neutrality With Value at Risk Constraint

Now consider the following problem:

$$\max_{d^{*}} Ec_{2}^{house},\ c_{2}^{house}=\left(e_{2}r^{*}-r\right)d^{*}+w_{2}+Yr$$

subject to

$$\alpha\left[var\left(c_{2}^{house}\right)\right]^{1/2}\leq V^{h}.$$

Again, under the assumption that $E\left(e_{2}r^{*}-r\right)\neq 0$, we have that Ec_{2}^{house} can be driven to positive infinity by driving d^{*} to $\pm\infty$. So, in this case the restriction will be binding. Writing the problem in Lagrangian form, we obtain

$$\max_{d^{*}} Ec_{2}^{house}+\xi\left(V^{h}-\alpha\left[var\left(c_{2}^{house}\right)\right]^{1/2}\right),$$

where $\xi\neq 0$. The first order conditions are:

$$E\left(e_{2}r^{*}-r\right)=\xi\frac{\alpha}{2\left[var\left(c_{2}^{house}\right)\right]^{1/2}}\frac{dvar\left(c_{2}^{house}\right)}{dd^{*}},\tag{L.6}$$

where, using equation (L.2)

$$\frac{dvar\left(c_{2}^{house}\right)}{dd^{*}}=2var\left(r^{*}e_{2}\right)d^{*}+2cov\left(r^{*}e_{2},w_{2}\right).$$

We can write equation (L.6) as follows:

$$E\left(e_{2}r^{*}-r\right)=\alpha\xi\frac{var\left(r^{*}e_{2}\right)d^{*}+cov\left(r^{*}e_{2},w_{2}\right)}{\left[var\left(c_{2}^{house}\right)\right]^{1/2}}=\alpha\xi\frac{var\left(r^{*}e_{2}\right)}{\left[var\left(c_{2}^{house}\right)\right]^{1/2}}d^{*}+\alpha\xi\frac{cov\left(r^{*}e_{2},w_{2}\right)}{\left[var\left(c_{2}^{house}\right)\right]^{1/2}},$$

or, using the fact that the constraint binds,

$$d^* = \frac{1}{\alpha\xi}\left[E\left(e_2r^* - r\right) - \alpha\xi\frac{cov\left(r^*e_2, w_2\right)}{\left[var\left(c_2^{house}\right)\right]^{1/2}}\right]\frac{\left[var\left(c_2^{house}\right)\right]^{1/2}}{var\left(r^*e_2\right)}$$

$$= \frac{V^h}{\alpha^2\xi}\frac{E\left(e_2r^* - r\right)}{var\left(r^*e_2\right)} - \frac{cov\left(r^*e_2, w_2\right)}{var\left(r^*e_2\right)}, \tag{L.7}$$

which looks just like equation (K.6), with $\lambda = \alpha^2\xi/V^h$. So, the solution is given by equation (L.7) and the binding constraint:

$$\alpha\left[var\left(r^*e_2\right)\left(d^*\right)^2 + var\left(w_2\right) + 2d^*cov\left(r^*e_2, w_2\right)\right]^{1/2} = V^h. \tag{L.8}$$

At this point, the problem is analytically complicated. It can be solved by choosing a particular value of ξ and then computing d^* using equation (L.7). Then, adjust ξ until (L.8) is satisfied.

In Danielsson et al. (2010) it is assumed that $var\left(w_2\right) = cov\left(r^*e_2, w_2\right) = 0$,so that (L.7) and (L.8) reduce to

$$d^* = \frac{V^h}{\alpha^2\xi}\frac{E\left(e_2r^* - r\right)}{var\left(r^*e_2\right)},\ V^h = \alpha\left[\left(d^*\right)^2 var\left(r^*e_2\right)\right]^{1/2}. \tag{L.9}$$

Note that the second equation cannot be used to compute d^*, only its absolute value. We first get an expression for ξ. Using the second equation in (L.9) to substitute out for V^h in the first equation,

$$d^* = \frac{\alpha\left[var\left(r^*e_2\right)\right]^{1/2} d^*}{\alpha^2\xi}\frac{E\left(e_2r^* - r\right)}{var\left(r^*e_2\right)},$$

so that, after cancelling d^* on both sides and rearranging:

$$\xi = \frac{E\left(e_2r^* - r\right)}{\alpha\left[var\left(r^*e_2\right)\right]^{1/2}}. \tag{L.10}$$

Just like in Danielsson et al. (2010, eq. 14), according to the first equality in (L.10), the multiplier, ξ, is proportional to an object that looks like the Sharpe ratio. Using equation (L.10) to substitute out for ξ in the expression for d^* in the first expression in (L.9):

$$d^* = \left(\frac{V^h}{\alpha^2\xi}\right)\frac{E\left(e_2r^* - r\right)}{var\left(r^*e_2\right)} = \frac{V^h}{\alpha^2}\frac{\alpha\left[var\left(r^*e_2\right)\right]^{1/2}}{E\left(e_2r^* - r\right)}\frac{E\left(e_2r^* - r\right)}{var\left(r^*e_2\right)} = \frac{V^h}{\alpha\left[var\left(r^*e_2\right)\right]^{1/2}} = d^*,$$

where the last equality uses the second equality in equation (L.10).

It seems misleading to think of the first equation in (L.9) as determining d^* as a function of the 'shifter', ξ. The latter variable moves with the mean return and the variance of r^*e_2. It seems like the only expression which delivers d^* as a function of exogenous variables alone is the binding constraint, adjusted so that you can sign d^* :

$$d^* = sign\left[E\left(e_2 r^* - r\right)\right] \frac{V^h}{\alpha\left[var\left(r^* e_2\right)\right]^{1/2}}$$

This looks very different from equation (K.6). Apart from the sign of $E\left(e_2 r^* - r\right)$, it seems to leave no role for the magnitude of $E\left(e_2 r^* - r\right)$, which plays an important role in the mean-variance approach.