Essays in International Macroeconomics

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This dissertation consists in three chapters, each making a distinct contribution. Chapter 1 empirically tests classic and new Uncovered Interest Parity puzzle in an innovative way. Findings suggest that government debt is significant and economically relevant for UIP puzzles estimation.
Chapter 2 shows that a class of macroeconomic models reproduce the UIP puzzle under a standard parametrization and adding convenience yields exogenous dynamics.
Chapter 3 is a theoretical model that links financial crises to the election of populists parties, matching empirical evidence from Europe.

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Life is beautiful since I live it with my friends and family: thank you for being with me.

Introduction

The dissertation consists in three Chapters.

Chapter 1 studies how government debt variables impact estimates of the classic and new UIP puzzles for quarterly data between 2000 and 2020 of 6 developed countries in relation to the United States. I estimate country-pair VECMs to model cointegration relations between debt variables, price differences, interest rates differences and nominal exchange rate.
I compare this framework with one without debt variables following Engel (2016) using quarterly data between 1979 and 2020. In the framework without debt, I don't find the new UIP puzzle while in the framework with debt, I do find it.
Government debt variables are significant and alter the sign of comovements between difference in interest rates and far-ahead ex-post and ex-ante excess currency returns. The magnitude of the effect is economically relevant.
Government debts coefficients cannot be uniquely associated with convenience yield story.

Production based models with Long Run Risks and recursive preferences cannot replicate the classic Uncovered Interest Parity Puzzle. Chapter 2 augments a EZ-BKK model with government bonds as exogenous processes so that they bring time-varying convenience yields. Permanent shocks to bonds replicate the UIP puzzle when they are positively correlated to long-run news under a standard parametrization. Temporary shocks to bonds may replicate the UIP puzzle if the volatility of short term shock is close to two times a standard parametrization, without needing the positive correlation with long-run news.

Chapter 3. Financial crises often seem to be associated with populism, although the populist banking policies introduced to address such crises are far from homogenous. This apparent paradox – a sort of "sight-unseen consensus" – suggests that specific economic drivers coupled with general psychological components can explain populist consensus. We propose a model of populist consensus, which we term "democratic rioting", in which individuals' decisions to support or resist a specific populist bailout policy after a financial crisis are heavily influenced by psychological group dynamics. Those dynamics, in turn, are driven by general, non-banking-related motivations, such as anti-elite sentiments. In a multiple equilibria setting, the more individuals are unhappy for general economic and/or psychological reasons, the more likely they are to support myopic and redistributive populist banking policies rather than long-sighted public interventions.

1 Chapter 1. Exchange Rates and Government Debt.

1.1 Introduction

Exchange rates have been studied for decades with different angles: from determination of the levels for demand of traded goods (based on Dornbusch (1976) and Mundell-Fleming) to resolution of puzzles (see review essays by Engel (1996, 2014) , Obstfeld and Rogoff (2000) and Ishtoki and Mukhin (2017)).
Two of the puzzles are referred to as the uncovered interest parity (UIP) , both in classic and new form. The classic UIP puzzle finds that there is positive correlation between high interest rate countries and excess currency returns. This happens at frequencies between six or more hours[1] and quarters for low inflation countries and does not happen for long term bonds (Chinn and Meredith (2004)).
The new UIP puzzle has been documented by Engel (2016) and Valchev(2020): after an initial positive correlation, there is a reversal between interest rates and excess currency returns. Part of the literature considers the role of liquidity or convenience into play in order to explain these puzzles. Intuitively, short-term bonds that are safe and liquid give an additional benefit to interest rate returns: counting this effect, the two puzzles may be jointly explained theoretically. Indeed, high value from liquidity is referred as high convenience yield of a bond and it may vary depending on the demand and supply of safe and liquid government bonds.
This paper studies the interaction of the classic and new UIP puzzle with government debts for each of G6 countries with the US. The motivation comes from two intuitions. First, if liquidity plays a role in explaining exchange rate puzzles, it is useful to incorporate a broad proxy for it in our estimation of the puzzles. Second, a decent and ready available proxy for every country is the amount of government debt. On top of these, another motivation is to check for possible long term relations between fundamentals and government debt in order to correctly estimate the UIP puzzles and other statistical facts.
As Engel (2016) points out, these countries' exchange rates are interesting to study because they have been floating since the early 1970's, with little state direct intervention and deep markets, relatively little inflation and very little default risk [2].
This paper first estimates a three variables Vector Error Correction Mechanism (VECM) for country pairs between nominal exchange rate, interest rates differences and price differences. I use the setup of Engel (2016) with extended data covering 1979-2020[3], but using quarterly data instead of monthly one.[4]
Secondly, I choose the best four-variable VECM between five types of government debt variables according to both intuition and cointegration relation's

[1]Chaboud and Wright (2005) finds that below six hours, classic UIP actually holds well.
[2]Apart from Italy during the 2010-2011 sovereign bond crisis.
[3]Previous data covers 1979-2009.
[4]This choice is due to the second step where government data are only released as quarterly.

smoothness [5]. The chosen model is estimated in a sample 2000-2020 due to data availability. Multiple regressions are performed after the VECM estimation.
First, I estimate Fama regressions both on real and nominal terms. These equations regress one step ahead excess currency returns against interest rates differences.
Second, I regress the level of real exchange rate on differences in real interest rates.
Third, I regress the sum of future expected excess currency returns on differences in real interest rates to estimate the potential reversal of the UIP puzzle (i.e. the new UIP puzzle).
Fourth, I regress far-ahead ex-ante excess currency returns on real and nominal differences in interest rates, doing so also over different subsamples. Fifth, I regress far-ahead ex-post excess currency returns on real and nominal differences in interet rates, for multiple quarters up to three years.

The following step adds debt variables to the previous equations. Generally I first estimate equations adding only the relative debt innovations, while in a second round I add to the estimation the total amount of Home government debt (US debt) and Foreign government debt.
Estimation results bring surprises. There is one key result from the model without debt in the quarterly sample 1979-2020: I do find the classic UIP puzzle but I cannot find the new UIP puzzle in the data.
This is stated by three regression results. First in eq. 9 I find positive and not significant coefficients for differences in real rates with respect to the future sums of expected foreign excess currency returns. In Engel(2016) these coefficients were negative and significant. This result is influenced by the different trend-cycle decomposition used for building the LHS of the equation, since I used an Hodrick-Prescott filter while Engel used the Beveridge-Nelson decomposition.
Second in eq 10 and 11 I find mostly positive coefficients, while Engel finds a lot of negative ones. This means that differences in real and nominal rates covary positively with far-ahead ex-ante excess currency returns.
Third in eq. 12 and 13 I find positive coefficients, while Engel finds negative ones. This means that differences in real and nominal rates covary positively with far-ahead ex-post excess currency returns.

The model with debt in the quarterly sample 2000-2020 brings some interesting findings.
First, the debt variables are significant for all the equations considered apart from the Fama regressions in real and nominal terms (where Foreign debt is somewhat significant in a minority of countries).
Second, introducing debt variables changes sign of coefficients for five out of eight sets of equations. For eq. 8a on the level of real exchange rate, for eq. 10a on ex-ante far-ahead excess currency returns and for eq. 12a on ex-post far-ahead excess currency returns.

[5] The debt variables have been added as fourth variables in the ordering.

Third, the magnitude of the coefficients for debt is economically important. Consider a 1 trillion increase in debt variables. For the real and nominal Fama regressions, Foreign debt has single digit percentage effects, while for the other regressions it has between single and double digit percentage effects.
Fourth, the coefficients on foreign debt are always an order of magnitude greater in absolute value than the coefficients on the other debt variables.
Fifth, the sign of US debt and Foreign debt are respectively positive and negative for almost all set of equations apart from the one in levels that is eq. 8a. These coefficients are not in line with government debt only as a function of past convenience yields, that would require opposite signs.
Sixth, relative debt innovations may be interpreted as differences in convenience yields, i.e. as $-(\Psi_h - \Psi_f)$ in Valchev (2020). Real convenience yields are positively correlated with real foreign excess currency returns (eq. 7a).
From a general standpoint, the results in eq. 7 and 8 partially solve one of the central puzzle of Engel (2016). Indeed, for France, Germany and Canada's pairs the high interest countries have now the lower level of real exchange rate that confirms them as the riskier countries in a bilateral comparison. Similarly, Italy and Japan have negative point estimates in eq. 8, but they are not statistically significant. These results strongly support a new coherence of the "risk" framework over the standard textbook Mundell-Fleming model.
In conclusion, this paper does not find confirmation of the reversal of UIP puzzle for the whole 1979-2020 sample at quarterly level, but only for the 2000-2020 sample. Taking into account government debt variables is helpful to study the new UIP puzzle, but not the classic one. Differences in interest rates are positively correlated with ex-ante and ex-post excess currency returns, while Home government debt is positively correlated and Foreign government debt is negatively correlated.

Sections 2 outlines the literature review, Section 3 explains data sources, Section 4 explains the model, Section 5 shows regression results, Section 6 concludes.

1.2 Literature review

The literature review on these topics is big and expanding. For somewhat comprehensive review, see Engel (1996) and Engel (2014).
The Uncovered Interest Parity puzzle in its classical form has been introduced by Fama (1984): defining $s_t = \frac{Home}{Foreign}$ as log nominal ER ($\uparrow s_t$ means Home depreciate), a typical Fama regression:

$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + \epsilon_{t+1}$$

Data suggests that $\hat{\beta} < 0$ instead of $\beta = 1$, i.e. high interest rates countries see overtime an appreciation of currency up to quarter time frequency.
This paper builds on two main previous works: Engel (2016) and Valchev (2020). Valchev (2020) uses panel data to find empirical evidence of convenience yields' importance for the classic and new UIP. He also builds a theoretical model with endogenous convenience yields' fluctuations that replicates both the classic UIP puzzle and the new one.
Ishtoki and Mukhin (2017) explain 6 exchange rate puzzles by using a setup that blends international asset demand shocks with a framework that makes these shocks propagates very little within the pair of countries. In their paper, shocks propagates little because of Home bias in consumption, weak substituability between domestic and foreign goods (little variance of Terms of Trade) and strategic complementarieties in price setting. They find that an increase in the demand for Foreign assets decreases the ex-ante foreign currency excess returns. In this paper, I find evidence that increase in supply of foreign government debt decreases the ex-ante and ex-post foreign currency excess returns.
Lately convenience yields and liquidity have been growingly incorporated in international macroeconomics and finance. Among the contributions, the paper by Krishnamurty and Vissing-Jorgensen (2012) finds that when debt to GDP ratio is low, Treasuries are more scarce and there is higher convenience yield. This implies that supply of government bonds impacts convenience yields such that higher supply decreases them.
In addition to Valchev (2020), there have been several key contributions. There are models that use the idea of bond convenience yields for closed economy asset puzzles, as Bansal and Coleman (1996) and Lagos (2010). The idea is that certain assets give an additional benefit other than the bare interest rate. Jiang et al (2018) build a theory that links demand for foreign safe assets and the nominal exchange rate for US. They claim to solve most of the exchange rate disconnect puzzle for US by defining a specific form of convenience yield. By defining as convenience yield the different yield between foreign government bonds and US bonds, they show that an increase in this convenience yield implies an impact appreciation of the dollar and a following depreciation that increases the ex-ante foreign currency excess return.
Engel and Wu (2019) find that accounting for liquidity yield on government bonds gives explanatory power to monetary shocks and price differences, differently from what the literature on forecasting and exchange rate disconnect had previously found.

Du et al (2018) study convenience yields for G10 currencies between 2000 and 2016. They include in their study US, Germany, Japan, UK that are useful for this work. The US treasury premium is defined as the convenience yield on US treasury bonds minus the convenience yield on foreign treasury bonds, such that a positive premium implies that US convenience yield is higher than foreign. They find that there are country-pair treasury premia with different average and dynamics. Treasury premia at 3 month horizon are higher than 5 year horizon, and they both increased during the Global Financial Crisis with higher jump by the 3 month premia. Moreover, there has been a steady decline in treasury premia after the GFC for the currencies considered. In line with this evidence, I find that US total debt has decisively lower coefficients than foreign total debt in prediction of both ex-ante and ex-post currency excess returns. Against this evidence, I find that the sign of coefficients is inverted: total US government debt correlates positively with foreign excess currency return and total foreign debt correlates negatively with foreign excess currency returns.

Van Bisbergen et al (2019) use a new methodology to estimate risk-free rates between 2004 and 2018, using the put-call parity relationship for European style options. By this method, they get risk-free rates from risky assets and compare them to risk- free rates on government bonds. The difference is indeed the convenience yield. As Du et al (2018), they find higher convenience yields at short term rather than long term horizon (65 versus 40 basis point) and strongly varying in time of financial distress.

Moreover they find that a forecasting factor constructed from cross section of convenience yields (a la Cochrane and Piazzesi 2005) has substantial forecasting power for both government bond excess returns (conventional risk premia) and their risk-free rate excess returns (risk premia minus the convenience yields), even when controlling for other factors of the literature. This evidence parallels my results that total government debt covaries with currency excess returns.

Lilley et al (2019) define as “Exchange Rate Reconnect” the fact that after the GFC , exchange rates correlate with macroeconomic fundamentals according to both IMF data [6] and a micro datasets with security level data. In particular, broad US dollar comoves closely with global risk appetite. In addition, only between 2007-2012 the broad US dollar co-moves also with US foreign bond purchases, even if they conclude that this correlation is probably caused by the movement in global risk appetite. The broad dollar and global risk appetite co-movement seems to depend on the changed relations between dollar and riskier currencies, such as Australian dollar. When US investors buy less US treasuries or more domestic corporate debt, the dollar depreciates.

Other approaches to the topic of safe and liquid assets includes Caballero, Farhi and Gourinchas (2017) on the safe asset conundrum and the same authors for the consequences of this for the growing difference between capital and equity risk premia.

One key aspect of the study is the long-run relation of nominal exchange rate

[6] balance of payment data and International Investment positions to measure quarterly US capital flows

with macroeconomic variables. Being unit root processes, the presence of a specific long run relation takes the form of cointegration. As Engel (2014) reports, there are 4 studies that find cointegration between economic fundamentals and exchange rates: Groen (2000), Mark and Sul (2001), Rapach and Wohar (2002), Cerra and Saxena (2010).

Groen (2000) studies cointegration between exchange rates and macroeconomic fundamentals given by the "monetary exchange model" (assuming quantity theory of money). Using both time series and panel data, the conclusion is that there is indeed cointegration between 14 bilateral exchange rates (with US and with the German mark) with relative log money supplies and relative log production.

This paper finds cointegration among nominal exchange rates and two fundamentals such as relative price differences and relative interest rates differences, plus adding relative government debt shocks.

1.3 Data

Price level data are taken from OECD quarterly data, with 2010 as base year. Government debt data are from the BIS, using nominal value data in US billion dollars.

Nominal exchange rates are daily values taken for every first day of the quarter at FRED, Federal Reserve Bank of Saint Louis. To be noted that this means that in the dataset, the nominal ER of December is the nominal ER of the first day of January.

Interest rates are constructed by using daily data of 1-month annual Eurorates provided by Intercapital from June 1979 to July or October 2020, depending on the pair of countries considered. These quarterly rates are calculated using this formula (as an example, the first 3 month of each year): $(1 + r_{january})(1 + r_{february})(1 + r_{march}) - 1$

This strategy should be equal to sell short a foreign bond today, convert foreign currency into dollars, buy US bonds, rollover the 1 month bond for 2 time until the last day of march and then buy back the short with the dollars from the maturing US bonds.

1.4 The model

This analysis follows closely the setup by Engel (2016).
I analyze country pairs for G6 countries with the United States as Home country and Canada, France, Germany, Italy, Japan, UK as Foreign countries (whose variables are denoted by an asterisk). I consider quarterly data for prices, interest rates and nominal exchange rates.
i_t is Home one-period nominal interest rate for deposits that pays off at time t+1.
s_t is the log of foreign exchange rate, denoted as US dollar price of foreign currency. This means that lower s_t implies dollar appreciation.
The excess return on foreign deposit from t to t+1 is:

$$\rho_{t+1} \equiv s_{t+1} - s_t + i_t^* - i_t \tag{1}$$

To be clear, this is the first-order log approximation of foreign excess return, expressed in Home currency terms.[7] In this paper, expected excess returns for one period ahead are defined as $E_t\rho_{t+1}$.
r_t is the ex-ante real interest rate, defined approximately by $r_t = i_t - E_t\pi_{t+1}$, where $\pi_{t+1} \equiv p_{t+1} - p_t$. This means that we approximate the real interest rate by taking the expectation of the difference between log prices tomorrow minus log prices today. As above, the variance of inflation is assumed constant.
The real exchange rate is $q_t \equiv s_t + p_t^* - p_t$.
I am interested in the classic UIP puzzle both in nominal and real terms, respectively defined here as: $cov(E_t\rho_{t+1}, i_t^* - i_t) > 0$ and $cov(E_t q_{t+1} - q_t + r_t^* - r_t, r_t^* - r_t) > 0$
In order to account for the new UIP puzzle, I am interested in the sum of future deviations from the UIP parity.
Engel (2016) explain in details his reasoning, but here is a quicker explanation.
By iteration of 1, we get:

$$(E_t \sum_{j=0}^{\infty}(\rho_{t+j+1} - \bar{\rho})) = s_t^{IP} - s_t^T \tag{2}$$

where $s_t^{IP} = E_t \sum_{j=0}^{\infty}(i_{t+j}^* - i_{t+j} - (\bar{i^* - i}))$ is the infinite sum of future expected UIP deviations from their mean and $s_t^T = s_t - \underbrace{lim}_{k\to\infty}(E_t s_{t+k} - k(\bar{s_{+1} - s}))$ is the transitory component, affected by a mean zero random walk that is the second part.
In simple terms, I am interested in the covariance between real interest rate differences and future expected excess returns, to see whether higher than average interest rates covary positively or else with future expected excess returns.
Intuitively, if UIP holds then $E_t\rho_{t+j} = 0$ for j a positive integer. Hence if UIP holds at all periods, the differences between the expected excess returns and their mean should be equal to zero. In this paper, I use a particular approximation of $(E_t \sum_{j=0}^{\infty}(\rho_{t+j+1} - \bar{\rho}))$ by using a Hodrick-Prescott filter to identify

[7] See Engel (2016) and (1996) for the role of variance in expected excess returns.

s_t^T.
Considering 2 and adding prices on both sides, Engel finds a real exchange rate version of 2[8] :

$$q_t - \underbrace{lim}_{k\to\infty}(E_t q_{t+k}) = E_t \sum_{j=0}^{\infty}(r^*_{t+j} - r_{t+j} - (\bar{r^* - r})) - E_t \sum_{j=0}^{\infty}(\rho_{t+j+1} - \bar{\rho}) \quad (3)$$

Differences in today real exchange rate from his long-run mean is given respectively by sum of future expected differences in real interest rates (UIP condition) minus the UIP deviations.
Below here I write the main equations:
A version of the Fama regression:

$$\rho_{t+1} = \zeta_s + \beta_s(i_t^* - i_t) + u_{s,t+1} \quad (4)$$

The VECM setup a la Engel:

$$x_t = \begin{bmatrix} s_t \\ p_t - p_t^* \\ i_t - i_t^* \end{bmatrix} \quad (5)$$

$$x_t - x_{t-1} = C_0 + Gx_{t-1} + C_1(x_{t-1} - x_{t-2}) + C_2(x_{t-2} - x_{t-3}) + C_3(x_{t-3} - x_{t-4}) + C_4(x_{t-4} - x_{t-5}) + u_t \quad (6)$$

The real version of Fama regression:

$$q_{t+1} - q_t + \hat{r}_t^* - \hat{r}_t = \zeta_q + \beta_q(\hat{r}_t^* - \hat{r}_t) + u_{q,t+1} \quad (7)$$

The regression of real exchange rate on differences in real interest rates:

$$q_t = \zeta_Q + \beta_Q(\hat{r}_t^* - \hat{r}_t) + u_{Q,t+1} \quad (8)$$

Eq. 9 search for comovements between the sum of future expected excess currency returns and real interest rates:

$$\hat{E}_t \sum_{j=0}^{\infty}(\rho_{t+j+1} - \bar{\rho}) = \zeta_\rho + \beta_\rho(\hat{r}_t^* - \hat{r}_t) + u_{\rho,t} \quad (9)$$

Eq. 10 and 11 search for comovements between expected future excess currency returns and interest rates, respectively real and nominal:

$$\hat{E}_t(\rho_{t+j}) = \zeta_j + \beta_j(\hat{r}_t^* - \hat{r}_t) + u_t^j \quad (10)$$

$$\hat{E}_t(\rho_{t+j}) = \zeta_j + \beta_j(i_t^* - i_t) + u_t^j \quad (11)$$

[8]The key assumption here is that Purchasing Power Parity holds in the long run, hence the real exchange rate is stationary and the second term on LHS is the unconditional mean

Eq. 12 and 13 search for comovements between ex-post future excess currency returns and interest rates, respectively real and nominal:

$$\rho_{t+j} = \zeta_j + \beta_j(\hat{r}^*_t - \hat{r}_t) + u^j_t \tag{12}$$

$$\rho_{t+j} = \zeta_j + \beta_j(i^*_t - i_t) + u^j_t \tag{13}$$

In my empirical excercise, I use Stata 15 and the VECM package found there.
For every Home-Foreign pair, I compared different information criteria to get the optimal lag lenght. As a general criteria, I gave preferences to single cointegration relation unless impossible to find.

After the 3 variables VECM, I add debt variables. I build 4 variables VECM in order to estimate properly the long-run relations between price differential, interest rate differential, nominal exchange rate and debt variables.
I have collected data from the BIS on nominal value in billion of dollars of outstanding government debt. Nominal value is taken to parse out consideration of value of debt and overall default risk: I want to observe known quantities instead of a function of these quantities that represents a judgement by markets.
For every 2 country pair Home-Foreign, I created 5 VECMs with a different specification of debt variables :

1. $debt_t = \Delta debt_{Home,t} - \Delta debt_{Foreign,t}$
2. $debt_t = debt_{Home,t} - debt_{Foreign,t}$
3. $debt_t = \Delta debt_{Foreign,t}$
4. $debt_t = \Delta debt_{Home,t}$
5. $debt_t = deb_{Home,t}$

The first is the relative difference in debt emission respect to the previous period, the second is the relative debt difference, the third is the difference of Foreign country's debt emission, the fourth is the difference in Home country's debt emission, the fifth is the Home debt (US debt).
The comparison of different options for the debt variables is useful to see what type of variable best represent a cointegration relation with the other 3 variables. The evaluation of this is done using two criteria: theoretical intuition and visual comparison of cointegration relationship. Theoretical intuition suggests that convenience yields are about relative marginal changes in debt emission, hence the first specification should be the best. Another specification that might make sense is the third one, in case US government debt are ignored in a two country setup since they matter for all countries because they are the dominant currency.
Visual comparison of the cointegration relationships over time works as the more

it seems a white noise process, the best the considered VECM is able to model it.

$$x_t = \begin{bmatrix} s_t \\ p_t - p_t^* \\ i_t - i_t^* \\ debt_t \end{bmatrix} \tag{5a}$$

The final choice is for the first specification of the VECM for every country pair, the one with $debt_t = \Delta debt_{Home,t} - \Delta debt_{Foreign,t}$ [9].

[9] Cointegration relations are graphed in the Online Appendix for all the 5 specifications for country pairs, together with information on rank and lag choice.

1.5 Regression results

First, I estimate Eq. 7, 8, 9, 10, 12, in a sample of quarterly data between 1979 and 2020. Second, I estimate both the equations $7, 8, 9, 10, 12$ and equations $7a, 8a, 9a, 10a, 12a$ in which I added debt variables as covariates in a sample of quarterly data between 2000 and 2020 [10].
I show here one part of the result, picking the country pair US-France for equations 10,12 and 10a,12a. The full results are in Section C and D of the Appendix.

[10] Generally I first estimate equations adding only the relative debt innovations, while in a second round I add to the estimation the total amount of Home government debt (US debt) and Foreign government debt.

First, for the full sample real Fama regression coefficients are significant and slightly smaller than Engel's, apart from Italy and Canada. For the smaller sample, coefficients are positive, slightly smaller and significant. Foreign debt coefficient is significant and negative only for France and Italy, with a 1 trillion increase effect to -5 % for both. Equation 7:

$$q_{t+1} - q_t + \hat{r}_t^* - \hat{r}_t = \zeta_q + \beta_q(\hat{r}_t^* - \hat{r}_t) + u_{q,t+1}$$

Figure 1: Equation 7. Fama regression in real terms.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.922***					
	(17.35)					
(r*-r) Canada		1.023***				
		(10.64)				
(r*-r) Germany			1.047***			
			(15.14)			
(r*-r) France				0.967***		
				(13.45)		
(r*-r) UK					0.966***	
					(9.54)	
(r*-r) Japan						0.888***
						(10.21)
Constant	0.00178	-0.00326	0.000599	-0.00264	-0.00514	-0.00398
	(0.26)	(-0.49)	(0.09)	(-0.36)	(-0.64)	(-0.34)
Observations	160	162	162	162	159	161

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$q_{t+1} - q_t + \hat{r}_t^* - \hat{r}_t = \zeta_q + \beta_q(\hat{r}_t^* - \hat{r}_t) + \phi_q debt_t + u_{q,t+1} \tag{7a}$$

Figure 2: Equation 7a. Real Fama regressions with debt.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.667***					
	(3.41)					
Rel.debt.innov.Ita	-0.00000818					
	(-0.34)					
Debt.US	-0.000000614	-0.00000186	-0.00000182	0.00000131	-0.00000220	0.00000299
	(-0.27)	(-0.58)	(-0.89)	(0.42)	(-0.52)	(0.81)
Debt.Ita	-0.0000520**					
	(-2.37)					
(r*-r) Canada		0.635***				
		(5.48)				
Rel.debt.innov.Can		0.0000221				
		(0.66)				
Debt.Can		-0.0000234				
		(-0.46)				
(r*-r) Germany			0.681***			
			(3.18)			
Rel.debt.innov.Ger			-0.0000170			
			(-0.60)			
Debt.Ger			-0.0000309+			
			(-1.85)			
(r*-r) France				0.657***		
				(3.26)		
Rel.debt.innov.Fra				-0.00000587		
				(-0.24)		
Debt.Fra				-0.0000527**		
				(-2.20)		
(r*-r) UK					0.230	
					(0.97)	
Rel.debt.innov.UK					-0.00000136	
					(-0.06)	
Debt.UK					-0.0000325	
					(-1.05)	
(r*-r) Japan						0.702***
						(4.63)
Rel.debt.innov.Jap						-0.0000287
						(-1.56)
Debt.Jap						-0.00000538
						(-0.51)
Constant	0.134***	0.0441	0.0976***	0.0928***	0.0928***	-0.00988
	(3.47)	(1.46)	(3.15)	(3.56)	(4.99)	(-0.18)
Observations	76	87	76	76	76	85

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Second, for the full sample the level of real exchange rate is correlated with real interest rate differences (apart from France and less for UK), but coefficients are two order of magnitude littler than Engel's. For the smaller sample, the level of real exchange rate is positively correlated (but not significant) with real interest rate differences only until all debt variables are included. Indeed this brings a negative correlation between the level of real exchange rate and real interest rate. All debt variables are significant and Foreign debt has big effects. Equation 8:

$$q_t = \zeta_Q + \beta_Q(\hat{r}^*_t - \hat{r}_t) + u_{Q,t+1}$$

Figure 3: Equation 8. Levels of real exchange rates and differences in real interest rates.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	0.423^{+} (1.87)					
(r*-r) Canada		1.428^{***} (2.62)				
(r*-r) Germany			1.565^{***} (3.95)			
(r*-r) France				-0.241 (-0.79)		
(r*-r) UK					0.691^{**} (2.01)	
(r*-r) Japan						1.358^{***} (2.70)
Constant	0.234^{***} (5.50)	-0.184^{***} (-3.79)	0.243^{***} (6.26)	0.219^{***} (5.05)	0.421^{***} (9.44)	-4.420^{***} (-62.62)
Observations	161	163	163	163	160	162

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$q_t = \zeta_Q + \beta_Q(\hat{r}_t^* - \hat{r}_t) + \phi_Q debt_t + u_{Q,t+1} \tag{8a}$$

Figure 4: Equation 8a.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	-0.222					
	(-1.15)					
Rel.debt.innov.Ita	0.0000923**					
	(2.30)					
Debt.US	-0.0000546***	-0.000135***	-0.0000437***	-0.000101***	-0.000106***	-0.0000884***
	(-13.91)	(-11.23)	(-11.97)	(-15.17)	(-6.71)	(-17.58)
Debt.Ita	0.000734***					
	(16.82)					
(r*-r) Canada		-0.532**				
		(-2.15)				
Rel.debt.innov.Can		0.000244***				
		(5.22)				
Debt.Can		0.00263***				
		(11.65)				
(r*-r) Germany			-0.849***			
			(-3.92)			
Rel.debt.innov.Ger			0.000105***			
			(2.88)			
Debt.Ger			0.000542***			
			(12.96)			
(r*-r) France				-0.682***		
				(-3.52)		
Rel.debt.innov.Fra				0.000116***		
				(3.14)		
Debt.Fra				0.000882***		
				(15.07)		
(r*-r) UK					0.135	
					(0.33)	
Rel.debt.innov.UK					0.00000984	
					(0.15)	
Debt.UK					0.000603***	
					(5.62)	
(r*-r) Japan						-0.197
						(-0.83)
Rel.debt.innov.Jap						0.0000413
						(1.57)
Debt.Jap						0.000218***
						(11.95)
Constant	-0.832***	-1.229***	-0.454***	-0.292***	0.746***	-5.140***
	(-11.81)	(-9.99)	(-6.23)	(-5.13)	(7.03)	(-40.05)
Observations	76	87	76	76	76	85

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results in Equations 7 and 8 constitute a significant redefinition of the central puzzle in Engel (2016). Indeed, Engel (2016) finds on one side the classic UIP puzzle for all the country pairs, while on the other side a positive coefficient in eq. 8 states that high interest rates countries have higher level of real exchange rates. This is a contradiction since the classic UIP puzzle implies that high interest rate countries are riskier, while high level of real exchange rates implies less risk. This contradiction puts "risk" models on one side and Mundell-Fleming models on the other, with both class of models being able to explain just one of the two empirical facts.

My findings state that including government debt quantities in the estimation changes the sign of the coefficients in eq. 8 for 5 pair of countries out of 6, with 3 that are statistically significant. For these country pairs, the Engel puzzle is not anymore there: high interest rate countries are more risky in both ways, from a UIP puzzle standpoint and by considering the now lower level of real exchange rates.

Third, for the full sample the sum of expected excess currency returns is positively correlated with differences in real rates [11], but not significant. This is starkly different from Engel's negative and significant coefficients. For the smaller sample, the sum of future expected excess currency returns is now negatively correlated with differences in real rates. US debt and Foreign debt have (mostly) significant coefficients, respectively positive and negative. A 1 trillion increase in Foreign debt has an effect between -28 and -5 %. Equation 9:

$$\hat{E}_t \sum_{j=0}^{\infty} (\rho_{t+j+1} - \bar{\rho}) = \zeta_\rho + \beta_\rho(\hat{r}_t^* - \hat{r}_t) + u_{\rho,t}$$

Figure 5: Equation 9. New UIP puzzle evidence.

	(1) Sum.exp.exc.ret.Ita	(2) Sum.exp.exc.ret.Can	(3) Sum.exp.exc.ret.Fra	(4) Sum.exp.exc.ret.Ger	(5) Sum.exp.exc.ret.UK	(6) Sum.exp.exc.ret.Jap
(r*-r) Italy	0.0788					
	(0.68)					
(r*-r) Canada		0.374				
		(0.90)				
(r*-r) France			0.192			
			(0.72)			
(r*-r) Germany				0.204^{**}		
				(2.16)		
(r*-r) UK					0.347^{+}	
					(1.77)	
(r*-r) Japan						-0.0874
						(-0.46)
Constant	0.149^{***}	0.150^{***}	0.173^{***}	-0.0485^{***}	0.296^{***}	0.102^{***}
	(6.87)	(5.74)	(5.21)	(-4.46)	(11.33)	(3.62)
Observations	161	163	163	163	160	162

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[11] Apart from Japan.

$$\hat{E}_t \sum_{j=0}^{\infty} (\rho_{t+j+1} - \bar{\rho}) = \zeta_\rho + \beta_\rho(\hat{r}_t^* - \hat{r}_t) + \phi_\rho debt_t + u_{\rho,t} \tag{9a}$$

Figure 6: Equation 9a.

	(1) Sum.exp.exc.ret.Fra	(2) Sum.exp.exc.ret.Fra
(r*-r) France	-0.501*** (-2.82)	-0.386^{+} (-1.74)
Rel.debt.innov.Fra		0.0000455 (1.54)
Debt.US		0.0000154*** (3.73)
Debt.Fra		-0.000148*** (-3.88)
Constant	-0.0258** (-2.18)	0.0752 (1.57)
Observations	76	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fourth, for the full sample differences in real and nominal rates covary positively with far-ahead ex-ante excess currency returns, confirming the fourth result and the difference with Engel's. Negative coefficients are found only for 2005-2020 and for some countries. For the smaller sample, differences in real and nominal rates covary (mostly) negatively with far-ahead ex-ante excess currency returns without debt variables, while adding debt variables creates a positive correlation.
US debt coefficients are all positive and significant, Foreign debt coefficients are all negative and significant. Equation 10:

$$\hat{E}_t(\rho_{t+j}) = \zeta_j + \beta_j(\hat{r}_t^* - \hat{r}_t) + u_t^j$$

In both the above equations, I computed the LHS by using an in-sample dynamic forecast. This forecast has been repeated for 3 time spans: post 1985 (columns 1 and 2), post 1995 (columns 3 and 4) and post 2005 (columns 5 and 6), in order to have different subsamples of data considered. This equations give betas that are a weighted average of the set of betas shown by Engel.

Figure 7: Equation 10. France.

	(1) Exp.exc.ret.post1985.Fra	(2) Exp.exc.ret.post1985.Fra	(3) Exp.exc.ret.post1995.Fra	(4) Exp.exc.ret.post1995.Fra	(5) Exp.exc.ret.post2005.Fra	(6) Exp.exc.ret.post2005.Fra
(r*-r) France	1.326***		0.125		-0.124	
	(4.93)		(0.25)		(-1.04)	
(i*-i) France		1.592***		0.189		-0.203
		(4.80)		(0.23)		(-0.97)
Constant	-0.678***	-0.681***	-0.0650+	-0.0637	-0.0480***	-0.0496***
	(-20.06)	(-20.62)	(-1.77)	(-1.58)	(-3.27)	(-3.19)
Observations	143	143	104	104	64	64

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$\hat{E}_t(\rho_{t+j}) = \zeta_{10a} + \beta_{10a}(\hat{r}_t^* - \hat{r}_t) + \phi_j debt_t + u_t^j \tag{10a}$$

In both the above equations, I computed the LHS by using an in-sample dynamic forecast. This forecast has been repeated for 3 time spans: post 2005 (columns 1 and 2), post 2010 (columns 3 and 4) and post 2015 (columns 5 and 6), in order to have different subsamples of data considered. This equations give betas that are a weighted average of the set of betas shown by Engel.

Figure 8: Equation 10a-11a. France.

	(1) Exp.exc.ret.post2005.Fra	(2) Exp.exc.ret.post2005.Fra	(3) Exp.exc.ret.post2010.Fra	(4) Exp.exc.ret.post2010.Fra	(5) Exp.exc.ret.post2015.Fra	(6) Exp.exc.ret.post2015.Fra
(r*-r) France	-0.591^{+}		-1.045^{***}		0.313	
	(-1.87)		(-5.66)		(0.86)	
(i*-i) France		-0.860^{+}		-1.561^{***}		0.602
		(-1.87)		(-3.48)		(1.53)
Constant	0.0509^{**}	0.0492^{**}	0.0850^{***}	0.0766^{***}	0.00238	0.0155
	(2.22)	(2.19)	(3.69)	(3.13)	(0.09)	(0.71)
Observations	63	65	43	45	23	25

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Fra	(2) Exp.exc.ret.post2005.Fra	(3) Exp.exc.ret.post2010.Fra	(4) Exp.exc.ret.post2010.Fra	(5) Exp.exc.ret.post2015.Fra	(6) Exp.exc.ret.post2015.Fra
(r*-r) France	0.888^{***}		0.748^{***}		0.726^{***}	
	(5.13)		(5.35)		(4.69)	
Rel.debt.innov.Fra	-0.0000236	-0.0000183	-0.0000716^{***}	-0.0000455^{***}	-0.0000509^{***}	-0.0000314^{**}
	(-0.66)	(-0.74)	(-6.58)	(-3.10)	(-3.80)	(-2.13)
Debt.US	0.0000527^{***}	0.0000561^{***}	0.0000499^{***}	0.0000489^{***}	0.0000380^{***}	0.0000342^{***}
	(11.50)	(17.14)	(17.56)	(9.36)	(7.38)	(10.99)
Debt.Fra	-0.000381^{***}	-0.000408^{***}	-0.000434^{***}	-0.000392^{***}	-0.000402^{***}	-0.000340^{***}
	(-11.63)	(-13.91)	(-13.27)	(-12.30)	(-13.84)	(-10.09)
(i*-i) France		1.279^{***}		0.826^{**}		0.770^{***}
		(8.53)		(2.48)		(4.96)
Constant	0.204^{***}	0.226^{***}	0.396^{***}	0.303^{***}	0.345^{***}	0.257^{**}
	(8.15)	(7.91)	(6.23)	(3.60)	(5.05)	(2.74)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fifth, for the full sample differences in real and nominal rates covary positively with far-ahead ex-post excess currency returns, differently from Engel's. For the smaller sample, differences in real and nominal rates still covary positively with far-ahead ex-post excess currency returns, but they often lose significance. US debt coefficients are significant and positive, Foreign debt coefficients are significant and negative.

Equation 12:

$$\rho_{t+j} = \zeta_j + \beta_j(\hat{r}_t^* - \hat{r}_t) + u_t^j$$

This regression uses ex-post excess returns on foreign deposit. The regression is performed from 1 quarter to 12 quarters (3 years).

Figure 9: Equation 12. France.

	(1) Exc.ret.(t+1) Fran	(2) Exc.ret.t+2.Fra	(3) Exc.ret.t+3.Fra	(4) Exc.ret.t+4.Fra	(5) Exc.ret.t+5.Fra	(6) Exc.ret.t+6.Fra
(r*-r) France	0.915***	0.899***	0.870***	0.858***	0.883***	0.884***
	(17.21)	(11.69)	(8.40)	(6.43)	(5.46)	(4.43)
Constant	0.000382	-0.00129	-0.00256	-0.00343	-0.00478	-0.00484
	(0.07)	(-0.13)	(-0.18)	(-0.19)	(-0.22)	(-0.20)
Observations	162	161	160	159	158	157

t statistics in parentheses

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

	(1) Exc.ret.t+7.Fra	(2) Exc.ret.t+8.Fra	(3) Exc.ret.t+9.Fra	(4) Exc.ret.t+10.Fra	(5) Exc.ret.t+11.Fra	(6) Exc.ret.t+12.Fra
(r*-r) France	0.881***	0.910***	0.929***	1.018***	1.048***	1.096***
	(3.92)	(3.67)	(3.52)	(3.70)	(3.85)	(4.02)
Constant	-0.00481	-0.00556	-0.00578	-0.00711	-0.00585	-0.00583
	(-0.18)	(-0.19)	(-0.18)	(-0.21)	(-0.17)	(-0.16)
Observations	156	155	154	153	152	151

t statistics in parentheses

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

$$\rho_{t+j} = \zeta_j + \beta_j(\hat{r}_t^* - \hat{r}_t) + \phi_j debt_t + u_t^j \tag{12a}$$

Figure 10: Equation 12a. France.

	(1) Exc.ret.(t+1) Fran	(2) Exc.ret.t+2.Fra	(3) Exc.ret.t+3.Fra
(r*-r) France	0.490**	0.360	0.420**
	(2.58)	(1.55)	(2.07)
Rel.debt.innov.Fra	0.0000138	0.0000436	0.0000419
	(0.47)	(0.94)	(0.77)
Debt.Fra	-0.0000573**	-0.000118***	-0.000180***
	(-2.47)	(-3.27)	(-4.37)
Debt.US	0.00000218	0.00000630	0.0000114**
	(0.70)	(1.38)	(2.05)
Constant	0.0856***	0.155***	0.222***
	(3.69)	(4.46)	(6.13)
Observations	76	76	75

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Fra	(2) Exc.ret.t+5.Fra	(3) Exc.ret.t+6.Fra
(r*-r) France	0.513**	0.609***	0.538**
	(2.50)	(2.83)	(2.61)
Rel.debt.innov.Fra	0.0000426	0.0000311	0.0000260
	(0.94)	(0.77)	(0.67)
Debt.Fra	-0.000236***	-0.000267***	-0.000291***
	(-5.32)	(-5.71)	(-5.96)
Debt.US	0.0000162***	0.0000189***	0.0000198***
	(2.66)	(3.17)	(3.24)
Constant	0.279***	0.315***	0.354***
	(7.47)	(7.58)	(8.05)
Observations	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 11: Equation 12a. France.

	(1) Exc.ret.t+7.Fra	(2) Exc.ret.t+8.Fra	(3) Exc.ret.t+9.Fra
(r*-r) France	0.452^{+}	0.478^{+}	0.468
	(1.95)	(1.80)	(1.61)
Rel.debt.innov.Fra	0.0000226	0.0000488	0.0000540
	(0.55)	(1.05)	(1.00)
Debt.Fra	-0.000319^{***}	-0.000358^{***}	-0.000377^{***}
	(-6.48)	(-7.69)	(-7.89)
Debt.US	0.0000217^{***}	0.0000252^{***}	0.0000263^{***}
	(3.46)	(4.33)	(4.40)
Constant	0.388^{***}	0.421^{***}	0.444^{***}
	(8.63)	(9.20)	(9.31)
Observations	71	70	69

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.Fra	(2) Exc.ret.t+11.Fra	(3) Exc.ret.t+12.Fra
(r*-r) France	0.582^{**}	0.760^{***}	0.871^{***}
	(2.11)	(2.93)	(3.76)
Rel.debt.innov.Fra	0.0000455	0.0000157	-0.00000488
	(0.81)	(0.33)	(-0.12)
Debt.Fra	-0.000397^{***}	-0.000396^{***}	-0.000396^{***}
	(-8.27)	(-7.92)	(-8.35)
Debt.US	0.0000282^{***}	0.0000283^{***}	0.0000279^{***}
	(4.77)	(4.77)	(5.07)
Constant	0.463^{***}	0.465^{***}	0.472^{***}
	(9.53)	(9.53)	(9.99)
Observations	68	67	66

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Eq. 9 and eq. 10 mark another difference with the Engel paper. Engel finds that the sum of future expected excess returns (minus the mean) is negatively correlated with real interest rates difference at monthly level between 1979 and 2009. This paper finds otherwise since in the full 1979-2020 sample at quarterly level there is no trace of the new UIP puzzle, i.e. the reversal of UIP puzzle. This result is confirmed by the two first columns of Figure 7, where there are positive coefficients in eq. 10 for France.
The new UIP puzzle is found in the subsample 2000-2020, as certified by eq. 9a and 10a. By using debt in the estimation process, but without including it as regressor, the new UIP puzzle exists in the subsample.
A further difference emerges when the debt variables are included as regressors, since real interest rate differences become positively correlated again. This complicates the interpretation and remains as an additional puzzle.

There are some comments on the results from a government debt standpoint.
In this framework, the debt variable used inside the VECM is $debt_t = \Delta debt_{Home,t} - \Delta debt_{Foreign,t}$ From now on, let's call it *delta* to differentiate it from total debt . This is a relative debt innovation at time t. For the purpose of comparison, a positive shock to this variable is having an effect that is similar to a negative shock to the difference in convenience yields. For example, in the Valchev (2020) framework, a positive shock to delta is a negative shock to $\Psi_h - \Psi_f$. I am not interested in the comparable magnitude of the shock, but on the general intuition of it.
One key dimension of analysis is the comparison between the effect of delta and the effect of total US and foreign debt. Indeed it is interesting to see whether all the signs are coherent with a convenience yield story.
The main results are stated here.
First, in eq. 7a delta's coefficients are negative. This means that real foreign excess currency returns are positively correlated with convenience yields.
Second, when the regression includes all forms of debt, in eq. 7a US debt has (mostly) a positive coefficient, while foreign debt has a negative coefficient. These signs are not consistent with government debt being a unique function of convenience yields.
Third, in eq. 8a delta's coefficients are positive, US debt's coefficients are negative and Foreign debt's ones are positive.
Fourth, in eq. 9a delta's coefficients are positive, US debt's coefficients are positive and Foreign debt's ones are negative. These three coefficients are consistent among themselves.
By using 9a, all three groups of coefficients are consistent between estimation, but they are not consistent with a convenience yield story. Indeed, increase in Home debt implies a decrease in relative convenience yields and this makes the foreign excess currency return to increase, contrary to theory (the reasoning is inverse for foreign debt increases).
Fifth, in eq. 10a delta's coefficients are negative, US debt's coefficients are positive and Foreign debt's ones are negative.
Sixth, in eq. 12a delta's coefficients are positive, US debt's coefficients are pos-

itive and Foreign debt's ones are negative.
In the last two points it is clear that US debt and foreign debt are not in line with a convenience yield story.

1.6 Conclusion

This paper studies exchange rates and government debt. This is motivated by growing evidence that liquidity measures and asset demand shocks are important for solving exchange rates puzzles.

In this paper, I compare a Engel (2016) framework with extended data with one augmented by government debt variables for a shorter period of time due to data availability. After selecting the best debt definition for the VECM, I proceed to estimate Fama regressions in real variables, an equation to directly links real exchange rate levels and differences in real interest rates and equations to verify the existence of the new UIP puzzle. This is done by regressing far-ahead ex-ante and ex-post excess currency returns against real interest rates differences.

Results confirm only partially Engel (2016) results, since the new UIP puzzle is not found in the sample without debt.

Once debt variables are introduced, there are some interesting results and here we outline some of them. First, the debt variables are significant for all the equations considered apart from the Fama regressions. Second, introducing debt variables changes sign of coefficients for five out of eight sets of equations. Third, the magnitude of the coefficients for debt is economically important. Consider a 1 trillion increase in debt variables. For the real Fama regressions Foreign debt has single digit percentage effects, while for the other regressions it has between single and double digit percentage effects. Fourth, the sign of coefficients for total government debt are not in line with government debt only as a function of past convenience yields, since that would require opposite signs. Fifth, the central puzzle of Engel (2016) is resolved for 3 out of 6 country pairs since high interest rates countries are riskier both from a level of exchange rates standpoint and a rate of exchange rates standpoint.

All together, these findings place government debt in a new light for the study of currency excess returns.

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Appendix C. Classic and new UIP puzzle without debt variables.

This section estimates Eq. 7, 8, 9, 10, 12 in a sample of quarterly data between 1979 and 2020.
The main findings are anticipated here.
First, real Fama regression coefficients are significant and slightly smaller than Engel's, apart from Italy and Canada.
Second, the level of real exchange rate is correlated with real interest rate differences (apart from France and less for UK), but coefficients are two order of magnitude littler than Engel's.
Third, the sum of expected excess currency returns is positively correlated with differences in real rates [12], but not significant. This is starkly different from Engel's negative and significant coefficients.
Fourth, differences in real rates covary positively with far-ahead ex-ante excess currency returns, confirming the third result and the difference with Engel's. Negative coefficients are found only for 2005-2020 and for some countries.
Fifth, differences in real rates covary positively with far-ahead ex-post excess currency returns, differently from Engel's.

Modifying slightly Fama (1984), uncovered interest parity implies that $\beta_s = 0$ and $\zeta_s = 0$. Previous studies find that $\beta_s > 0$ that is the UIP puzzle. Equations use Newey West standard errors.

[12] Apart from Japan.

Equation 7:

$$q_{t+1} - q_t + \hat{r}_t^* - \hat{r}_t = \zeta_q + \beta_q(\hat{r}_t^* - \hat{r}_t) + u_{q,t+1}$$

It is a Fama regression in real terms, built using estimates coming from the VECM. Coefficients are slightly smaller here for 4 country pairs, apart from Italy and Canada.

Figure 12: Equation 7. Fama regression in real terms.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.922^{***} (17.35)					
(r*-r) Canada		1.023^{***} (10.64)				
(r*-r) Germany			1.047^{***} (15.14)			
(r*-r) France				0.967^{***} (13.45)		
(r*-r) UK					0.966^{***} (9.54)	
(r*-r) Japan						0.888^{***} (10.21)
Constant	0.00178 (0.26)	-0.00326 (-0.49)	0.000599 (0.09)	-0.00264 (-0.36)	-0.00514 (-0.64)	-0.00398 (-0.34)
Observations	160	162	162	162	159	161

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Equation 8:

$$q_t = \zeta_Q + \beta_Q(\hat{r}^*_t - \hat{r}_t) + u_{Q,t+1}$$

This equation states how real exchange rate covaries with differences in real interest rates.
Coefficients are remarkably little respect to Engel (2016): the difference is two orders of magnitude. Significance is absent for France and at 95% for UK

Figure 13: Equation 8. Levels of real exchange rates and differences in real interest rates.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	0.423^{+} (1.87)					
(r*-r) Canada		1.428^{***} (2.62)				
(r*-r) Germany			1.565^{***} (3.95)			
(r*-r) France				-0.241 (-0.79)		
(r*-r) UK					0.691^{**} (2.01)	
(r*-r) Japan						1.358^{***} (2.70)
Constant	0.234^{***} (5.50)	-0.184^{***} (-3.79)	0.243^{***} (6.26)	0.219^{***} (5.05)	0.421^{***} (9.44)	-4.420^{***} (-62.62)
Observations	161	163	163	163	160	162

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Equation 9:

$$\hat{E}_t \sum_{j=0}^{\infty} (\rho_{t+j+1} - \bar{\rho}) = \zeta_\rho + \beta_\rho(\hat{r}_t^* - \hat{r}_t) + u_{\rho,t}$$

This equation get the LHS by Eq 2 and defines the new UIP puzzle: do higher real interest rates countries see higher or lower cumulative anticipated risk premiums ?
The temporary component of nominal exchange rate is derived by using a Hodrick-Prescott filter. Coefficients are very different from Engel (2016): positive instead of strongly negative (apart from Japan) and in general not significant.

Figure 14: Equation 9. New UIP puzzle evidence.

	(1) Sum.exp.exc.ret.Ita	(2) Sum.exp.exc.ret.Can	(3) Sum.exp.exc.ret.Fra	(4) Sum.exp.exc.ret.Ger	(5) Sum.exp.exc.ret.UK	(6) Sum.exp.exc.ret.Jap
(r*-r) Italy	0.0788 (0.68)					
(r*-r) Canada		0.374 (0.90)				
(r*-r) France			0.192 (0.72)			
(r*-r) Germany				0.204^{**} (2.16)		
(r*-r) UK					0.347^{+} (1.77)	
(r*-r) Japan						-0.0874 (-0.46)
Constant	0.149^{***} (6.87)	0.150^{***} (5.74)	0.173^{***} (5.21)	-0.0485^{***} (-4.46)	0.296^{***} (11.33)	0.102^{***} (3.62)
Observations	161	163	163	163	160	162

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Equation 10:

$$\hat{E}_t(\rho_{t+j}) = \zeta_j + \beta_j(\hat{r}^*_t - \hat{r}_t) + u^j_t$$

This equation is meant to capture specific betas at different expectation' horizons, to see if and where the reversal of UIP takes place.
I implemented regressions:

$$\hat{E}_t(\rho_{t+j}) = \zeta_{10b} + \beta_{10b}(\hat{r}^*_t - \hat{r}_t) + u^j_t \tag{10b}$$

In the above equation, I computed the LHS by using an in-sample dynamic forecast. This forecast has been repeated for 3 time spans: post 1985 (columns 1 and 2), post 1995 (columns 3 and 4) and post 2005 (columns 5 and 6), in order to have different subsamples of data considered. This equation give betas that are a weighted average of the set of betas shown by Engel.
For most country pairs, the only negative value I find comes on post 2005 data, while for the whole sample (columns 1 and 2) a positive coefficient means that in quarterly data there is no reversal of UIP puzzle.

Figure 15: Equation 10. Italy and Canada.

	(1) Exp.exc.ret.post1985.Ita	(2) Exp.exc.ret.post1985.Ita	(3) Exp.exc.ret.post1995.Ita	(4) Exp.exc.ret.post1995.Ita	(5) Exp.exc.ret.post2005.Ita	(6) Exp.exc.ret.post2005.Ita
(r*-r) Italy	0.387**		0.352		-0.356**	
	(2.34)		(1.49)		(-2.15)	
(i*-i) Italy		0.434**		0.469		-0.603**
		(2.32)		(1.55)		(-2.21)
Constant	-0.177***	-0.179***	0.0631**	0.0633**	-0.0167	-0.0219
	(-6.96)	(-6.97)	(2.36)	(2.38)	(-0.92)	(-1.18)
Observations	143	143	104	104	64	64

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post1985.Can	(2) Exp.exc.ret.post1985.Can	(3) Exp.exc.ret.post1995.Can	(4) Exp.exc.ret.post1995.Can	(5) Exp.exc.ret.post2005.Can	(6) Exp.exc.ret.post2005.Can
(r*-r) Canada	0.853***		-0.137		-0.554	
	(2.65)		(-0.19)		(-0.98)	
(i*-i) Canada		0.903***		-0.166		-1.258
		(2.72)		(-0.18)		(-1.49)
Constant	-0.120***	-0.121***	-0.175***	-0.175***	-0.0914***	-0.0898***
	(-4.13)	(-4.14)	(-5.77)	(-5.80)	(-4.58)	(-4.52)
Observations	143	143	103	103	63	63

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 16: Equation 10. France and Germany.

	(1) Exp.exc.ret.post1985.Fra	(2) Exp.exc.ret.post1985.Fra	(3) Exp.exc.ret.post1995.Fra	(4) Exp.exc.ret.post1995.Fra	(5) Exp.exc.ret.post2005.Fra	(6) Exp.exc.ret.post2005.Fra
(r*-r) France	1.326***		0.125		-0.124	
	(4.93)		(0.25)		(-1.04)	
(i*-i) France		1.592***		0.189		-0.203
		(4.80)		(0.23)		(-0.97)
Constant	-0.678***	-0.681***	-0.0650+	-0.0637	-0.0480***	-0.0496***
	(-20.06)	(-20.62)	(-1.77)	(-1.58)	(-3.27)	(-3.19)
Observations	143	143	104	104	64	64

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

	(1) Exp.exc.ret.post1985.Ger	(2) Exp.exc.ret.post1985.Ger	(3) Exp.exc.ret.post1995.Ger	(4) Exp.exc.ret.post1995.Ger	(5) Exp.exc.ret.post2005.Ger	(6) Exp.exc.ret.post2005.Ger
(r*-r) Germany	0.296		0.252		-0.643+	
	(1.39)		(0.67)		(-1.87)	
(i*-i) Germany		0.403		0.434		-1.022+
		(1.53)		(0.73)		(-1.91)
Constant	-0.348***	-0.347***	0.0931***	0.0975***	0.0717***	0.0637**
	(-14.28)	(-14.31)	(3.11)	(3.07)	(2.77)	(2.56)
Observations	143	143	104	104	64	64

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

Figure 17: Equation 10. Japan and United Kingdom.

	(1) Exp.exc.ret.post1985.Jap	(2) Exp.exc.ret.post1985.Jap	(3) Exp.exc.ret.post1995.Jap	(4) Exp.exc.ret.post1995.Jap	(5) Exp.exc.ret.post2005.Jap	(6) Exp.exc.ret.post2005.Jap
(r*-r) Japan	0.585^{***}		0.794^{***}		0.0805	
	(3.12)		(3.18)		(0.24)	
(i*-i) Japan		1.312^{***}		1.717^{***}		0.263
		(3.34)		(3.49)		(0.39)
Constant	-0.354^{***}	-0.305^{***}	0.311^{***}	0.382^{***}	0.0821	0.0907
	(-9.45)	(-6.61)	(6.56)	(6.39)	(1.53)	(1.35)
Observations	143	143	103	103	63	63

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post1985.UK	(2) Exp.exc.ret.post1985.UK	(3) Exp.exc.ret.post1995.UK	(4) Exp.exc.ret.post1995.UK	(5) Exp.exc.ret.post2005.UK	(6) Exp.exc.ret.post2005.UK
(r*-r) UK	0.213		-0.437^{+}		-0.534^{**}	
	(1.45)		(-1.86)		(-2.07)	
(i*-i) UK		0.327^{+}		-0.757^{+}		-1.262^{**}
		(1.74)		(-1.67)		(-2.15)
Constant	-0.0362^{+}	-0.0424^{+}	0.0162	0.0223	0.0196	0.0239
	(-1.67)	(-1.76)	(0.74)	(0.94)	(0.80)	(1.03)
Observations	143	143	103	103	63	63

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Equation 12:

$$\rho_{t+j} = \zeta_j + \beta_j(\hat{r}_t^* - \hat{r}_t) + u_t^j$$

This regression uses ex-post excess returns on foreign deposit. The regression is performed from 1 quarter to 12 quarters (3 years). Coefficients are consistently positive and significant for all countries at all time, hence confirming that the new UIP puzzle does not result in quarterly data in this form.

Figure 18: Equation 12. Canada.

	(1) Exc.ret.(t+1) Can	(2) Exc.ret.t+2.Can	(3) Exc.ret.t+3.Can	(4) Exc.ret.t+4.Can	(5) Exc.ret.t+5.Can	(6) Exc.ret.t+6.Can
(r*-r) Canada	0.975***	0.957***	0.997***	0.986***	1.028***	1.051***
	(20.56)	(11.05)	(9.27)	(7.21)	(6.21)	(5.49)
Constant	-0.000262	-0.000816	-0.00250	-0.00298	-0.00456	-0.00575
	(-0.08)	(-0.14)	(-0.31)	(-0.29)	(-0.37)	(-0.41)
Observations	162	161	160	159	158	157

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Can	(2) Exc.ret.t+8.Can	(3) Exc.ret.t+9.Can	(4) Exc.ret.t+10.Can	(5) Exc.ret.t+11.Can	(6) Exc.ret.t+12.Can
(r*-r) Canada	0.975***	0.954***	0.880***	0.828***	0.779***	0.721**
	(4.59)	(4.10)	(3.56)	(3.27)	(2.93)	(2.57)
Constant	-0.00456	-0.00472	-0.00366	-0.00271	-0.00160	-0.000431
	(-0.29)	(-0.28)	(-0.20)	(-0.14)	(-0.08)	(-0.02)
Observations	156	155	154	153	152	151

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 19: Equation 12. France.

	(1) Exc.ret.(t+1) Fran	(2) Exc.ret.t+2.Fra	(3) Exc.ret.t+3.Fra	(4) Exc.ret.t+4.Fra	(5) Exc.ret.t+5.Fra	(6) Exc.ret.t+6.Fra
(r*-r) France	0.915***	0.899***	0.870***	0.858***	0.883***	0.884***
	(17.21)	(11.69)	(8.40)	(6.43)	(5.46)	(4.43)
Constant	0.000382	-0.00129	-0.00256	-0.00343	-0.00478	-0.00484
	(0.07)	(-0.13)	(-0.18)	(-0.19)	(-0.22)	(-0.20)
Observations	162	161	160	159	158	157

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Fra	(2) Exc.ret.t+8.Fra	(3) Exc.ret.t+9.Fra	(4) Exc.ret.t+10.Fra	(5) Exc.ret.t+11.Fra	(6) Exc.ret.t+12.Fra
(r*-r) France	0.881***	0.910***	0.929***	1.018***	1.048***	1.096***
	(3.92)	(3.67)	(3.52)	(3.70)	(3.85)	(4.02)
Constant	-0.00481	-0.00556	-0.00578	-0.00711	-0.00585	-0.00583
	(-0.18)	(-0.19)	(-0.18)	(-0.21)	(-0.17)	(-0.16)
Observations	156	155	154	153	152	151

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 20: Equation 12. Italy.

	(1) Exc.ret.(t+1)Ita	(2) Exc.ret.t+2.Ita	(3) Exc.ret.t+3.Ita	(4) Exc.ret.t+4.Ita	(5) Exc.ret.t+5.Ita	(6) Exc.ret.t+6.Ita
(r*-r) Italy	0.893***	0.837***	0.784***	0.753***	0.729***	0.689***
	(22.72)	(15.12)	(9.68)	(7.98)	(6.88)	(6.00)
Constant	0.00493	0.00616	0.00762	0.00808	0.00792	0.00933
	(0.90)	(0.67)	(0.60)	(0.51)	(0.41)	(0.43)
Observations	160	159	158	157	156	155

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Ita	(2) Exc.ret.t+8.Ita	(3) Exc.ret.t+9.Ita	(4) Exc.ret.t+10.Ita	(5) Exc.ret.t+11.Ita	(6) Exc.ret.t+12.Ita
(r*-r) Italy	0.645***	0.627***	0.598***	0.599***	0.592***	0.589***
	(5.03)	(4.48)	(4.21)	(4.00)	(3.71)	(3.48)
Constant	0.0116	0.0120	0.0139	0.0131	0.0134	0.0139
	(0.48)	(0.46)	(0.49)	(0.44)	(0.44)	(0.43)
Observations	154	153	152	151	150	149

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 21: Equation 12. Germany.

	(1) Exc.ret.(t+1) Germ	(2) Exc.ret.t+2.Ger	(3) Exc.ret.t+3.Ger	(4) Exc.ret.t+4.Ger	(5) Exc.ret.t+5.Ger	(6) Exc.ret.t+6.Ger
(r*-r) Germany	0.919***	0.952***	0.974***	1.005***	1.020***	1.003***
	(15.65)	(9.91)	(7.72)	(6.34)	(5.23)	(4.67)
Constant	-0.00224	-0.000849	0.000324	0.00260	0.00459	0.00615
	(-0.41)	(-0.09)	(0.03)	(0.16)	(0.25)	(0.30)
Observations	162	161	160	159	158	157

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Ger	(2) Exc.ret.t+8.Ger	(3) Exc.ret.t+9.Ger	(4) Exc.ret.t+10.Ger	(5) Exc.ret.t+11.Ger	(6) Exc.ret.t+12.Ger
(r*-r) Germany	1.005***	1.003***	1.000***	1.024***	0.990***	0.967***
	(4.08)	(3.78)	(3.38)	(3.23)	(2.98)	(2.73)
Constant	0.00801	0.00981	0.0117	0.0151	0.0174	0.0195
	(0.36)	(0.41)	(0.47)	(0.58)	(0.63)	(0.68)
Observations	156	155	154	153	152	151

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 22: Equation 12. Japan.

	(1) Exc.ret.(t+1) Jap	(2) Exc.ret.t+2.Jap	(3) Exc.ret.t+3.Jap	(4) Exc.ret.t+4.Jap	(5) Exc.ret.t+5.Jap	(6) Exc.ret.t+6.Jap
(r*-r) Japan	0.604^{***}	0.725^{***}	0.768^{***}	0.746^{***}	0.731^{***}	0.719^{***}
	(5.55)	(6.60)	(6.21)	(4.61)	(4.36)	(4.13)
Constant	-0.0276^{***}	-0.0129	-0.00525	-0.00280	0.000167	0.00450
	(-2.82)	(-0.99)	(-0.32)	(-0.14)	(0.01)	(0.16)
Observations	161	160	159	158	157	156

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Jap	(2) Exc.ret.t+8.Jap	(3) Exc.ret.t+9.Jap	(4) Exc.ret.t+10.Jap	(5) Exc.ret.t+11.Jap	(6) Exc.ret.t+12.Jap
(r*-r) Japan	0.708^{***}	0.642^{***}	0.651^{***}	0.660^{***}	0.576^{**}	0.507^{+}
	(3.81)	(3.36)	(3.17)	(3.02)	(2.48)	(1.96)
Constant	0.00844	0.00778	0.0137	0.0204	0.0196	0.0191
	(0.27)	(0.22)	(0.36)	(0.50)	(0.46)	(0.42)
Observations	155	154	153	152	151	150

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 23: Equation 12. UK.

	(1) Exc.ret.(t+1) UK	(2) Exc.ret.t+2.UK	(3) Exc.ret.t+3.UK	(4) Exc.ret.t+4.UK	(5) Exc.ret.t+5.UK	(6) Exc.ret.t+6.UK
(r*-r) UK	0.762***	0.812***	0.824***	0.831***	0.899***	0.916***
	(8.39)	(7.84)	(6.66)	(6.46)	(6.06)	(5.36)
Constant	0.00692	0.000764	-0.00275	-0.00579	-0.0116	-0.0147
	(0.96)	(0.07)	(-0.21)	(-0.36)	(-0.61)	(-0.68)
Observations	159	158	157	156	155	154

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.UK	(2) Exc.ret.t+8.UK	(3) Exc.ret.t+9.UK	(4) Exc.ret.t+10.UK	(5) Exc.ret.t+11.UK	(6) Exc.ret.t+12.UK
(r*-r) UK	0.912***	0.919***	0.953***	0.981***	0.943***	0.927***
	(4.82)	(4.62)	(4.26)	(4.18)	(3.80)	(3.53)
Constant	-0.0168	-0.0194	-0.0228	-0.0247	-0.0237	-0.0240
	(-0.70)	(-0.74)	(-0.80)	(-0.81)	(-0.72)	(-0.67)
Observations	153	152	151	150	149	148

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix D. Classic and new UIP puzzle with debt variables.

This section estimates both the equations $7, 8, 9, 10, 12$ and equations $7a, 8a, 9a, 10a, 12a$ in which I added debt variables as covariates in a sample of quarterly data between 2000 and 2020. Generally I first estimate equations adding only the relative debt innovations, while in a second round I add to the estimation the total amount of Home government debt (US debt) and Foreign government debt.
The main findings are anticipated here.

First, the real version of Fama regression coefficients are positive, slightly smaller and significant. Foreign debt coefficient is significant and negative only for France and Italy, with a 1 trillion increase effect to -5 % for both.
Second, the level of real exchange rate is positively correlated (but not significant) with real real interest rate differences only until all debt variables are included. Indeed this brings a negative correlation between the level of real exchange rate and real interest rate. All debt variables are significant and Foreign debt has big effects.
Third, the sum of future expected excess currency returns is now negatively correlated with differences in real rates. US debt and Foreign debt have (mostly) significant coefficients, respectively positive and negative. A 1 trillion increase in Foreign debt has an effect between -28 % and -5 %.
Fourth, without debt variables differences in real rates covary (mostly) negatively with far-ahead ex-ante excess currency returns, while adding debt variables creates a positive correlation.
US debt coefficients are all positive and significant, Foreign debt coefficients are all negative and significant.
Fifth, differences in real rates still covary positively with far-ahead ex-post excess currency returns, but they often lose significance. US debt coefficients are significant and positive, Foreign debt coefficients are significant and negative.

In this framework, the debt variable used inside the VECM is $debt_t = \Delta debt_{Home,t} - \Delta debt_{Foreign,t}$ From now on, let's call it *delta* to differentiate it from total debt . This is a relative debt innovation at time t. For the purpose of comparison, a positive shock to this variable is having an effect that is similar to a negative shock to the difference in convenience yields. For example, in the Valchev (2020) framework, a positive shock to delta is a negative shock to $\Psi_h - \Psi_f$. I am not interested in the comparable magnitude of the shock, but on the general intuition of it.

One key dimension of analysis is the comparison between the effect of delta and the effect of total US and foreign debt. Indeed it is interesting to see whether all the signs are coherent with a convenience yield story.
The main results are stated here.

First, in eq. 7a delta's coefficients are negative. This means that real foreign excess currency returns are positively correlated with convenience yields.
Second, when the regression includes all forms of debt, in eq. 7a US debt has (mostly) a positive coefficient, while foreign debt has a negative coefficient. These signs are not consistent with government debt being a unique function of convenience yields.
Third, in eq. 8a delta's coefficients are positive, US debt's coefficients are negative and Foreign debt's ones are positive.
Fourth, in eq. 9a delta's coefficients are positive, US debt's coefficients are positive and Foreign debt's ones are negative. These three coefficients are consistent among themselves.
By using 9a, all three groups of coefficients are consistent between estimation, but they are not consistent with a convenience yield story. Indeed, increase in Home debt implies a decrease in relative convenience yields and this makes the foreign excess currency return to increase, contrary to theory (the reasoning is inverse for foreign debt increases).

Fifth, in eq. 10a delta's coefficients are negative, US debt's coefficients are positive and Foreign debt's ones are negative.
Sixth, in eq. 12a delta's coefficients are positive, US debt's coefficients are positive and Foreign debt's ones are negative.
In the last two points it is clear that US debt and foreign debt are not in line with a convenience yield story.

$$q_{t+1} - q_t + \hat{r}_t^* - \hat{r}_t = \zeta_q + \beta_q(\hat{r}_t^* - \hat{r}_t) + \phi_q debt_t + u_{q,t+1} \tag{7a}$$

For the real version of the Fama regression, coefficients are slightly smaller and positive. Adding debt variables is useful only for France and Italy, with negative coefficients and somewhat significant.
On the first round of estimations, relative debt innovations are not significant, while 1 trillion changes are between - 5 and 0 % effects.
On the second round of estimations, all debt variables are not significant except for Foreign debt for Italy and France. 1 trillion changes have effects between -3 and and 2.2% for relative debt innovations, -0.3 and 1.3 % for US debt and between -5 and -0.5 % for Foreign debt.

Figure 24: Equation 7a. Real Fama regressions with debt.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.807^{***} (3.85)					
(r*-r) Canada		0.634^{***} (5.17)				
(r*-r) Germany			0.778^{***} (3.84)			
(r*-r) France				0.791^{***} (3.85)		
(r*-r) UK					0.546^{+} (1.96)	
(r*-r) Japan						0.656^{***} (4.44)
Constant	0.00254 (0.26)	0.00345 (0.36)	0.00184 (0.19)	0.00192 (0.20)	0.00455 (0.51)	-0.0251^{+} (-1.98)
Observations	76	87	76	76	76	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 25: Equation 7a. Real Fama regressions with debt.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.849^{***} (3.99)					
Rel.debt.innov.Ita	-0.0000367 (-1.42)					
(r*-r) Canada		0.636^{***} (5.10)				
Rel.debt.innov.Can		-0.00000336 (-0.12)				
(r*-r) Germany			0.822^{***} (4.07)			
Rel.debt.innov.Ger			-0.0000459 (-1.64)			
(r*-r) France				0.822^{***} (3.95)		
Rel.debt.innov.Fra				-0.0000343 (-1.33)		
(r*-r) UK					0.545^{+} (1.96)	
Rel.debt.innov.UK					-0.0000277 (-1.43)	
(r*-r) Japan						0.699^{***} (4.46)
Rel.debt.innov.Jap						-0.0000244 (-1.54)
Constant	0.0104 (0.82)	0.00406 (0.33)	0.0117 (0.92)	0.00899 (0.71)	0.0101 (1.03)	-0.0194 (-1.62)
Observations	76	87	76	76	76	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 26: Equation 7a. Real Fama regressions with debt.

	(1) Real.Exc.ret.t+1.Ita	(2) Real.Exc.ret.t+1.Can	(3) Real.Exc.ret.t+1.Ger	(4) Real.Exc.ret.t+1.Fra	(5) Real.Exc.ret.t+1.UK	(6) Real.Exc.ret.t+1.Jap
(r*-r) Italy	0.667***					
	(3.41)					
Rel.debt.innov.Ita	-0.00000818					
	(-0.34)					
Debt.US	-0.000000614	-0.00000186	-0.00000182	0.00000131	-0.00000220	0.00000299
	(-0.27)	(-0.58)	(-0.89)	(0.42)	(-0.52)	(0.81)
Debt.Ita	-0.0000520**					
	(-2.37)					
(r*-r) Canada		0.635***				
		(5.48)				
Rel.debt.innov.Can		0.0000221				
		(0.66)				
Debt.Can		-0.0000234				
		(-0.46)				
(r*-r) Germany			0.681***			
			(3.18)			
Rel.debt.innov.Ger			-0.0000170			
			(-0.60)			
Debt.Ger			-0.0000309+			
			(-1.85)			
(r*-r) France				0.657***		
				(3.26)		
Rel.debt.innov.Fra				-0.00000587		
				(-0.24)		
Debt.Fra				-0.0000527**		
				(-2.20)		
(r*-r) UK					0.230	
					(0.97)	
Rel.debt.innov.UK					-0.00000136	
					(-0.06)	
Debt.UK					-0.0000325	
					(-1.05)	
(r*-r) Japan						0.702***
						(4.63)
Rel.debt.innov.Jap						-0.0000287
						(-1.56)
Debt.Jap						-0.00000538
						(-0.51)
Constant	0.134***	0.0441	0.0976***	0.0928***	0.0928***	-0.00988
	(3.47)	(1.46)	(3.15)	(3.56)	(4.99)	(-0.18)
Observations	76	87	76	76	76	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$q_t = \zeta_Q + \beta_Q(\hat{r}_t^* - \hat{r}_t) + \phi_Q debt_t + u_{Q,t+1} \tag{8a}$$

Coefficients are halved with respect to the estimation without debt. They are positive and they lose significance (except for UK).
On the first round of estimation, β_Qs remain positive and relative debt innovations are not significant except for UK. A 1 trillion change has effects between -24 % (UK) and 29 % (Canada).
On the second round of estimations, β_Qs become negative and coefficients for all debt variables are significant. Relative debt innovations have positive coefficients, US debt has negative coefficients (except Uk and Japan) and Foreign debt has big and positive coefficients. A 1 trillion change in Foreign debt has effects between 22 % and 263 % .

Figure 27: Equation 8.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	0.715					
	(0.88)					
(r*-r) Canada		0.728				
		(1.55)				
(r*-r) Germany			0.745			
			(0.96)			
(r*-r) France				0.790		
				(0.95)		
(r*-r) UK					2.023***	
					(3.85)	
(r*-r) Japan						0.573
						(1.11)
Constant	0.254***	-0.160**	0.272***	0.275***	0.385***	-4.346***
	(4.58)	(-2.04)	(5.12)	(4.92)	(7.53)	(-55.02)
Observations	76	87	76	76	76	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 28: Equation 8a.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	0.644					
	(0.69)					
Rel.debt.innov.Ita	0.0000617					
	(0.46)					
(r*-r) Canada		0.494				
		(1.09)				
Rel.debt.innov.Can		0.000294				
		(1.47)				
(r*-r) Germany			0.708			
			(0.82)			
Rel.debt.innov.Ger			0.0000388			
			(0.30)			
(r*-r) France				0.738		
				(0.81)		
Rel.debt.innov.Fra				0.0000569		
				(0.43)		
(r*-r) UK					2.010^{***}	
					(4.09)	
Rel.debt.innov.UK					-0.000242^{**}	
					(-2.32)	
(r*-r) Japan						0.727
						(1.35)
Rel.debt.innov.Jap						-0.0000893
						(-1.66)
Constant	0.241^{***}	-0.213^{**}	0.263^{***}	0.263^{***}	0.433^{***}	-4.325^{***}
	(3.16)	(-2.37)	(3.54)	(3.52)	(6.75)	(-51.43)
Observations	76	87	76	76	76	85

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 29: Equation 8a.

	(1) Real ER Italy	(2) Real ER Canada	(3) Real ER Germany	(4) Real ER France	(5) Real ER UK	(6) Real ER Japan
(r*-r) Italy	-0.222					
	(-1.15)					
Rel.debt.innov.Ita	0.0000923**					
	(2.30)					
Debt.US	-0.0000546***	-0.000135***	-0.0000437***	-0.000101***	-0.000106***	-0.0000884***
	(-13.91)	(-11.23)	(-11.97)	(-15.17)	(-6.71)	(-17.58)
Debt.Ita	0.000734***					
	(16.82)					
(r*-r) Canada		-0.532**				
		(-2.15)				
Rel.debt.innov.Can		0.000244***				
		(5.22)				
Debt.Can		0.00263***				
		(11.65)				
(r*-r) Germany			-0.849***			
			(-3.92)			
Rel.debt.innov.Ger			0.000105***			
			(2.88)			
Debt.Ger			0.000542***			
			(12.96)			
(r*-r) France				-0.682***		
				(-3.52)		
Rel.debt.innov.Fra				0.000116***		
				(3.14)		
Debt.Fra				0.000882***		
				(15.07)		
(r*-r) UK					0.135	
					(0.33)	
Rel.debt.innov.UK					0.00000984	
					(0.15)	
Debt.UK					0.000603***	
					(5.62)	
(r*-r) Japan						-0.197
						(-0.83)
Rel.debt.innov.Jap						0.0000413
						(1.57)
Debt.Jap						0.000218***
						(11.95)
Constant	-0.832***	-1.229***	-0.454***	-0.292***	0.746***	-5.140***
	(-11.81)	(-9.99)	(-6.23)	(-5.13)	(7.03)	(-40.05)
Observations	76	87	76	76	76	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$\hat{E}_t \sum_{j=0}^{\infty} (\rho_{t+j+1} - \bar{\rho}) = \zeta_\rho + \beta_\rho(\hat{r}_t^* - \hat{r}_t) + \phi_\rho debt_t + u_{\rho,t} \tag{9a}$$

Coefficients β_ρ are negative and somewhat significant (except for Canada, Japan). Adding debt variables makes β_ρs not significant, but still negative.
US debt's coefficients are positive, strongly significant for Canada, Japan and France, less for UK, no for Germany and Italy. Foreign debt's coefficients are all negative and significant. 1 trillion change in US debt has an effect between 0.4 and 2 % . 1 trillion change in Foreign debt has an effect between -28 and -5 % .

Figure 30: Equation 9a.

	(1) Sum.exp.exc.ret.Can	(2) Sum.exp.exc.ret.Can
(r*-r) Canada	0.0624	0.136
	(0.84)	(1.58)
Rel.debt.innov.Can		0.0000457
		(1.18)
Debt.US		0.0000146***
		(4.03)
Debt.Can		-0.000276***
		(-5.37)
Constant	-0.00646	0.0875***
	(-0.69)	(4.03)
Observations	87	87

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Sum.exp.exc.ret.Fra	(2) Sum.exp.exc.ret.Fra
(r*-r) France	-0.501***	-0.386+
	(-2.82)	(-1.74)
Rel.debt.innov.Fra		0.0000455
		(1.54)
Debt.US		0.0000154***
		(3.73)
Debt.Fra		-0.000148***
		(-3.88)
Constant	-0.0258**	0.0752
	(-2.18)	(1.57)
Observations	76	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 31: Equation 9a.

	(1) Sum.exp.exc.ret.Ger	(2) Sum.exp.exc.ret.Ger
(r*-r) Germany	-0.462**	-0.394
	(-2.58)	(-1.64)
Rel.debt.innov.Ger		0.0000548+
		(1.99)
Debt.US		0.00000434+
		(1.68)
Debt.Ger		-0.0000833***
		(-3.19)
Constant	-0.0288**	0.0962+
	(-2.46)	(1.67)
Observations	76	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Sum.exp.exc.ret.Ita	(2) Sum.exp.exc.ret.Ita
(r*-r) Italy	-0.430**	-0.444+
	(-2.45)	(-1.92)
Rel.debt.innov.Ita		0.0000581**
		(2.01)
Debt.US		0.00000583+
		(1.98)
Debt.Ita		-0.0000934***
		(-2.82)
Constant	-0.0147	0.122+
	(-1.26)	(1.78)
Observations	76	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 32: Equation 9a.

	(1) Sum.exp.exc.ret.Jap	(2) Sum.exp.exc.ret.Jap
(r*-r) Japan	-0.286^{+}	-0.106
	(-1.74)	(-0.71)
Rel.debt.innov.Jap		0.0000314^{**}
		(2.51)
Debt.US		0.0000180^{***}
		(5.88)
Debt.Jap		-0.0000511^{***}
		(-7.54)
Constant	-0.0469^{**}	0.166^{***}
	(-2.48)	(3.37)
Observations	85	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Sum.exp.exc.ret.UK	(2) Sum.exp.exc.ret.UK
(r*-r) UK	-0.306^{***}	-0.252
	(-2.66)	(-1.64)
Rel.debt.innov.UK		0.0000514
		(1.22)
Debt.US		0.0000154^{**}
		(2.41)
Debt.UK		-0.000123^{***}
		(-2.76)
Constant	-0.00395	-0.00258
	(-0.34)	(-0.09)
Observations	76	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$\hat{E}_t(\rho_{t+j}) = \zeta_{10a} + \beta_{10a}(\hat{r}_t^* - \hat{r}_t) + \phi_j debt_t + u_t^j \tag{10a}$$

In the above equation, I computed the LHS by using an in-sample dynamic forecast. This forecast has been repeated for 3 time spans: post 2005 (columns 1 and 2), post 2010 (columns 3 and 4) and post 2015 (columns 5 and 6), in order to have different subsamples of data considered. This equation give betas that are a weighted average of the set of betas shown by Engel. Consider that here I use different time spans respect to the 3 variable VECM, hence comparison is more tricky.
Comparing equations 10 and 10a, β_{10a} go from mixed (both in sign and significance) to strongly positive and significant. US debt's coefficients are always positive and significant, while Foreign debt's coefficients are negative and significant. Only for Italy, Japan and UK the delta- variables have some significance (they are positive).
In terms of magnitude of coefficients, 1 trillion change has single digit percentage effects on the dependent variables for relative debt innovations and US debt, while has a double digit percentage effect for Foreign debt.

Figure 33: Equation 10a. Canada.

	(1) Exp.exc.ret.post2005.Can	(2) Exp.exc.ret.post2005.Can	(3) Exp.exc.ret.post2010.Can	(4) Exp.exc.ret.post2010.Can	(5) Exp.exc.ret.post2015.Can	(6) Exp.exc.ret.post2015.Can
(r*-r) Canada	0.0206		-0.207		0.186^{**}	
	(0.12)		(-1.01)		(2.08)	
(i*-i) Canada		-0.963		-4.686^{***}		-0.404
		(-0.70)		(-4.58)		(-0.58)
Constant	-0.0130	-0.00774	0.157^{***}	0.197^{***}	0.0333^{***}	0.0347^{***}
	(-0.41)	(-0.24)	(4.30)	(7.22)	(3.12)	(3.12)
Observations	63	64	43	44	23	24

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Can	(2) Exp.exc.ret.post2005.Can	(3) Exp.exc.ret.post2010.Can	(4) Exp.exc.ret.post2010.Can	(5) Exp.exc.ret.post2015.Can	(6) Exp.exc.ret.post2015.Can
(r*-r) Canada	0.313^{***}		0.303^{***}		0.308^{***}	
	(4.02)		(3.59)		(3.84)	
Rel.debt.innov.Can	-0.0000279	-0.0000310	-0.0000647^{***}	-0.0000484^{**}	-0.0000348^{+}	-0.0000111
	(-0.89)	(-1.26)	(-3.60)	(-2.71)	(-1.77)	(-0.49)
Debt.US	0.0000526^{***}	0.0000556^{***}	0.0000514^{***}	0.0000548^{***}	0.0000316^{***}	0.0000306^{***}
	(15.84)	(18.70)	(18.88)	(16.65)	(6.77)	(6.33)
Debt.Can	-0.000739^{***}	-0.000818^{***}	-0.000646^{***}	-0.000704^{***}	-0.000584^{***}	-0.000486^{***}
	(-11.73)	(-12.57)	(-9.06)	(-9.49)	(-6.20)	(-3.92)
(i*-i) Canada		1.211^{***}		1.117^{**}		0.683^{+}
		(4.40)		(2.53)		(1.87)
Constant	0.101^{**}	0.149^{***}	0.152^{+}	0.161^{**}	0.204^{**}	0.0926
	(2.17)	(3.21)	(1.98)	(2.49)	(2.82)	(0.76)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 34: Equation 10a. France.

	(1) Exp.exc.ret.post2005.Fra	(2) Exp.exc.ret.post2005.Fra	(3) Exp.exc.ret.post2010.Fra	(4) Exp.exc.ret.post2010.Fra	(5) Exp.exc.ret.post2015.Fra	(6) Exp.exc.ret.post2015.Fra
(r*-r) France	-0.591^{+}		-1.045***		0.313	
	(-1.87)		(-5.66)		(0.86)	
(i*-i) France		-0.860^{+}		-1.561***		0.602
		(-1.87)		(-3.48)		(1.53)
Constant	0.0509**	0.0492**	0.0850***	0.0766***	0.00238	0.0155
	(2.22)	(2.19)	(3.69)	(3.13)	(0.09)	(0.71)
Observations	63	65	43	45	23	25

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Fra	(2) Exp.exc.ret.post2005.Fra	(3) Exp.exc.ret.post2010.Fra	(4) Exp.exc.ret.post2010.Fra	(5) Exp.exc.ret.post2015.Fra	(6) Exp.exc.ret.post2015.Fra
(r*-r) France	0.888***		0.748***		0.726***	
	(5.13)		(5.35)		(4.69)	
Rel.debt.innov.Fra	-0.0000236	-0.0000183	-0.0000716***	-0.0000455***	-0.0000509***	-0.0000314**
	(-0.66)	(-0.74)	(-6.58)	(-3.10)	(-3.80)	(-2.13)
Debt.US	0.0000527***	0.0000561***	0.0000499***	0.0000489***	0.0000380***	0.0000342***
	(11.50)	(17.14)	(17.56)	(9.36)	(7.38)	(10.99)
Debt.Fra	-0.000381***	-0.000408***	-0.000434***	-0.000392***	-0.000402***	-0.000340***
	(-11.63)	(-13.91)	(-13.27)	(-12.30)	(-13.84)	(-10.09)
(i*-i) France		1.279***		0.826**		0.770***
		(8.53)		(2.48)		(4.96)
Constant	0.204***	0.226***	0.396***	0.303***	0.345***	0.257**
	(8.15)	(7.91)	(6.23)	(3.60)	(5.05)	(2.74)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 35: Equation 10a. Germany.

	(1) Exp.exc.ret.post2005.Ger	(2) Exp.exc.ret.post2005.Ger	(3) Exp.exc.ret.post2010.Ger	(4) Exp.exc.ret.post2010.Ger	(5) Exp.exc.ret.post2015.Ger	(6) Exp.exc.ret.post2015.Ger
(r*-r) Germany	-0.601^{+}		-1.061***		0.273	
	(-1.87)		(-5.67)		(0.78)	
(i*-i) Germany		-0.873^{+}		-1.607***		0.591
		(-1.84)		(-3.51)		(1.54)
Constant	0.0552**	0.0536**	0.0753***	0.0664***	0.00218	0.0167
	(2.36)	(2.36)	(3.23)	(2.70)	(0.09)	(0.80)
Observations	63	65	43	45	23	25

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Ger	(2) Exp.exc.ret.post2005.Ger	(3) Exp.exc.ret.post2010.Ger	(4) Exp.exc.ret.post2010.Ger	(5) Exp.exc.ret.post2015.Ger	(6) Exp.exc.ret.post2015.Ger
(r*-r) Germany	0.833***		1.034***		0.916***	
	(3.55)		(4.38)		(3.60)	
Rel.debt.innov.Ger	-0.0000131	-0.0000171	-0.0000665***	-0.0000362**	-0.0000141	-0.00000471
	(-0.34)	(-0.65)	(-3.57)	(-2.11)	(-0.81)	(-0.21)
Debt.US	0.0000275***	0.0000310***	0.0000256***	0.0000409***	-0.00000887	0.0000101**
	(8.29)	(10.89)	(5.86)	(8.03)	(-1.30)	(2.26)
Debt.Ger	-0.000216***	-0.000267***	-0.000238***	-0.000287***	-0.000421***	-0.000326***
	(-6.63)	(-9.40)	(-5.38)	(-9.26)	(-9.45)	(-7.44)
(i*-i) Germany		1.522***		2.707***		1.742***
		(5.15)		(6.37)		(9.48)
Constant	0.235***	0.324***	0.331**	0.232**	1.227***	0.674***
	(4.04)	(5.94)	(2.17)	(2.55)	(8.01)	(3.97)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 36: Equation 10a. Italy.

	(1) Exp.exc.ret.post2005.Ita	(2) Exp.exc.ret.post2005.Ita	(3) Exp.exc.ret.post2010.Ita	(4) Exp.exc.ret.post2010.Ita	(5) Exp.exc.ret.post2015.Ita	(6) Exp.exc.ret.post2015.Ita
(r*-r) Italy	-0.607^{+}		-1.055^{***}		0.372	
	(-1.93)		(-5.57)		(1.23)	
(i*-i) Italy		-0.883^{+}		-1.577^{***}		0.698^{+}
		(-1.91)		(-3.73)		(1.95)
Constant	0.0625^{***}	0.0606^{***}	0.0867^{***}	0.0780^{***}	-0.0114	0.00335
	(2.71)	(2.68)	(4.11)	(3.41)	(-0.50)	(0.17)
Observations	63	65	43	45	23	25

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Ita	(2) Exp.exc.ret.post2005.Ita	(3) Exp.exc.ret.post2010.Ita	(4) Exp.exc.ret.post2010.Ita	(5) Exp.exc.ret.post2015.Ita	(6) Exp.exc.ret.post2015.Ita
(r*-r) Italy	0.767^{***}		0.752^{***}		0.661^{***}	
	(4.36)		(4.59)		(3.62)	
Rel.debt.innov.Ita	-0.0000296	-0.0000178	-0.0000748^{***}	-0.0000432^{**}	-0.0000389^{**}	-0.0000197
	(-0.76)	(-0.68)	(-4.83)	(-2.71)	(-2.13)	(-1.08)
Debt.US	0.0000351^{***}	0.0000360^{***}	0.0000363^{***}	0.0000367^{***}	0.0000192^{***}	0.0000213^{***}
	(10.89)	(19.03)	(13.42)	(6.19)	(4.46)	(5.17)
Debt.Ita	-0.000350^{***}	-0.000357^{***}	-0.000380^{***}	-0.000339^{***}	-0.000351^{***}	-0.000288^{***}
	(-10.73)	(-15.34)	(-9.95)	(-9.31)	(-8.23)	(-6.01)
(i*-i) Italy		1.000^{***}		0.837^{+}		0.920^{***}
		(4.74)		(2.00)		(3.46)
Constant	0.497^{***}	0.505^{***}	0.559^{***}	0.435^{***}	0.583^{***}	0.385^{**}
	(9.69)	(11.27)	(5.82)	(3.84)	(7.01)	(2.44)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 37: Equation 10a. Japan.

	(1) Exp.exc.ret.post2005.Jap	(2) Exp.exc.ret.post2005.Jap	(3) Exp.exc.ret.post2010.Jap	(4) Exp.exc.ret.post2010.Jap	(5) Exp.exc.ret.post2015.Jap	(6) Exp.exc.ret.post2015.Jap
(r*-r) Japan	-0.248		-0.589***		0.462	
	(-1.03)		(-2.97)		(1.70)	
(i*-i) Japan		-0.396		-2.014**		1.868***
		(-0.78)		(-2.07)		(4.20)
Constant	-0.108**	-0.114**	0.123***	0.0915	-0.0896***	-0.0364
	(-2.63)	(-2.18)	(2.95)	(1.64)	(-3.35)	(-1.30)
Observations	63	64	43	44	23	24

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.Jap	(2) Exp.exc.ret.post2005.Jap	(3) Exp.exc.ret.post2010.Jap	(4) Exp.exc.ret.post2010.Jap	(5) Exp.exc.ret.post2015.Jap	(6) Exp.exc.ret.post2015.Jap
(r*-r) Japan	0.370***		0.401***		0.250**	
	(2.88)		(4.12)		(2.69)	
Rel.debt.innov.Jap	-0.0000128	-0.00000569	-0.0000195	-0.0000114	-0.0000154**	-0.00000438
	(-1.03)	(-0.53)	(-1.40)	(-1.45)	(-2.52)	(-0.72)
Debt.US	0.0000368***	0.0000362***	0.0000373***	0.0000486***	0.00000802	0.00000826**
	(11.83)	(12.47)	(9.43)	(13.06)	(1.67)	(2.74)
Debt.Jap	-0.000110***	-0.000112***	-0.000108***	-0.000101***	-0.000109***	-0.0000928***
	(-12.29)	(-12.73)	(-10.05)	(-19.09)	(-14.89)	(-9.79)
(i*-i) Japan		0.569**		1.888***		0.652***
		(2.44)		(6.93)		(4.90)
Constant	0.405***	0.439***	0.613***	0.383***	0.812***	0.664***
	(5.03)	(4.94)	(4.39)	(4.44)	(13.30)	(11.60)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 38: Equation 10a. UK.

	(1) Exp.exc.ret.post2005.UK	(2) Exp.exc.ret.post2005.UK	(3) Exp.exc.ret.post2010.UK	(4) Exp.exc.ret.post2010.UK	(5) Exp.exc.ret.post2015.UK	(6) Exp.exc.ret.post2015.UK
(r*-r) UK	-0.373^{+}		-0.448^{**}		-0.184	
	(-1.98)		(-2.38)		(-0.77)	
(i*-i) UK		-0.688^{+}		-1.375^{***}		-0.433
		(-1.91)		(-4.00)		(-0.74)
Constant	0.131^{***}	0.134^{***}	0.0177	0.0121	0.0488^{**}	0.0442^{+}
	(6.76)	(7.06)	(1.21)	(0.90)	(2.72)	(1.74)
Observations	63	64	43	44	23	24

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exp.exc.ret.post2005.UK	(2) Exp.exc.ret.post2005.UK	(3) Exp.exc.ret.post2010.UK	(4) Exp.exc.ret.post2010.UK	(5) Exp.exc.ret.post2015.UK	(6) Exp.exc.ret.post2015.UK
(r*-r) UK	0.236		0.196		0.379^{***}	
	(1.36)		(1.20)		(3.39)	
Rel.debt.innov.UK	0.0000659	0.0000485	-0.0000286	-0.0000367	0.00000473	-0.00000810
	(1.26)	(1.03)	(-1.68)	(-1.61)	(0.17)	(-0.23)
Debt.US	0.0000311^{***}	0.0000391^{***}	0.0000277^{***}	0.0000417^{***}	0.00000700^{+}	0.0000120^{***}
	(3.70)	(4.44)	(5.53)	(3.59)	(1.99)	(2.99)
Debt.UK	-0.000172^{***}	-0.000200^{***}	-0.000237^{***}	-0.000307^{***}	-0.000438^{***}	-0.000385^{***}
	(-3.38)	(-3.88)	(-5.41)	(-4.69)	(-6.80)	(-6.10)
(i*-i) UK		1.105^{***}		1.640^{+}		0.600^{**}
		(3.05)		(1.90)		(2.33)
Constant	0.00228	-0.0609	0.0936^{+}	0.0292	0.963^{***}	0.753^{***}
	(0.04)	(-1.21)	(1.71)	(0.47)	(5.13)	(4.31)
Observations	63	63	43	43	23	23

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$\rho_{t+j} = \zeta_j + \beta_j(\hat{r}^*_t - \hat{r}_t) + \phi_j debt_t + u^j_t \quad (12a)$$

Comparing 12 and 12a for the first 12 quarters, the β_js coefficients are still positive, but lose a lot of significance in the 4 variable VECM. Adding debt variables, β_js coefficients gain back some significance. US debt's coefficients are positive (not significant only for Italy), Foreign debt's coefficients are negative. Relative debt innovations' coefficients are only significant and positive for Canada and UK.

In terms of magnitude, 1 trillion change in relative debt innovations and US debt has a single digit percentage effect, while the effect of Foreign debt range from decimal percentage to double digit percentage.

Figure 39: Equation 12. Canada.

	(1) Exc.ret.(t+1) Can	(2) Exc.ret.t+2.Can	(3) Exc.ret.t+3.Can	(4) Exc.ret.t+4.Can	(5) Exc.ret.t+5.Can	(6) Exc.ret.t+6.Can
(r*-r) Canada	0.193**	0.102	0.189	0.136	0.155	0.335**
	(2.02)	(0.89)	(1.33)	(0.88)	(1.01)	(2.05)
Constant	0.00530	0.00675	0.00760	0.00974	0.0113	0.0117
	(0.87)	(0.71)	(0.59)	(0.60)	(0.58)	(0.53)
Observations	87	86	85	84	83	82

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

	(1) Exc.ret.t+7.Can	(2) Exc.ret.t+8.Can	(3) Exc.ret.t+9.Can	(4) Exc.ret.t+10.Can	(5) Exc.ret.t+11.Can	(6) Exc.ret.t+12.Can
(r*-r) Canada	0.197	0.200	0.146	0.216	0.209	0.220
	(1.06)	(0.91)	(0.65)	(0.95)	(0.94)	(0.98)
Constant	0.0142	0.0161	0.0187	0.0209	0.0240	0.0269
	(0.57)	(0.59)	(0.63)	(0.65)	(0.70)	(0.73)
Observations	81	80	79	78	77	76

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

Figure 40: Equation 12a. Canada.

	(1) Exc.ret.(t+1) Can	(2) Exc.ret.t+2.Can	(3) Exc.ret.t+3.Can
(r*-r) Canada	0.161	0.0585	0.184
	(1.62)	(0.57)	(1.38)
Rel.debt.innov.Can	0.0000590**	0.000109***	0.0000949**
	(2.40)	(3.02)	(2.33)
Debt.Can	-0.0000212	-0.0000744	-0.000136+
	(-0.52)	(-1.16)	(-1.76)
Debt.US	-0.000000793	0.000000299	0.00000289
	(-0.33)	(0.08)	(0.61)
Constant	0.0248	0.0572+	0.0914**
	(1.09)	(1.79)	(2.27)
Observations	87	86	85

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Can	(2) Exc.ret.t+5.Can	(3) Exc.ret.t+6.Can
(r*-r) Canada	0.162	0.198	0.403***
	(1.22)	(1.54)	(2.95)
Rel.debt.innov.Can	0.000113**	0.000153***	0.000176***
	(2.54)	(2.89)	(3.25)
Debt.Can	-0.000231**	-0.000295***	-0.000371***
	(-2.33)	(-2.70)	(-3.31)
Debt.US	0.00000724	0.00000909	0.0000117+
	(1.19)	(1.38)	(1.72)
Constant	0.134***	0.169***	0.209***
	(2.73)	(3.10)	(3.60)
Observations	84	83	82

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 41: Equation 12a. Canada.

	(1) Exc.ret.t+7.Can	(2) Exc.ret.t+8.Can	(3) Exc.ret.t+9.Can
(r*-r) Canada	0.293**	0.332+	0.314**
	(2.07)	(1.94)	(2.08)
Rel.debt.innov.Can	0.000169***	0.000174***	0.000191***
	(3.17)	(2.83)	(2.84)
Debt.Can	-0.000428***	-0.000514***	-0.000588***
	(-3.93)	(-4.58)	(-5.08)
Debt.US	0.0000142**	0.0000179***	0.0000206***
	(2.30)	(2.90)	(3.26)
Constant	0.241***	0.282***	0.323***
	(3.65)	(4.01)	(4.34)
Observations	81	80	79

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.Can	(2) Exc.ret.t+11.Can	(3) Exc.ret.t+12.Can
(r*-r) Canada	0.430***	0.500***	0.527***
	(3.09)	(3.55)	(3.54)
Rel.debt.innov.Can	0.000193***	0.000153**	0.000146**
	(2.82)	(2.42)	(2.48)
Debt.Can	-0.000668***	-0.000728***	-0.000770***
	(-6.27)	(-6.40)	(-6.68)
Debt.US	0.0000245***	0.0000270***	0.0000282***
	(4.45)	(4.64)	(4.87)
Constant	0.359***	0.398***	0.428***
	(4.75)	(4.95)	(5.21)
Observations	78	77	76

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 42: Equation 12. France.

	(1) Exc.ret.(t+1) Fran	(2) Exc.ret.t+2.Fra	(3) Exc.ret.t+3.Fra	(4) Exc.ret.t+4.Fra	(5) Exc.ret.t+5.Fra	(6) Exc.ret.t+6.Fra
(r*-r) France	0.618^{***}	0.556^{**}	0.615^{**}	0.703^{**}	0.795^{**}	0.745^{+}
	(3.60)	(2.22)	(2.23)	(2.26)	(2.27)	(1.88)
Constant	0.000155	0.00292	0.00702	0.0110	0.0140	0.0158
	(0.02)	(0.22)	(0.41)	(0.54)	(0.61)	(0.62)
Observations	76	76	75	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Fra	(2) Exc.ret.t+8.Fra	(3) Exc.ret.t+9.Fra	(4) Exc.ret.t+10.Fra	(5) Exc.ret.t+11.Fra	(6) Exc.ret.t+12.Fra
(r*-r) France	0.665	0.725	0.723	0.796^{+}	0.901^{**}	0.929^{**}
	(1.49)	(1.48)	(1.49)	(1.76)	(2.17)	(2.13)
Constant	0.0166	0.0177	0.0183	0.0192	0.0199	0.0205
	(0.60)	(0.61)	(0.60)	(0.61)	(0.62)	(0.62)
Observations	71	70	69	68	67	66

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 43: Equation 12a. France.

	(1) Exc.ret.(t+1) Fran	(2) Exc.ret.t+2.Fra	(3) Exc.ret.t+3.Fra
(r*-r) France	0.490**	0.360	0.420**
	(2.58)	(1.55)	(2.07)
Rel.debt.innov.Fra	0.0000138	0.0000436	0.0000419
	(0.47)	(0.94)	(0.77)
Debt.Fra	-0.0000573**	-0.000118***	-0.000180***
	(-2.47)	(-3.27)	(-4.37)
Debt.US	0.00000218	0.00000630	0.0000114**
	(0.70)	(1.38)	(2.05)
Constant	0.0856***	0.155***	0.222***
	(3.69)	(4.46)	(6.13)
Observations	76	76	75

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Fra	(2) Exc.ret.t+5.Fra	(3) Exc.ret.t+6.Fra
(r*-r) France	0.513**	0.609***	0.538**
	(2.50)	(2.83)	(2.61)
Rel.debt.innov.Fra	0.0000426	0.0000311	0.0000260
	(0.94)	(0.77)	(0.67)
Debt.Fra	-0.000236***	-0.000267***	-0.000291***
	(-5.32)	(-5.71)	(-5.96)
Debt.US	0.0000162***	0.0000189***	0.0000198***
	(2.66)	(3.17)	(3.24)
Constant	0.279***	0.315***	0.354***
	(7.47)	(7.58)	(8.05)
Observations	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 44: Equation 12a. France.

	(1) Exc.ret.t+7.Fra	(2) Exc.ret.t+8.Fra	(3) Exc.ret.t+9.Fra
(r*-r) France	0.452^{+}	0.478^{+}	0.468
	(1.95)	(1.80)	(1.61)
Rel.debt.innov.Fra	0.0000226	0.0000488	0.0000540
	(0.55)	(1.05)	(1.00)
Debt.Fra	-0.000319^{***}	-0.000358^{***}	-0.000377^{***}
	(-6.48)	(-7.69)	(-7.89)
Debt.US	0.0000217^{***}	0.0000252^{***}	0.0000263^{***}
	(3.46)	(4.33)	(4.40)
Constant	0.388^{***}	0.421^{***}	0.444^{***}
	(8.63)	(9.20)	(9.31)
Observations	71	70	69

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.Fra	(2) Exc.ret.t+11.Fra	(3) Exc.ret.t+12.Fra
(r*-r) France	0.582^{**}	0.760^{***}	0.871^{***}
	(2.11)	(2.93)	(3.76)
Rel.debt.innov.Fra	0.0000455	0.0000157	-0.00000488
	(0.81)	(0.33)	(-0.12)
Debt.Fra	-0.000397^{***}	-0.000396^{***}	-0.000396^{***}
	(-8.27)	(-7.92)	(-8.35)
Debt.US	0.0000282^{***}	0.0000283^{***}	0.0000279^{***}
	(4.77)	(4.77)	(5.07)
Constant	0.463^{***}	0.465^{***}	0.472^{***}
	(9.53)	(9.53)	(9.99)
Observations	68	67	66

t statistics in parentheses

$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 45: Equation 12. Germany.

	(1) Exc.ret.(t+1) Germ	(2) Exc.ret.t+2.Ger	(3) Exc.ret.t+3.Ger	(4) Exc.ret.t+4.Ger	(5) Exc.ret.t+5.Ger	(6) Exc.ret.t+6.Ger
(r*-r) Germany	0.609^{***}	0.558^{**}	0.605^{**}	0.697^{**}	0.786^{**}	0.738^{+}
	(3.59)	(2.27)	(2.20)	(2.25)	(2.28)	(1.90)
Constant	0.0000944	0.00298	0.00694	0.0109	0.0140	0.0158
	(0.01)	(0.23)	(0.40)	(0.53)	(0.61)	(0.63)
Observations	76	76	75	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Ger	(2) Exc.ret.t+8.Ger	(3) Exc.ret.t+9.Ger	(4) Exc.ret.t+10.Ger	(5) Exc.ret.t+11.Ger	(6) Exc.ret.t+12.Ger
(r*-r) Germany	0.649	0.710	0.701	0.777^{+}	0.871^{**}	0.907^{**}
	(1.48)	(1.47)	(1.47)	(1.76)	(2.13)	(2.12)
Constant	0.0165	0.0177	0.0183	0.0192	0.0199	0.0204
	(0.60)	(0.61)	(0.60)	(0.61)	(0.62)	(0.62)
Observations	71	70	69	68	67	66

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 46: Equation 12a. Germany.

	(1) Exc.ret.(t+1) Germ	(2) Exc.ret.t+2.Ger	(3) Exc.ret.t+3.Ger
(r*-r) Germany	0.471**	0.351	0.392+
	(2.31)	(1.44)	(1.87)
Rel.debt.innov.Ger	0.00000981	0.0000418	0.0000455
	(0.32)	(0.88)	(0.84)
Debt.Ger	-0.0000269	-0.0000624**	-0.0000999***
	(-1.61)	(-2.41)	(-3.14)
Debt.US	-0.00000222	-0.00000234	-0.00000158
	(-1.04)	(-0.81)	(-0.44)
Constant	0.0858***	0.164***	0.243***
	(3.00)	(3.73)	(4.94)
Observations	76	76	75

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Ger	(2) Exc.ret.t+5.Ger	(3) Exc.ret.t+6.Ger
(r*-r) Germany	0.490**	0.611**	0.548**
	(2.41)	(2.65)	(2.38)
Rel.debt.innov.Ger	0.0000502	0.0000345	0.0000288
	(1.17)	(0.93)	(0.86)
Debt.Ger	-0.000135***	-0.000159***	-0.000178***
	(-3.84)	(-4.28)	(-4.59)
Debt.US	-0.000000445	0.000000808	0.000000693
	(-0.11)	(0.20)	(0.16)
Constant	0.313***	0.359***	0.406***
	(5.99)	(6.31)	(6.71)
Observations	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 47: Equation 12a. Germany.

	(1) Exc.ret.t+7.Ger	(2) Exc.ret.t+8.Ger	(3) Exc.ret.t+9.Ger
(r*-r) Germany	0.451^{+}	0.470	0.430
	(1.74)	(1.58)	(1.41)
Rel.debt.innov.Ger	0.0000251	0.0000523	0.0000654
	(0.65)	(1.05)	(1.18)
Debt.Ger	-0.000197***	-0.000225***	-0.000243***
	(-4.92)	(-5.54)	(-5.79)
Debt.US	0.000000995	0.00000228	0.00000282
	(0.22)	(0.52)	(0.61)
Constant	0.448***	0.492***	0.526***
	(7.06)	(7.51)	(7.77)
Observations	71	70	69

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.Ger	(2) Exc.ret.t+11.Ger	(3) Exc.ret.t+12.Ger
(r*-r) Germany	0.535^{+}	0.719***	0.822***
	(1.96)	(2.73)	(3.69)
Rel.debt.innov.Ger	0.0000589	0.0000272	0.00000566
	(1.07)	(0.60)	(0.16)
Debt.Ger	-0.000262***	-0.000269***	-0.000279***
	(-6.11)	(-6.58)	(-7.52)
Debt.US	0.00000426	0.00000568	0.00000662^{+}
	(0.92)	(1.38)	(1.85)
Constant	0.553***	0.560***	0.575***
	(8.12)	(8.52)	(9.52)
Observations	68	67	66

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 48: Equation 12. Italy.

	(1) Exc.ret.(t+1)Ita	(2) Exc.ret.t+2.Ita	(3) Exc.ret.t+3.Ita	(4) Exc.ret.t+4.Ita	(5) Exc.ret.t+5.Ita	(6) Exc.ret.t+6.Ita
(r*-r) Italy	0.621***	0.562**	0.611**	0.692**	0.793**	0.742+
	(3.61)	(2.25)	(2.21)	(2.22)	(2.28)	(1.88)
Constant	0.000160	0.00296	0.00702	0.0110	0.0141	0.0158
	(0.02)	(0.23)	(0.41)	(0.53)	(0.61)	(0.62)
Observations	76	76	75	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Ita	(2) Exc.ret.t+8.Ita	(3) Exc.ret.t+9.Ita	(4) Exc.ret.t+10.Ita	(5) Exc.ret.t+11.Ita	(6) Exc.ret.t+12.Ita
(r*-r) Italy	0.664	0.715	0.712	0.771+	0.881**	0.918**
	(1.50)	(1.47)	(1.47)	(1.69)	(2.10)	(2.10)
Constant	0.0166	0.0177	0.0183	0.0191	0.0199	0.0205
	(0.61)	(0.61)	(0.60)	(0.60)	(0.62)	(0.62)
Observations	71	70	69	68	67	66

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 49: Equation 12a. Italy.

	(1) Exc.ret.(t+1)Ita	(2) Exc.ret.t+2.Ita	(3) Exc.ret.t+3.Ita
(r*-r) Italy	0.476**	0.313	0.325
	(2.57)	(1.35)	(1.52)
Rel.debt.innov.Ita	0.0000112	0.0000412	0.0000440
	(0.39)	(0.90)	(0.82)
Debt.Ita	-0.0000553***	-0.000108***	-0.000161***
	(-2.81)	(-3.45)	(-4.68)
Debt.US	-9.30e-08	0.00000107	0.00000304
	(-0.04)	(0.33)	(0.76)
Constant	0.129***	0.235***	0.340***
	(3.96)	(4.49)	(6.38)
Observations	76	76	75

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Ita	(2) Exc.ret.t+5.Ita	(3) Exc.ret.t+6.Ita
(r*-r) Italy	0.380+	0.477**	0.406**
	(1.70)	(2.04)	(2.02)
Rel.debt.innov.Ita	0.0000460	0.0000352	0.0000273
	(1.06)	(0.96)	(0.79)
Debt.Ita	-0.000206***	-0.000232***	-0.000252***
	(-5.96)	(-6.46)	(-7.16)
Debt.US	0.00000479	0.00000598	0.00000576
	(1.15)	(1.49)	(1.46)
Constant	0.428***	0.480***	0.534***
	(8.27)	(8.73)	(9.83)
Observations	74	73	72

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 50: Equation 12a. Italy.

	(1) Exc.ret.t+7.Ita	(2) Exc.ret.t+8.Ita	(3) Exc.ret.t+9.Ita
(r*-r) Italy	0.303	0.301	0.267
	(1.47)	(1.24)	(0.98)
Rel.debt.innov.Ita	0.0000300	0.0000517	0.0000637
	(0.76)	(1.10)	(1.15)
Debt.Ita	-0.000277***	-0.000305***	-0.000321***
	(-8.13)	(-9.58)	(-9.26)
Debt.US	0.00000624	0.00000727+	0.00000732+
	(1.52)	(1.87)	(1.74)
Constant	0.587***	0.635***	0.671***
	(10.99)	(11.80)	(11.54)
Observations	71	70	69

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

	(1) Exc.ret.t+10.Ita	(2) Exc.ret.t+11.Ita	(3) Exc.ret.t+12.Ita
(r*-r) Italy	0.357	0.550**	0.699***
	(1.32)	(2.08)	(2.94)
Rel.debt.innov.Ita	0.0000583	0.0000248	-0.00000627
	(1.07)	(0.54)	(-0.16)
Debt.Ita	-0.000331***	-0.000323***	-0.000319***
	(-8.90)	(-7.89)	(-8.29)
Debt.US	0.00000747+	0.00000710	0.00000671+
	(1.76)	(1.65)	(1.68)
Constant	0.693***	0.685***	0.686***
	(10.94)	(9.96)	(10.29)
Observations	68	67	66

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

Figure 51: Equation 12. Japan.

	(1) Exc.ret.(t+1) Jap	(2) Exc.ret.t+2.Jap	(3) Exc.ret.t+3.Jap	(4) Exc.ret.t+4.Jap	(5) Exc.ret.t+5.Jap	(6) Exc.ret.t+6.Jap
(r*-r) Japan	0.436***	0.544***	0.561***	0.465**	0.438+	0.417
	(3.24)	(3.56)	(2.89)	(1.99)	(1.70)	(1.48)
Constant	-0.0335***	-0.0260+	-0.0255	-0.0315	-0.0333	-0.0344
	(-4.03)	(-1.96)	(-1.38)	(-1.39)	(-1.26)	(-1.15)
Observations	85	84	83	82	81	80

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.Jap	(2) Exc.ret.t+8.Jap	(3) Exc.ret.t+9.Jap	(4) Exc.ret.t+10.Jap	(5) Exc.ret.t+11.Jap	(6) Exc.ret.t+12.Jap
(r*-r) Japan	0.369	0.233	0.147	0.0817	-0.0461	-0.207
	(1.16)	(0.72)	(0.44)	(0.22)	(-0.13)	(-0.57)
Constant	-0.0374	-0.0452	-0.0490	-0.0512	-0.0577	-0.0656
	(-1.12)	(-1.26)	(-1.26)	(-1.24)	(-1.36)	(-1.53)
Observations	79	78	77	76	75	74

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 52: Equation 12a. Japan.

	(1) Exc.ret.(t+1) Jap	(2) Exc.ret.t+2.Jap	(3) Exc.ret.t+3.Jap
(r*-r) Japan	0.308**	0.542***	0.671***
	(2.28)	(3.87)	(3.87)
Rel.debt.innov.Jap	0.00000999	0.0000175	-0.00000820
	(0.67)	(1.34)	(-0.53)
Debt.Jap	0.00000413	-0.0000121	-0.0000217
	(0.48)	(-0.92)	(-1.38)
Debt.US	0.00000199	0.00000530	0.00000773
	(0.62)	(1.15)	(1.40)
Constant	-0.0998**	0.00888	0.0691
	(-2.16)	(0.14)	(0.92)
Observations	85	84	83

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.Jap	(2) Exc.ret.t+5.Jap	(3) Exc.ret.t+6.Jap
(r*-r) Japan	0.644***	0.675***	0.721***
	(3.07)	(3.10)	(3.39)
Rel.debt.innov.Jap	-0.0000215	-0.00000932	-0.00000535
	(-1.01)	(-0.40)	(-0.23)
Debt.Jap	-0.0000309+	-0.0000427**	-0.0000531***
	(-1.76)	(-2.32)	(-2.97)
Debt.US	0.0000108+	0.0000140**	0.0000168***
	(1.76)	(2.19)	(2.70)
Constant	0.108	0.168+	0.223**
	(1.26)	(1.80)	(2.40)
Observations	82	81	80

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 53: Equation 12a. Japan.

	(1) Exc.ret.t+7.Jap	(2) Exc.ret.t+8.Jap	(3) Exc.ret.t+9.Jap
(r*-r) Japan	0.736***	0.608**	0.586**
	(3.01)	(2.54)	(2.48)
Rel.debt.innov.Jap	-0.0000129	-0.00000303	-0.00000370
	(-0.49)	(-0.10)	(-0.11)
Debt.Jap	-0.0000612***	-0.0000675***	-0.0000773***
	(-3.40)	(-3.31)	(-3.64)
Debt.US	0.0000191***	0.0000214***	0.0000242***
	(3.13)	(3.37)	(3.74)
Constant	0.265***	0.282**	0.330**
	(2.70)	(2.37)	(2.61)
Observations	79	78	77

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.Jap	(2) Exc.ret.t+11.Jap	(3) Exc.ret.t+12.Jap
(r*-r) Japan	0.587**	0.463+	0.322
	(2.33)	(1.70)	(1.21)
Rel.debt.innov.Jap	-0.00000250	0.00000304	0.00000357
	(-0.08)	(0.09)	(0.11)
Debt.Jap	-0.0000869***	-0.0000915***	-0.0000967***
	(-4.00)	(-3.76)	(-3.94)
Debt.US	0.0000267***	0.0000285***	0.0000307***
	(3.99)	(3.94)	(4.19)
Constant	0.381***	0.392***	0.405***
	(3.08)	(2.77)	(2.86)
Observations	76	75	74

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 54: Equation 12. United Kingdom.

	(1) Exc.ret.(t+1) UK	(2) Exc.ret.t+2.UK	(3) Exc.ret.t+3.UK	(4) Exc.ret.t+4.UK	(5) Exc.ret.t+5.UK	(6) Exc.ret.t+6.UK
(r*-r) UK	0.341	0.367	0.441^{+}	0.485^{+}	0.561^{+}	0.654^{+}
	(1.46)	(1.32)	(1.72)	(1.71)	(1.92)	(1.95)
Constant	0.0110	0.00904	0.00725	0.00472	0.000215	-0.00392
	(1.30)	(0.75)	(0.48)	(0.26)	(0.01)	(-0.16)
Observations	76	75	74	73	72	71

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+7.UK	(2) Exc.ret.t+8.UK	(3) Exc.ret.t+9.UK	(4) Exc.ret.t+10.UK	(5) Exc.ret.t+11.UK	(6) Exc.ret.t+12.UK
(r*-r) UK	0.697^{+}	0.787^{+}	0.987^{**}	1.184^{***}	1.158^{**}	1.285^{**}
	(1.88)	(1.87)	(2.16)	(2.65)	(2.47)	(2.36)
Constant	-0.00819	-0.0139	-0.0220	-0.0296	-0.0338	-0.0426
	(-0.31)	(-0.49)	(-0.72)	(-0.96)	(-1.05)	(-1.25)
Observations	70	69	68	67	66	65

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 55: Equation 12a. United Kingdom.

	(1) Exc.ret.(t+1) UK	(2) Exc.ret.t+2.UK	(3) Exc.ret.t+3.UK
(r*-r) UK	-0.0546	-0.0456	0.0657
	(-0.27)	(-0.21)	(0.49)
Rel.debt.innov.UK	0.0000360^{+}	0.0000252	0.0000122
	(1.96)	(0.60)	(0.27)
Debt.UK	-0.0000338	-0.0000899**	-0.000157**
	(-1.25)	(-2.06)	(-2.55)
Debt.US	-0.00000359	0.00000266	0.0000112
	(-0.95)	(0.45)	(1.27)
Constant	0.113***	0.129***	0.134***
	(5.18)	(5.70)	(4.80)
Observations	76	75	74

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+4.UK	(2) Exc.ret.t+5.UK	(3) Exc.ret.t+6.UK
(r*-r) UK	0.0447	0.114	0.235
	(0.38)	(0.74)	(0.95)
Rel.debt.innov.UK	0.0000339	0.0000405	0.0000429
	(1.05)	(1.29)	(1.35)
Debt.UK	-0.000222***	-0.000263***	-0.000311***
	(-2.72)	(-2.70)	(-2.95)
Debt.US	0.0000188	0.0000239	0.0000305^{+}
	(1.56)	(1.60)	(1.84)
Constant	0.143***	0.144***	0.137**
	(3.68)	(2.68)	(2.06)
Observations	73	72	71

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 56: Equation 12a. United Kingdom.

	(1) Exc.ret.t+7.UK	(2) Exc.ret.t+8.UK	(3) Exc.ret.t+9.UK
(r*-r) UK	0.291	0.324	0.532
	(0.96)	(0.90)	(1.32)
Rel.debt.innov.UK	0.0000283	0.0000517	0.0000785
	(0.78)	(1.19)	(1.57)
Debt.UK	-0.000367***	-0.000421***	-0.000467***
	(-3.25)	(-3.56)	(-3.72)
Debt.US	0.0000386**	0.0000457**	0.0000527**
	(2.11)	(2.31)	(2.54)
Constant	0.131+	0.128	0.107
	(1.71)	(1.49)	(1.17)
Observations	70	69	68

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) Exc.ret.t+10.UK	(2) Exc.ret.t+11.UK	(3) Exc.ret.t+12.UK
(r*-r) UK	0.849**	0.801+	0.899+
	(2.02)	(1.92)	(1.96)
Rel.debt.innov.UK	0.0000456	0.0000319	0.0000568
	(0.82)	(0.60)	(1.23)
Debt.UK	-0.000501***	-0.000509***	-0.000523***
	(-3.85)	(-3.97)	(-4.17)
Debt.US	0.0000595***	0.0000604***	0.0000627***
	(2.81)	(2.89)	(3.08)
Constant	0.0771	0.0785	0.0640
	(0.80)	(0.78)	(0.63)
Observations	67	66	65

t statistics in parentheses
$^{+}$ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

2 Chapter 2. Government Bonds and the Exchange Rate in EZ-BKK model.

2.1 Introduction

Exchange rates have been studied for decades with different angles: from determination of the levels for demand of traded goods (based on Dornbusch (1976) and Mundell-Fleming) to resolution of puzzles (see review essays by Engel (1996, 2014) , Obstfeld and Rogoff (2000) and Ishtoki and Mukhin (2017)).

Two of the puzzles are referred to as the uncovered interest parity (UIP) , both in classic and new form. The classic UIP puzzle finds that there is positive correlation between high interest rate countries and excess currency returns. This happens at frequencies between six or more hours[13] and quarters for low inflation countries and does not happen for long term bonds (Chinn and Meredith (2004)).

The new UIP puzzle has been documented by Engel (2016) and Valchev(2020) and recently discussed by Favaretto(2021). After an initial positive correlation, there is a reversal between interest rates and excess currency returns.

Part of the literature considers the role of liquidity or convenience into play in order to explain these puzzles. Intuitively, short-term bonds that are safe and liquid give an additional benefit to interest rate returns. High value from liquidity is referred as high convenience yield of a bond and it may vary depending on the demand and supply of safe and liquid government bonds.

This paper focuses on the replication of the classic UIP puzzle using a model with recursive preferences and Long Run Risks. Previously, a similar endowment economy model from Colacito and Croce (2013) showed that the UIP puzzle may be replicated by Stochastic Discount Factor (SDF) dynamics. The same is not true for a production economy model within the same class of models (Colacito et al (2018), from now on CCHH).

This paper augments a production based LRR model (CCHH) with government bonds. These government bonds are assumed to be out of control from the social planner and only subjects to exogenous shocks.[14] They take up real resources in the budget constraint and deliver convenience yields to consumers. Accordingly, convenience yields fluctuations impact the exchange rate autonomously respect to the risk part.

The model is a EZ-BKK model: infinite horizon, two good, two countries BKK (Backus et al (1992, 1993)) with Home Bias in consumption, recursive preferences and permanent news shocks to growth rate of productivity. Within this framework, positive long run news shock to Home implies a net outflow of resources to Foreign under preferences for early resolution of uncertainty. Indeed this happens for the predominance of the risk sharing channel between Home and Foreign over the productivity channel, implying positive domestic net exports until the actual productivity news is materialized. The same is not true

[13] Chaboud and Wright (2005) finds that below six hours, classic UIP actually holds well."

[14] This feature is a consequence to the difficulty of solving the recursive preference's Pareto problem with bonds.

for a positive short run shock to Home since it implies an immediate prevalence of the productivity channel that implies higher inflow of capital and negative net exports [15].
I study what are the conditions for the emergence of the UIP puzzle under this setup. The UIP puzzle does not emerge under temporary bond shocks and the CCHH parametrization. The UIP puzzle is replicated for temporary bond shocks under a nearly doubled standard deviation of short term shocks. Under permanent bond shocks, the UIP puzzle is replicated with CCHH parametrization only if there is a positive correlation between Home long-run shocks and bond shocks.
The expected change in exchange rate is defined here by the typical risk component i.e. differences in interest rates and an additional liquidity component i.e. the convenience yield part.
Positive long-run news shock to Home productivity increase the difference between Home and Foreign risk-free interest rates as the risk sharing channel dominates the productivity channel under preferences for early resolution of uncertainty and Home bias in consumption. This has a little positive effect also on the second component of the expected change in exchange rate that depends on convenience yields [16].
Positive shock to Home bonds increase the difference between Home and Foreign risk-free interest rates due to the additional multiplicative component in the SDF of both countries, while at the same time lowering the second component of expected change in exchange rate. Indeed the convenience yield difference shrinks due to lower marginal effect of additional Home bond holdings. The overall effect balances out to replicate the classic UIP puzzle depending on how frequent and strong are the two opposing channels.
I report UIP puzzle coefficients and the Confidence Intervals at 95 % probability for six scenarios, four under permanent shocks and changing covariances, two for temporary shocks and changing covariances.
I show IRFs for the baseline model and comparison of IRFs between three interesting cases for 11 variables: the baseline case with positive covariance between long-run news shock and bond shocks, then adding a positive covariance between short-run productivity shocks and bond shocks, and finally almost doubling the standard deviation of short run shocks.
I report in the appendix the full list of parameters, variables and first order conditions used in the model. Moreover, the appendix shows the full IRFs for CCHH (2018).

Section 2 outlines the literature review on the topic, Section 3 outlines the model, Section 4 shows the results and Section 5 concludes.

[15] These shocks are identified by regressing Solow residuals on price-dividend ratios.
[16] This is why this mechanism alone is not able to replicate the UIP puzzle.

2.2 Literature review

This paper builds heavily on work done by CCHH(2018). They develop a EZ-BKK model that uses a BKK approach and adds Epstein-Zin preferences (recursive preferences) and long run risks (LRR), introduced in international macroeconomics and finance for explaining a number of puzzles such as the low risk free interest rates, the high equity premium and so on (Bansal and Yaron (2004)). They study how long run and short run growth news impacts investment flows among G7 countries and show that an EZ-BKK model is consistent with data such that positive long-run news for domestic productivity induces a net outflow of investments, while short-run news do the opposite.

My approach adds government bonds as exogenous processes and assumes that these bonds give a liquidity convenience yield effect to the consumers in the economy.

In this setup, short-run and long-run shocks are respectively one period permanent innovations of the growth rate of productivity and multiple periods ones (Favilukis and Lin (2013)). These shocks are identified by regressing Solow residuals on lagged country-specific price-dividend ratios, in the spirit of Bansal,Kiku, Yaron (2016) and Colacito and Croce (2011).

This paper follows CCHH in using Greenwood, Hercowitz and Huffman (1988) preferences to bundle consumption and leisure to adress the critique by Raffo (2008): GHH preferences prevent term of trade adjustment , so that countercyclical trade balance comes from adjustment in quantity traded. Colacito and Croce (2013) use a two-country, two good endowment economy with Epstein-Zin preferences and complete markets to show how the classic UIP puzzle and the Backus Smith puzzle may be generated. CC(2013) shows that introducing recursive preferences and growth news about endowment shocks implies that positive long-run endowment shocks to Home lower consumption today to have less variance of continuation utility, thus reproducing higher relative interest rate in Home together with an expected appreciation of Home. Similar models with a production side failed to explain the UIP puzzle, probably lacking the increase in variance that an endowment shock implies.

Introducing a convenience part inside the utility function is equivalent to introducing a transaction cost component. Walsh (2017, ch2 and 3) details that it is similar to introducing a time-varying wedge inside the Euler equation. In my setup, transaction costs are real costs since there are no sticky prices or money balances.

There is a vast literature that studied how asset pricing facts may be reproduced by macroeconomic models. Boldrin et al (2001) generate equity premium and low risk free rate in a one country model with internal habit consumption and lack of perfect capital reallocation between two sectors of the economy. Ulhig (2007) achieves a lower degree of consumption smoothing across countries by having a one country model with external habits in consumption, adjustment costs for capital and real wage rigidity. Croce (2014) is able to reproduce the equity risk premium in a one country model with recursive preferences, a production economy and convex adjustment costs for capital.

The literature review on the UIP puzzles is big and expanding. For somewhat comprehensive review, see Engel (1996) and Engel (2014).
The Uncovered Interest Parity puzzle in its classical form has been introduced by Fama (1984): defining $s_t = \frac{Home}{Foreign}$ as log nominal ER ($\uparrow s_t$ means Home depreciate), a typical Fama regression:

$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + \epsilon_{t+1}$$

Data suggests that $\hat{\beta} < 0$ instead of $\beta = 1$, i.e. high interest rates countries see overtime an appreciation of currency up to quarter time frequency.
There are two papers that define the new UIP puzzle and propose a convenience yield-liquidity explanation to both UIP puzzles: Engel (2016) and Valchev (2020). Valchev (2020) uses panel data to find empirical evidence of convenience yields' importance for the classic and new UIP. He also builds a theoretical model with endogenous convenience yields' fluctuations that replicates both the classic UIP puzzle and the new one.
Ishtoki and Mukhin (2017) explain 6 exchange rate puzzles by using a setup that blends international asset demand shocks with a framework that makes these shocks propagates very little within the pair of countries. In their paper, shocks propagates little because of Home bias in consumption, weak substituability between domestic and foreign goods (little variance of Terms of Trade) and strategic complementarities in price setting. They find that an increase in the demand for Foreign assets decreases the ex-ante foreign currency excess returns.
Lately convenience yields and liquidity have been growingly incorporated in international macroeconomics and finance. Among the contributions, the paper by Krishnamurty and Vissing-Jorgensen (2012) finds that when debt to GDP ratio is low, Treasuries are more scarce and there is higher convenience yield. This implies that supply of government bonds impacts convenience yields such that higher supply decreases them.
There are models that use the idea of bond convenience yields for closed economy asset puzzles, as Bansal and Coleman (1996) and Lagos (2010). The idea is that certain assets give an additional benefit other than the bare interest rate. Jiang et al (2018) build a theory that links demand for foreign safe assets and the nominal exchange rate for US. They claim to solve most of the exchange rate disconnect puzzle for the US by defining a specific form of convenience yield. By defining as convenience yield the different yield between foreign government bonds and US bonds, they show that an increase in this convenience yield implies an impact appreciation of the dollar and a following depreciation that increases the ex-ante foreign currency excess return.
Engel and Wu (2019) find that accounting for liquidity yield on government bonds gives explanatory power to monetary shocks and price differences, differently from what the literature on forecasting and exchange rate disconnect had previously found.
Du et al (2018) study convenience yields for G10 currencies between 2000 and 2016. The US treasury premium is defined as the convenience yield on US trea-

sury bonds minus the convenience yield on foreign treasury bonds, such that a positive premium implies that US convenience yield is higher than foreign. They find that there are country-pair treasury premia with different average and dynamics. Treasury premia at 3 month horizon are higher than 5 year horizon, and they both increased during the Global Financial Crisis with higher jump by the 3 month premia. Moreover, there has been a steady decline in treasury premia after the GFC for the currencies considered.

Van Bisbergen et al (2019) use a new methodology to estimate risk-free rates between 2004 and 2018, using the put-call parity relationship for European style options. By this method, they get risk-free rates from risky assets and compare them to risk- free rates on government bonds. The difference is indeed the convenience yield. As Du et al (2018), they find higher convenience yields at short term rather than long term horizon (65 versus 40 basis point) and strongly varying in time of financial distress.

Moreover they find that a forecasting factor constructed from cross section of convenience yields (a la Cochrane and Piazzesi 2005) has substantial forecasting power for both government bond excess returns (conventional risk premia) and their risk-free rate excess returns (risk premia minus the convenience yields), even when controlling for other factors of the literature.

Lilley et al (2019) define as "Exchange Rate Reconnect" the fact that after the GFC , exchange rates correlate with macroeconomic fundamentals according to both IMF data [17] and a micro datasets with security level data. In particular, broad US dollar comoves closely with global risk appetite. In addition, only between 2007-2012 the broad US dollar co-moves also with US foreign bond purchases, even if they conclude that this correlation is probably caused by the movement in global risk appetite. The broad dollar and global risk appetite comovement seems to depend on the changed relations between dollar and riskier currencies, such as Australian dollar. When US investors buy less US treasuries or more domestic corporate debt, the dollar depreciates.

Other approaches to the topic of safe and liquid assets includes Caballero, Farhi and Gourinchas (2017) on the safe asset conundrum and the same authors for the consequences of this for the growing difference between capital and equity risk premia.

[17] balance of payment data and International Investment positions to measure quarterly US capital flows

2.3 The model

The model is very close to the CCHH (2018) model and I added the convenience yield part inside the utility function, the modified expected change in exchange rate, the government bonds, the shock to bonds. Full parameters and definitions for the variables are in the Appendix.
The model is an infinite horizon, two-country, two-goods BKK economy with recursive preferences and new shocks. Being in complete markets, agents trade a complete set of securities to maximize their utility at time zero.
The Home country utility [18] is:

$$U_t = [(1-\beta)(\tilde{C}_t^{1-1/\psi})(1+\psi^h) + \beta E_t[U_{t+1}^{1-\gamma}]^{\frac{(1-1/\psi)}{(1-\gamma)}}]^{\frac{1}{(1-1/\psi)}} \tag{14}$$

where

$$\psi^h(BH, BF) = \bar{\psi}(a_b BH^{\frac{\eta_b-1}{\eta_b}} + (1-a_b)BF^{\frac{\eta_b-1}{\eta_b}})^{\frac{\eta_b}{\eta_b-1}} \tag{15}$$

$$\psi^{h*}(BH^*, BF^*) = \bar{\psi}(a_b BF^{*\frac{\eta_b-1}{\eta_b}} + (1-a_b)BH^{*\frac{\eta_b-1}{\eta_b}})^{\frac{\eta_b}{\eta_b-1}} \tag{16}$$

γ is relative risk aversion, ψ is intertemporal elasticity of substitution (IES). Under preferences for early resolution of uncertainty, $\gamma > 1/\psi$.

Good X and Y are consumed by both countries via consumption aggregations ($\lambda > 0.5$ gives Home bias in consumption):

$$C_t = X_t^{\lambda} Y_t^{1-\lambda} \tag{17}$$

$$C_t^* = X_t^{*(1-\lambda)} Y^* \lambda_t \tag{18}$$

Following the Raffo (2008) critique, there is GHH preferences:

$$\tilde{C}_t = C_t - \varphi_t N_t^{1+\frac{1}{f}} \tag{19}$$

$$\tilde{C}_t^* = C_t^* - \varphi_t^* N_t^{*(1+\frac{1}{f})} \tag{20}$$

What is not consumed of either goods in both countries is invested in capital investment (λ_I is an investment Home bias):

$$G_t = I_{x,t}^{\lambda_I} I_{x,t}^{*(1-\lambda_I)} \tag{21}$$

$$G_t^* = I_{y,t}^{1-\lambda_I} I_{y,t}^{*(\lambda_I)} \tag{22}$$

Capital dynamics:

$$K_{t+1} = (1-\delta_k)K_t + G_t \tag{23}$$

$$K_{t+1}^* = (1-\delta_k)K_t^* + G_t^* \tag{24}$$

Total production:

$$X_t^T = K_t^{\alpha}(A_t N_t)^{1-\alpha} \tag{25}$$

[18]Foreign country variables are often omitted, but when they are inserted they present asterisks

$$Y_t^T = K^* \alpha_t (A_t^* N_t^*)^{1-\alpha} \tag{26}$$

Total production in one country is either consumed or invested, but the government bonds takes a share of the total value of production:

$$X_t^T = X_t + X_t^* + I_{x,t} + I_{y,t} + BH + BH^* \tag{27}$$

$$Y_t^T = Y_t + Y_t^* + I_{x,t}^* + I_{y,t}^* + BF + BF^* \tag{28}$$

Defining the utility preferences in a compact way i.e $U_t = W(\tilde{C}_t, U_{t+1})$, the social planner chooses $\{X_t, X_t^*, Y_t, Y_t^*, N_t, N_t^*, K_t, K_t^*, I_{x,t}, I_{y,t}, I_{x,t}^*, I_{y,t}^*\}$ to maximize $\mu_0 W_0 + (1-\mu_0) W_0^*$ under the resource constraints and the investment dynamics 27, 28, 23, 24.
μ_0 is the Pareto weight at time-0. The optimality conditions are derived by Colacito et al. (2018), but here I am outlining the main differences.

The Home SDF is:

$$M_{t+1} = \beta\left(\frac{1+\psi_{t+1}^h}{1+\psi_t^h}\right)\left(\frac{\tilde{C}_{t+1}}{\tilde{C}_t}\right)^{-\frac{1}{\psi}}\left(\frac{U_{t+1}}{E_t[U_{t+1}^{1-\gamma}]^{\frac{1}{1-\gamma}}}\right)^{\frac{1}{\psi}-\gamma} \tag{29}$$

From FOCs of X and Y:

$$S_t \frac{\partial C_t}{\partial X_t}\frac{1}{C_t} = \frac{\partial C_t^*}{\partial X_t^*}\frac{1}{C_t^*} \tag{30}$$

$$S_t \frac{\partial C_t}{\partial Y_t}\frac{1}{C_t} = \frac{\partial C_t^*}{\partial Y_t^*}\frac{1}{C_t^*} \tag{31}$$

where

$$S_t = \frac{\mu_t}{\mu_t^*} \tag{32}$$

where μ_t is the date t Pareto weight for Home country.
Moreover, the dynamics of S_t is:

$$S_t = S_{t-1}\frac{M_t}{M_t^*}\frac{e^{\delta c_t}}{e^{\delta c_t^*}} \tag{33}$$

Optimal within-country investment implies:

$$\frac{1}{\lambda_I}\frac{I_{x,t}}{G_t} = E_t[M_{t+1}^X(\alpha\frac{X_{t+1}^T}{K_{t+1}} + (1-\delta_k)Q_{k,t+1})] \tag{34}$$

$$\frac{1}{\lambda_I}\frac{I_{x,t}^*}{G_t^*} = E_t[M_{t+1}^Y(\alpha\frac{Y_{t+1}^T}{K_{t+1}^*} + (1-\delta_k)Q_{k,t+1}^*)] \tag{35}$$

where we have respectively the SDF in X units and SDF in Y units:

$$M_{t+1}^X = \frac{X_t}{X_{t+1}}\frac{C_{t+1}}{C_t}M_{t+1} \tag{36}$$

$$M_{t+1}^{Y} = \frac{Y_t^*}{Y_{t+1}^*}\frac{C_{t+1}^*}{C_t^*}M_{t+1}^* \tag{37}$$

The returns of capital are :

$$R_{k,t+1} = \frac{\alpha\frac{X_{t+1}^T}{K_{t+1}} + (1-\delta_k)Q_{k,t+1}}{Q_{k,t}} \tag{38}$$

$$R_{k,t+1}^* = \frac{\alpha\frac{Y_{t+1}^T}{K_{t+1}^*} + (1-\delta_k)Q_{k,t+1}^*}{Q_{k,t}^*} \tag{39}$$

Excess returns with respect to returns of capital are:

$$R_t^{ex} = \frac{R_{k,t+1}}{R_{f,t}} \tag{40}$$

$$R_t^{*ex} = \frac{R_{k,t+1}^*}{R_{f,t}^*} \tag{41}$$

The no-arbitrage equations for investment abroad:

$$\frac{1}{1-\lambda_I}\frac{I_{y,t}}{G_t^*} = E_t[M_{t+1}^X(\alpha\frac{Y_{t+1}^T}{K_{t+1}^*} + (1-\delta_k)Q_{k,t+1}^*)P_{t+1}] \tag{42}$$

$$\frac{1}{1-\lambda_I}\frac{I_{x,t}^*}{G_t} = E_t[M_{t+1}^Y(\alpha\frac{X_{t+1}^T}{K_{t+1}} + (1-\delta_k)Q_{k,t+1})/P_{t+1}] \tag{43}$$

Exogenous processes are:

$$\Delta a_t = \mu + z_{t-1} - \tau log(\frac{A_{t-1}}{A_{t-1}^*}) + \epsilon_{a,t} \tag{44}$$

$$\Delta a_t^* = \mu + z_{t-1}^* + \tau log(\frac{A_{t-1}}{A_{t-1}^*}) + \epsilon_{a,t}^* \tag{45}$$

Levels of productivity processes A and A^* are cointegrated with speed 0.007 (a moderate amount).

$$z_t = \rho z_{t-1} + \epsilon_{z,t} \tag{46}$$

$$z_t^* = \rho z_{t-1}^* + \epsilon_{z,t}^* \tag{47}$$

I modeled shocks to bond so that there is only one shock that drives a wedge between the "country" preferred government bonds[19].

$$BH_t = \rho_b BH_{t-1} + \epsilon_{b,t} \tag{48}$$

[19] This choice is motivated by the intuition that these shocks matter here only since they drive a relative bond shock between the two countries.

$$BF_t^* = \rho_b BF_{t-1}^* - \epsilon_{b,t} \tag{49}$$

The expressions φ_t and φ_t^* within the GHH bundles of consumption and leisure are modeled as cointegrated with levels of productivity to guarantee balanced growth:

$$log(\frac{\varphi_t}{A_t}) = log(\varphi) + \mu(1-\hat{\theta}) + (\hat{\theta}-1)(\Delta a_t - log(\frac{\varphi_{t-1}}{A_{t-1}}))) \tag{50}$$

$$log(\frac{\varphi_t^*}{A_t^*}) = log(\varphi) + \mu(1-\hat{\theta}) + (\hat{\theta}-1)(\Delta a_t^* - log(\frac{\varphi_{t-1}^*}{A_{t-1}^*}))) \tag{51}$$

where $\hat{\theta} = 0.1$.

The expected change in exchange rate is $E_t[\Delta e_{t+1}]$ (when increases, there is expected Home depreciation):

$$E_t[\Delta e_{t+1}] = R_{f,t} - R_{f,t}^* + \frac{\partial \tilde{C}_t^{1-1/\psi} \psi^h}{\partial BH} + \frac{\partial \tilde{C}_t^{1-1/\psi} \psi^h}{\partial BF} - \frac{\partial \tilde{C}_t^{*,1-1/\psi}}{\psi}^{h*} \partial BH^* - \frac{\partial \tilde{C}_t^{*,1-1/\psi} \psi^{h*}}{\partial BF^*} \tag{52}$$

2.3.1 Parametrization

In order to get a sense of the impact of the addition of government bonds, I make note that in steady state, $BH/UC = 0.00033099$, $BH/Q = 0.00060953$, $BH/xaTot = 0.00044183$. Moreover, in most of the model simulations, $Sigmab/sigmaz = 2.0408$ and $Sigmab/sigmaa = 0.25974$.
Within the Dynare file, $\tilde{C}_t$ present inside $E_t[\Delta e_{t+1}]$ has been approximated by $\tilde{C}_t/A_t$.

2.4 Results

My simulations show that EZ-BKK models cannot replicate the UIP puzzle [20], but they do it if government bonds and convenience yields are inserted. Indeed, permanent shocks to bonds allow a typical parametrization to deliver the UIP puzzle at the condition of assuming that long-run news shocks and bond shocks are positively correlated. Under the typical preferences for early resolution of uncertainty, a positive long-run news to Home allocates more resources into bonds and at the same time more outflows of resources to Foreign to sustain consumption.
Both these results emerge from a minimal resource holding by bonds as we see from the ratio of Home bonds to UC being 0.03% (utility over period one consumption), the ratio of Home bonds to Q being 0.06% (utility from time $t+1$ on) and the ratio of Home bonds to Home production being 0.04%.
Being unable to show impulse response functions (IRFs) for permanent shocks,

[20] See Appendix B for the IRFs of the CCHH model.

I report UIP puzzle coefficients and confidence intervals under three different parametrization [21].

$$A = \begin{bmatrix} \rho_b = 1 \\ \sigma_a = 0.0385 \\ covariance(eb, ez) = 0.00001 \end{bmatrix}$$

$$UIP_A = \begin{bmatrix} 5.6412 \\ -4.5829 \end{bmatrix}$$

$$CI_A = \begin{bmatrix} 3.9473 & 7.3352 \\ -37.5118 & 28.3459 \end{bmatrix}$$

$$B = \begin{bmatrix} \rho_b = 1 \\ \sigma_a = 0.0385 \\ covariance(eb, ez) = 0 \end{bmatrix}$$

$$UIP_B = \begin{bmatrix} 6.7576 \\ 8.5064 \end{bmatrix}$$

$$CI_B = \begin{bmatrix} 5.0702 & 8.4451 \\ -27.1624 & 44.1752 \end{bmatrix}$$

$$C = \begin{bmatrix} \rho_b = 1 \\ \sigma_a = 0.0385 \\ covariance(eb, ez) = 0.00001 \\ covariance(eb, ea) = 0.0001 \end{bmatrix}$$

$$UIP_C = \begin{bmatrix} 4.4195 \\ -85.6790 \end{bmatrix}$$

$$CI_C = \begin{bmatrix} 1.8984 & 6.9405 \\ -107.8705 & -63.4875 \end{bmatrix}$$

$$D = \begin{bmatrix} \rho_b = 1 \\ \sigma_a = 0.0385 \\ covariance(eb, ez) = 0.00001 \\ covariance(eb, ea) = -0.0001 \end{bmatrix}$$

[21] These simulations are done without modeling the covariance of Foreign long-run shocks and the bond shock or the covariance of short-run shocks and the bond shock. Indeed in that case I find UIP coefficients negative and much bigger in absolute value.

$$UIP_D = \begin{bmatrix} 6.1062 \\ 8.1918 \end{bmatrix}$$

$$CI_D = \begin{bmatrix} 4.3977 & 7.8147 \\ -28.0239 & 44.4075 \end{bmatrix}$$

Under temporary bond shocks the only way in which the UIP puzzle is replicable is by having a nearly double standard deviation of short-run shocks under no other conditions.

$$E = \begin{bmatrix} \rho_b = 0.5 \\ \sigma_a = 0.05 \\ covariance(eb, ez) = 0.00001 \end{bmatrix}$$

$$UIP_E = \begin{bmatrix} 6.9173 \\ -0.2113 \end{bmatrix}$$

$$CI_E = \begin{bmatrix} 4.8733 & 8.9613 \\ -34.4910 & 34.0683 \end{bmatrix}$$

$$F = \begin{bmatrix} \rho_b = 0.5 \\ \sigma_a = 0.05 \\ covariance(eb, ez) = 0 \end{bmatrix}$$

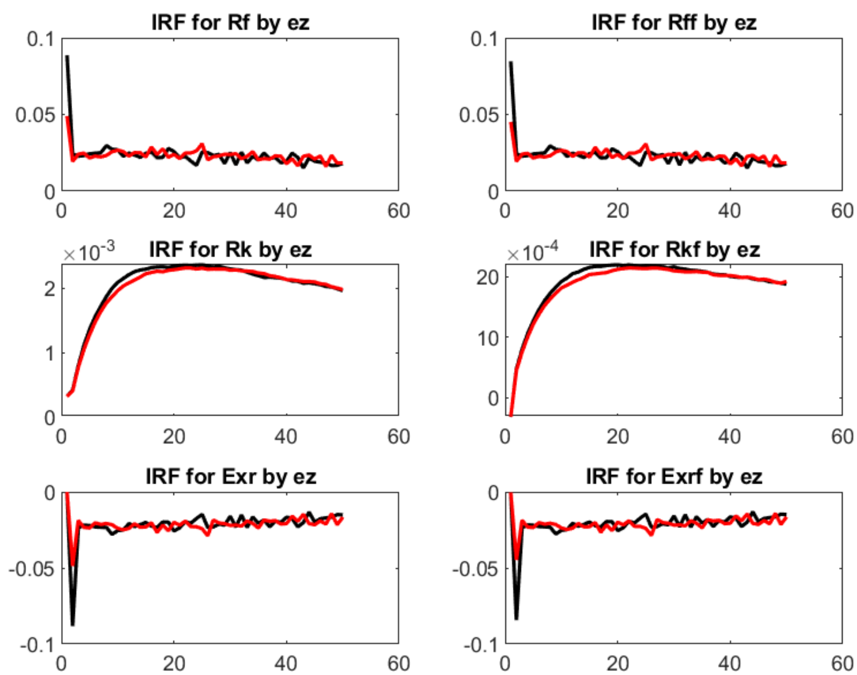
$$UIP_F = \begin{bmatrix} 6.9586 \\ -0.1788 \end{bmatrix}$$

$$CI_F = \begin{bmatrix} 4.9128 & 9.0044 \\ -34.4624 & 34.1048 \end{bmatrix}$$

2.4.1 Comparing IRFs: CCHH and baseline model.

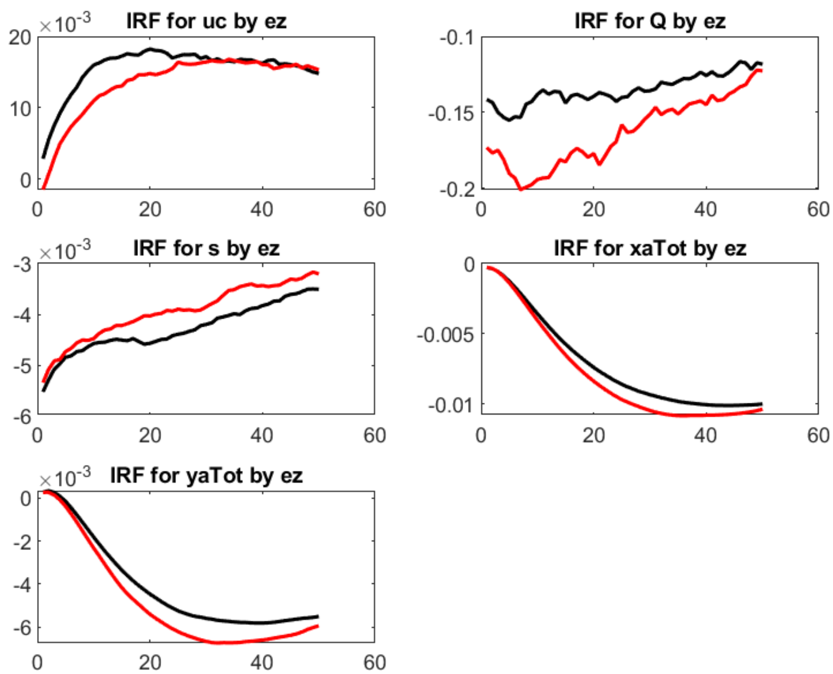
In this IRFs comparison, in black my model, in red the CCHH (2018) one. Changes seem to be minimal for the variables considered.

Figure 57: IRF comparison between CCHH(red) and my model. (1)



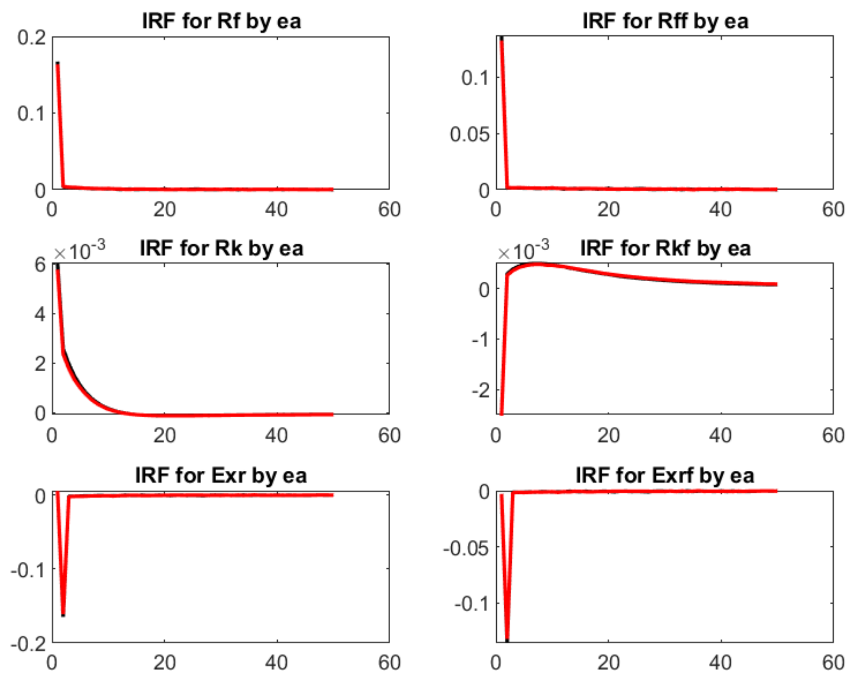
Annual deviations from steady state.

Figure 58: IRF comparison between CCHH(red) and my model. (2)



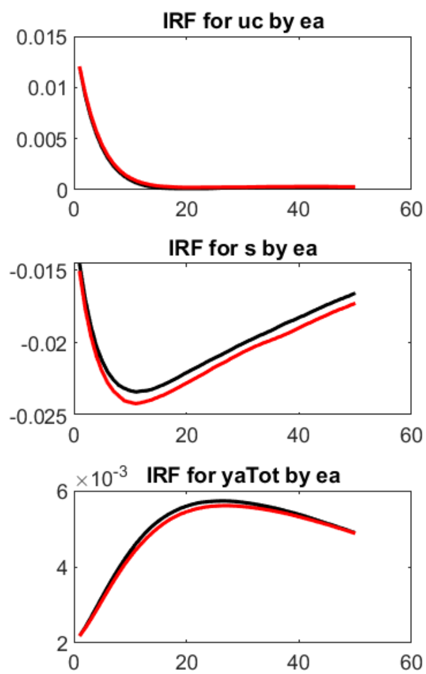
Annual log deviations from steady state.

Figure 59: IRF comparison between CCHH(red) and my model. (3)



Annual deviations from steady state.

Figure 60: IRF comparison between CCHH(red) and my model. (4)

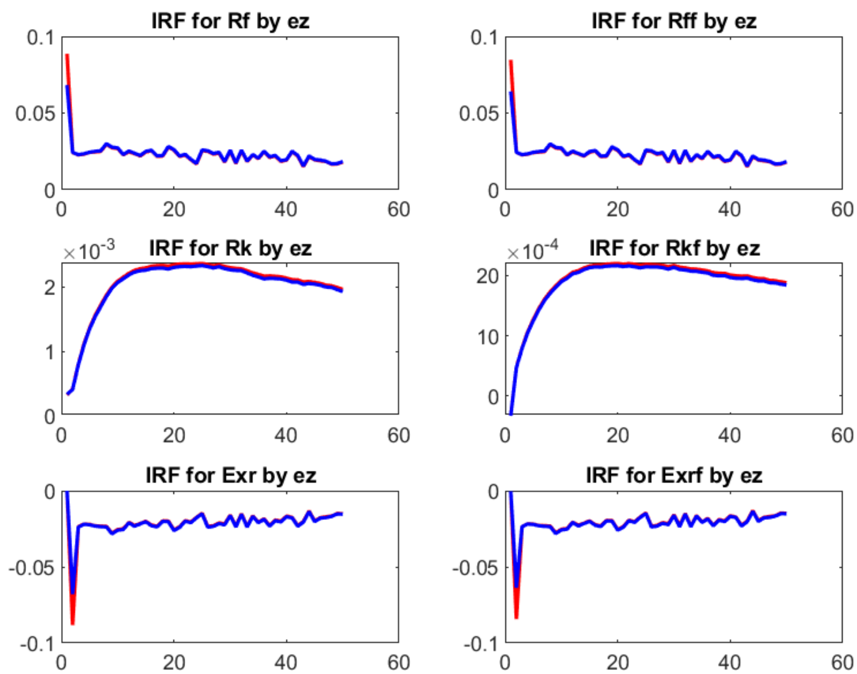


Annual log deviations from steady state.

2.4.2 Comparing IRFs: baseline with different covariances between shock processes.

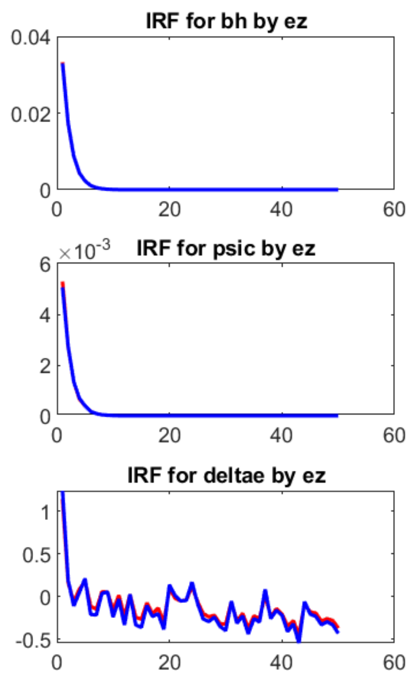
I compare IRFs from the baseline model (specification A above, but $\rho_b = 0.5$), a model with additional positive covariance between long-run news shocks and short-run shocks (specification C above,but $\rho_b = 0.5$) and finally the baseline model with higher covariance of short-run shocks (specification E from above).

Figure 61: Comparing IRFs: different covariances (1).



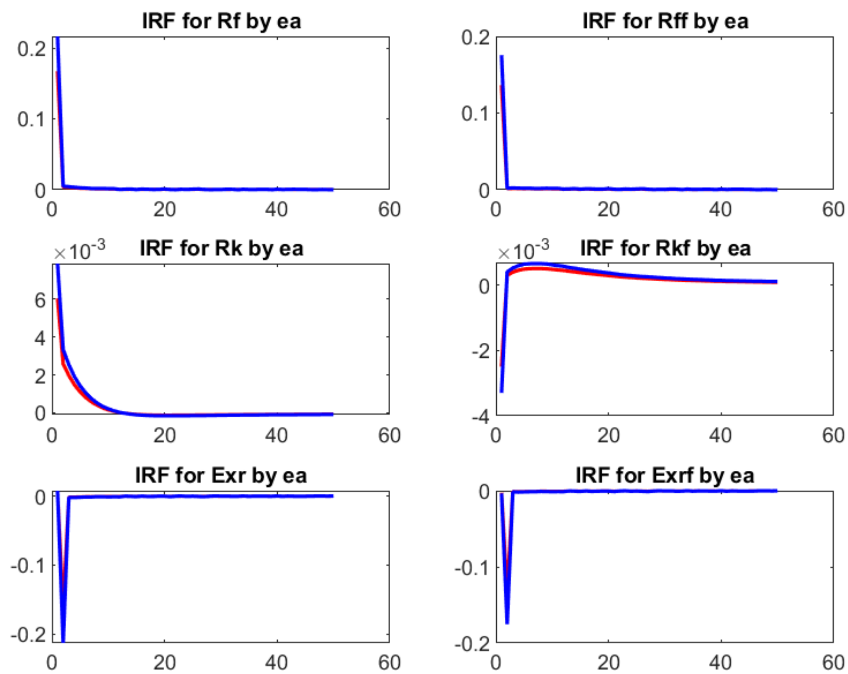
Annual deviations from steady state.

Figure 62: Comparing IRFs: different covariances (2).



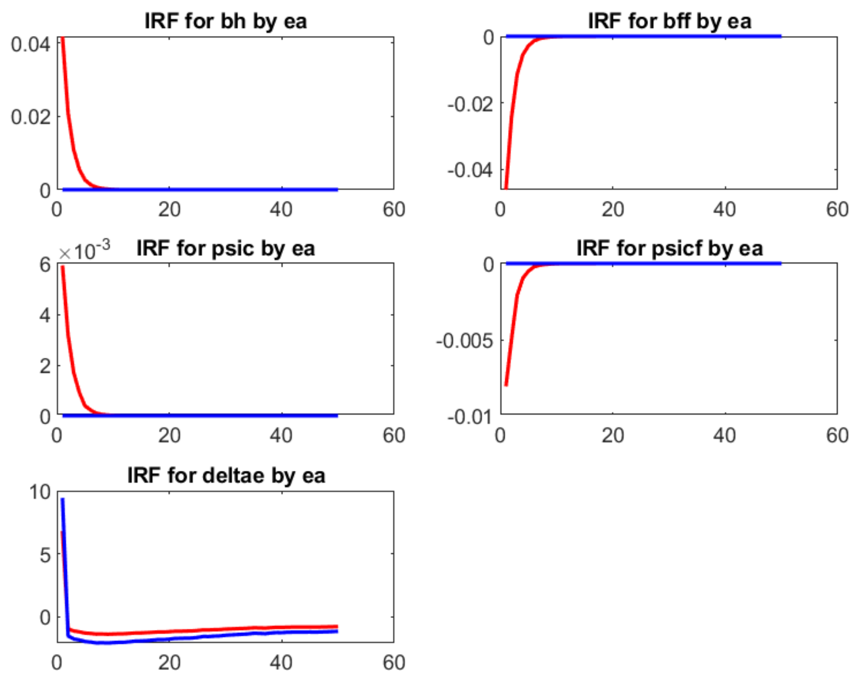
Annual log deviations from steady state.

Figure 63: Comparing IRFs: different covariances (3).



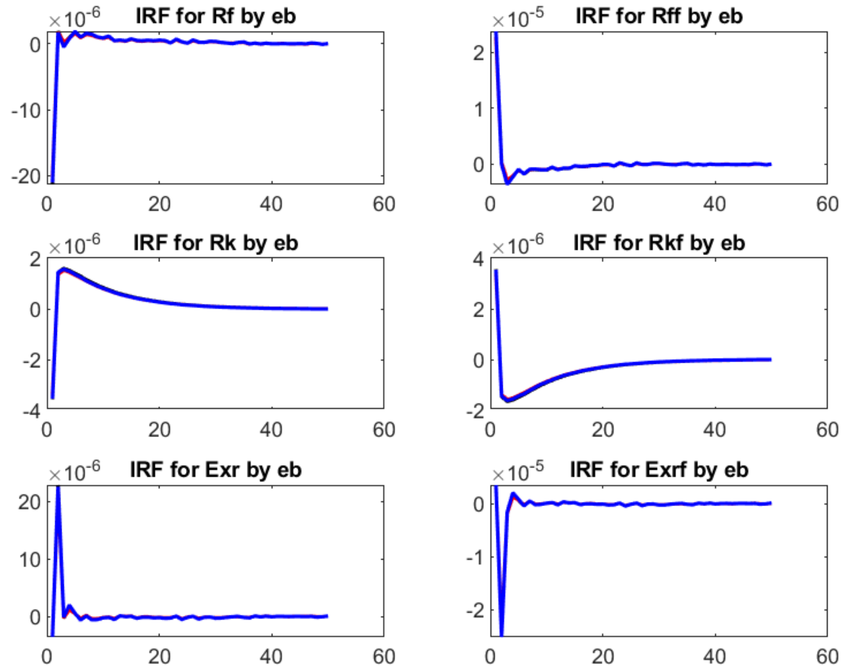
Annual deviations from steady state.

Figure 64: Comparing IRFs: different covariances (4).



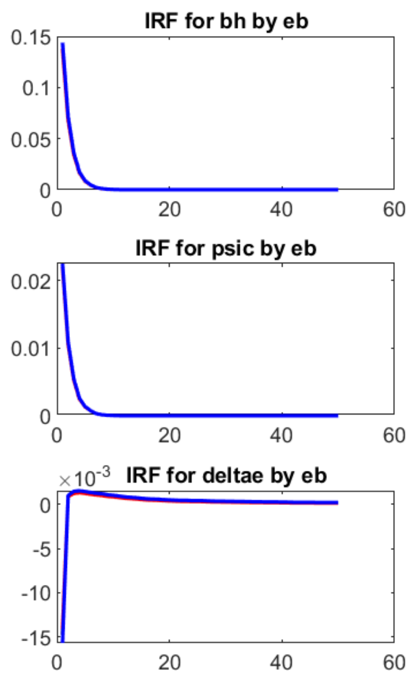
Annual log deviations from steady state.

Figure 65: Comparing IRFs: different covariances (5).



Annual deviations from steady state.

Figure 66: Comparing IRFs: different covariances (6).



Annual log deviations from steady state.

2.5 Conclusion

This paper replicates the UIP puzzle by combining an EZ-BKK model with exogenous fluctuations in convenience yields. Under a typical parametrization, permanent shocks to bonds and a positive covariance between bond shocks and long-run news shocks are needed to achieve this result. Under greater variance for short-run shocks, the UIP puzzle is replicated without particular covariances. Further research may find useful to endogenize bond shocks within this class of models.

Appendix A.

$$delta_{a\,t} = \mu + z_{t-1} - \tau\, arr_{t-1} + ea_t \tag{40}$$

$$delta_a f_t = \tau\, arr_{t-1} + \mu + zf_{t-1} + eaf_t \tag{41}$$

$$arr_t = ea_t + z_{t-1} + arr_{t-1}\,(1 - 2\,\tau) - zf_{t-1} - eaf_t \tag{42}$$

$$arrf_t = (-arr_t) \tag{43}$$

$$z_t = z_{t-1}\,\rho + ez_t \tag{44}$$

$$zf_t = zf_{t-1}\,\rho + ezf_t \tag{45}$$

$$w_t = \left(-\left(\frac{1}{\alpha} - 1\right)\right)(delta_{a\,t} - \mu)\; switch\_olg \tag{46}$$

$$wf_t = switch\_olg\,\left(-\left(\frac{1}{\alpha} - 1\right)\right)(delta_a f_t - \mu) \tag{47}$$

$$dtc_t = delta_{a\,t} + dtca_t \tag{48}$$

$$dtcf_t = delta_a f_t + dtcaf_t \tag{49}$$

$$dtca_t = tca_t - tca_{t-1} \tag{50}$$

$$dtcaf_t = tcaf_t - tcaf_{t-1} \tag{51}$$

$$dc_t = \lambda\, dx_t + (1-\lambda)\; dy_t \tag{52}$$

$$dcf_t = \lambda\, dyf_t + (1-\lambda)\; dxf_t \tag{53}$$

$$dx_t = delta_{a\,t} + dxa_t \tag{54}$$

$$dxf_t = delta_{a\,t} + dxaf_t \tag{55}$$

$$dy_t = delta_a f_t + dya_t \tag{56}$$

$$dyf_t = delta_a f_t + dyaf_t \tag{57}$$

$$dxa_t = xa_t - xa_{t-1} \tag{58}$$

$$dxaf_t = xaf_t - xaf_{t-1} \tag{59}$$

$$dya_t = ya_t - ya_{t-1} \tag{60}$$

$$dyaf_t = yaf_t - yaf_{t-1} \tag{61}$$

$$gdp\_growth_t = delta_{a\,t} + xaTot_t - xaTot_{t-1} \tag{62}$$

$$gdp\_growthf_t = delta_a f_t + yaTot_t - yaTot_{t-1} \tag{63}$$

$$diy_t = delta_a f_t + iay_t - iay_{t-1} \tag{64}$$

$$dpy_t = delta_a f_t + ya_t + p_t - p_{t-1} - ya_{t-1} \tag{65}$$

$$dpixf_t = delta_{a\,t} + p_t - p_{t-1} + iaxf_t - iaxf_{t-1} \tag{66}$$

$$exp\left(\left(1 - \frac{1}{\psi}\right) uc_t\right) = (1-\beta)\;(1 + exp\,(psic_t)) + \beta\, Q_t{}^{\theta} \tag{67}$$

$$exp\left(\left(1 - \frac{1}{\psi}\right) ucf_t\right) = (1-\beta)\;(1 + exp\,(psicf_t)) + \beta\, Qf_t{}^{\theta} \tag{68}$$

$$Q_t = exp\,((uc_{t+1} + dtc_{t+1})\;(1-\gamma)) \tag{69}$$

$$logQ_t = log\left(Q_t\right) \tag{70}$$

$$Qf_t = exp\left(\left(1-\gamma\right)\,\left(ucf_{t+1}+dtcf_{t+1}\right)\right) \tag{71}$$

$$logQf_t = log\left(Qf_t\right) \tag{72}$$

$$psic_t = log\left(\bar{\psi}\,\left(a_b\,exp\left(bh_t\right)^{\frac{\eta_b-1}{\eta_b}}+\left(1-a_b\right)\,exp\left(bf_t\right)^{\frac{\eta_b-1}{\eta_b}}\right)^{\frac{\eta_b}{\eta_b-1}}\right) \tag{73}$$

$$psicf_t = log\left(\bar{\psi}\,\left(\left(1-a_b\right)\,exp\left(bhf_t\right)^{\frac{\eta_b-1}{\eta_b}}+a_b\,exp\left(bff_t\right)^{\frac{\eta_b-1}{\eta_b}}\right)^{\frac{\eta_b}{\eta_b-1}}\right) \tag{74}$$

$$exp\left(bh_t\right) = m4\,m1+\rho_b\,exp\left(bh_{t-1}\right)+exp\left(eb_t\right)\,m3 \tag{75}$$

$$exp\left(bf_t\right) = m1\,m5+\rho_b\,exp\left(bf_{t-1}\right) \tag{76}$$

$$exp\left(bhf_t\right) = m1\,m5+\rho_b\,exp\left(bhf_{t-1}\right) \tag{77}$$

$$exp\left(bff_t\right) = m4\,m1+\rho_b\,exp\left(bff_{t-1}\right)-exp\left(eb_t\right)\,m3 \tag{78}$$

$$\begin{aligned}deltae_t = {} & exp\left(rf_t\right)-exp\left(rff_t\right)\\ & +\bar{\psi}\,exp\left(ca_t\right)^{1-\frac{1}{\psi}}\,\left(a_b\,exp\left(bh_t\right)^{\frac{\eta_b-1}{\eta_b}}+\left(1-a_b\right)\,exp\left(bf_t\right)^{\frac{\eta_b-1}{\eta_b}}\right)^{\frac{1}{\eta_b-1}}\,\left(a_b\,exp\left(bh_t\right)^{\frac{(-1)}{\eta_b}}-\left(1-a_b\right)\,exp\left(bf_t\right)^{\frac{(-1)}{\eta_b}}\right)\\ & -\bar{\psi}\,exp\left(caf_t\right)^{1-\frac{1}{\psi}}\,\left(\left(1-a_b\right)\,exp\left(bhf_t\right)^{\frac{\eta_b-1}{\eta_b}}+a_b\,exp\left(bff_t\right)^{\frac{\eta_b-1}{\eta_b}}\right)^{\frac{1}{\eta_b-1}}\,\left(\left(1-a_b\right)\,exp\left(bhf_t\right)^{\frac{(-1)}{\eta_b}}+a_b\,exp\left(bff_t\right)^{\frac{(-1)}{\eta_b}}\right)\end{aligned} \tag{79}$$

$$exp\left(m_t\right) = \frac{\beta\,\frac{1+exp(psic_t)}{1+exp\left(psic_{t-1}\right)}\,exp\left(dtc_t\,\frac{(-1)}{\psi}\right)\,exp\left(\left(dtc_t+uc_t\right)\,\left(\frac{1}{\psi}-\gamma\right)\right)}{exp\left(logQ_{t-1}\,\left(1-\theta\right)\right)} \tag{80}$$

$$exp\left(mf_t\right) = \frac{\beta\,\frac{1+exp(psicf_t)}{1+exp\left(psicf_{t-1}\right)}\,exp\left(dtcf_t\,\frac{(-1)}{\psi}\right)\,exp\left(\left(\frac{1}{\psi}-\gamma\right)\,\left(dtcf_t+ucf_t\right)\right)}{exp\left(\left(1-\theta\right)\,logQf_{t-1}\right)} \tag{81}$$

$$exp\left(xaTot_t\right) = exp\left(bhf_t\right)+exp\left(bh_t\right)+exp\left(xa_t\right)+exp\left(xaf_t\right)+exp\left(iax_t\right)+exp\left(iay_t-arr_t\right) \tag{82}$$

$$exp\left(yaTot_t\right) = exp\left(bff_t\right)+exp\left(bf_t\right)+exp\left(ya_t\right)+exp\left(yaf_t\right)+exp\left(arr_t+iaxf_t\right)+exp\left(iayf_t\right) \tag{83}$$

$$ca_t = \lambda\,xa_t+\left(1-\lambda\right)\,\left(ya_t-arr_t\right) \tag{84}$$

$$caf_t = \left(1-\lambda\right)\,\left(arr_t+xaf_t\right)+\lambda\,yaf_t \tag{85}$$

$$exp\left(tca_t\right) = exp\left(ca_t\right)-\varphi\,exp\left(n_t\,\left(1+\frac{1}{f}\right)\right)\,exp\left(sla_t\right) \tag{86}$$

$$exp\left(tcaf_t\right) = exp\left(caf_t\right)-\varphi\,exp\left(\left(1+\frac{1}{f}\right)\,nf_t\right)\,exp\left(slaf_t\right) \tag{87}$$

$$sla_t = \left(1-\phi\right)\,\left(\mu+sla_{t-1}-delta_{a\,t}\right) \tag{88}$$

$$slaf_t = \left(1-\phi\right)\,\left(\mu+slaf_{t-1}-delta_a f_t\right) \tag{89}$$

$$xaTot_t = \alpha\,ka_t+n_t\,\left(1-\alpha\right) \tag{90}$$

$$yaTot_t = \alpha\,kaf_t+nf_t\,\left(1-\alpha\right) \tag{91}$$

$$exp\left(ka_t\right) = \left(1-\delta_k\right)\,exp\left(ka_{t-1}\right)\,exp\left(\left(-delta_{a\,t}\right)\right)+exp\left(\left(-delta_{a\,t}\right)\right)\,exp\left(w_t\right)\,exp\left(ga_{t-1}\right) \tag{92}$$

$$exp\left(kaf_t\right) = \left(1-\delta_k\right)\,exp\left(kaf_{t-1}\right)\,exp\left(\left(-delta_a f_t\right)\right)+exp\left(\left(-delta_a f_t\right)\right)\,exp\left(wf_t\right)\,exp\left(gaf_{t-1}\right) \tag{93}$$

$$ga_t = iax_t\,\lambda_I + iaxf_t\,(1-\lambda_I) \tag{94}$$
$$gaf_t = iay_t\,(1-\lambda_I) + iayf_t\,\lambda_I \tag{95}$$
$$\frac{1}{\lambda_I}\,exp\left(iax_t\,\frac{1}{xi}\right)\,exp\left(ga_t\,\left(-\left(\frac{1}{xi}\right)\right)\right) = exp\left(mx_{t+1} + pk_{t+1} + w_{t+1}\right) \tag{96}$$
$$\frac{1}{1-\lambda_I}\,exp\left(iay_t\,\frac{1}{xi}\right)\,exp\left(gaf_t\,\left(-\left(\frac{1}{xi}\right)\right)\right) = exp\left(mx_{t+1} + pkf_{t+1} + p_{t+1} + wf_{t+1}\right) \tag{97}$$
$$exp\left(gaf_t\,\left(-\left(\frac{1}{xi}\right)\right)\right)\,\frac{1}{\lambda_I}\,exp\left(iayf_t\,\frac{1}{xi}\right) = exp\left(wf_{t+1} + pkf_{t+1} + my_{t+1}\right) \tag{98}$$
$$exp\left(ga_t\,\left(-\left(\frac{1}{xi}\right)\right)\right)\,\frac{1}{1-\lambda_I}\,exp\left(iaxf_t\,\frac{1}{xi}\right) = exp\left(w_{t+1} + pk_{t+1} + my_{t+1} - p_{t+1}\right) \tag{99}$$
$$NN\_tot = exp\left(n_t\right) + exp\left(l_t\right) \tag{100}$$
$$NN\_tot = exp\left(nf_t\right) + exp\left(lf_t\right) \tag{101}$$
$$(1-\alpha)\;exp\left(xaTot_t - n_t\right) = exp\left(sla_t\right)\,\varphi\,\left(1+\frac{1}{f}\right)\,exp\left(\frac{n_t}{f}\right)\,\frac{1}{\lambda}\,exp\left(\frac{1}{beth}\,\left(xa_t - ca_t\right)\right) \tag{102}$$
$$(1-\alpha)\;exp\left(yaTot_t - nf_t\right) = \frac{1}{\lambda}\,exp\left(slaf_t\right)\,\varphi\,\left(1+\frac{1}{f}\right)\,exp\left(\frac{nf_t}{f}\right)\,exp\left(\frac{1}{beth}\,\left(yaf_t - caf_t\right)\right) \tag{103}$$
$$\frac{1}{exp\left(rf_t\right)} = exp\left(m_t\right) \tag{104}$$
$$\frac{1}{exp\left(rff_t\right)} = exp\left(mf_t\right) \tag{105}$$
$$exp\left(pk_t\right) = \alpha\,exp\left(xaTot_t - ka_t\right) + (1-\delta_k)\;exp\left(qk_t\right) \tag{106}$$
$$exp\left(pkf_t\right) = \alpha\,exp\left(yaTot_t - kaf_t\right) + (1-\delta_k)\;exp\left(qkf_t\right) \tag{107}$$
$$mx_t = m_t + \frac{1}{beth}\,\left(dc_t - dx_t\right) \tag{108}$$
$$my_t = mf_t + \frac{1}{beth}\,\left(dcf_t - dyf_t\right) \tag{109}$$
$$1 = exp\left(mx_{t+1} + rk_{t+1}\right) \tag{110}$$
$$1 = exp\left(my_{t+1} + rkf_{t+1}\right) \tag{111}$$
$$rk_t = pk_t - qk_{t-1} \tag{112}$$
$$rkf_t = pkf_t - qkf_{t-1} \tag{113}$$
$$exr_t = rk_t - rf_{t-1} \tag{114}$$
$$exrf_t = rkf_t - rff_{t-1} \tag{115}$$
$$exp\left(p\_xf_t\right) = exp\left(mx_{t+1} + log\left(1 + exp\left(p\_xf_{t+1}\right)\right) + dxf_{t+1}\right) \tag{116}$$
$$exp\left(p\_iy_t\right) = exp\left(mx_{t+1} + log\left(1 + exp\left(p\_iy_{t+1}\right)\right) + diy_{t+1}\right) \tag{117}$$
$$exp\left(p\_py_t\right) = exp\left(mx_{t+1} + log\left(1 + exp\left(p\_py_{t+1}\right)\right) + dpy_{t+1}\right) \tag{118}$$
$$exp\left(p\_pixf_t\right) = exp\left(mx_{t+1} + log\left(1 + exp\left(p\_pixf_{t+1}\right)\right) + dpixf_{t+1}\right) \tag{119}$$
$$p_t = arr_t + xa_t + log\left(\frac{1-\lambda}{\lambda}\right) - ya_t \tag{120}$$
$$pf_t = \left(-p_t\right) \tag{121}$$
$$s_t = dc_t + m_t + s_{t-1} - mf_t - dcf_t \tag{122}$$
$$s_t = xa_t + log\left(\frac{1-\lambda}{\lambda}\right) - xaf_t \tag{123}$$
$$s_t = ya_t + log\left(\frac{\lambda}{1-\lambda}\right) - yaf_t \tag{124}$$
$$sf_t = \left(-s_t\right) \tag{125}$$

Variable	LaTeX	Description
`da`	$delta_a$	Home productivity growth
`daf`	$delta_a f$	Foreign productivity growth
`arr`	arr	Home cointegration term
`arrf`	$arrf$	Foreign cointegration term
`z`	z	Home Long Run Risk
`zf`	zf	Foreign Long Run Risk
`w`	w	Home productivity gap (=1)
`wf`	wf	Foreign productivity gap (=1)
`dc`	dc	Home consumption growth
`dcf`	dcf	Foreign consumption growth
`dx`	dx	Growth rate of Home consumption of Home good
`dxf`	dxf	Growth rate of Foreign consumption of Home good
`dy`	dy	Growth rate of Home consumption of Foreign good
`dyf`	dyf	Growth rate of Foreign consumption of Foreign good
`dxa`	dxa	dx over Home productivity
`dxaf`	$dxaf$	dxf over Foreign productivity
`xa`	xa	log of Home consumption of X over Home productivity
`xaf`	xaf	log of Foreign consumption of X over Home productivity
`dya`	dya	growth rate of ya
`dyaf`	$dyaf$	growth rate of ya
`ya`	ya	log of Home consumption of Y over Foreign productivity
`yaf`	yaf	log of Foreign consumption of Y over Foreign productivity
`uc`	uc	log of Home utility over consumption bundle
`ucf`	ucf	log of Foreign utility over consumption bundle
`Q`	Q	Epstein Zin certain equivalent for Home
`logQ`	$logQ$	log Q
`Qf`	Qf	Epstein Zin certain equivalent for Foreign
`logQf`	$logQf$	log Q*
`m`	m	log Home SDF in C_tilda units
`mf`	mf	log Foreign SDF in C_tilda* units
`mx`	mx	log Home SDF in X units
`my`	my	log Foreign SDF in Y units

Variable	LaTeX	Description
`p`	p	log terms of trade
`pf`	pf	log Foreign terms of trade
`ka`	ka	log Home capital to Home productivity
`kaf`	kaf	log Foreign capital to Foreign productivity
`iax`	iax	log Home investment into Home Capital over Home product.
`iaxf`	$iaxf$	log Foreign investment into Home Capital over Home product.
`iay`	iay	log Home investment into Foreign Capital over Foreign producti.
`iayf`	$iayf$	log Foreign investment into Foreign Capital over Foreign producti.
`ga`	ga	log Home investment bundle over Home productivity
`gaf`	gaf	log Foreign investment bundle over Foreign productivity
`s`	s	log Home Pareto weight
`sf`	sf	log Foreign Pareto weight
`rf`	rf	Home risk free rate
`rff`	rff	Foreign risk free rate
`pk`	pk	Log cum-dividend price of Home Capital in X units
`pkf`	pkf	Log cum-dividend price of Foreign Capital in Y units
`qk`	qk	Log ex-dividend price of Home Capital in X units
`qkf`	qkf	Log ex-dividend price of Foreign Capital in Y units
`rk`	rk	Home return on capital
`rkf`	rkf	Foreign return on capital
`exr`	exr	Home excess return on capital
`exrf`	$exrf$	Foreign excess return on capital
`xaTot`	$xaTot$	log Home GDP over Home productiv.
`yaTot`	$yaTot$	log Foreign GDP over Foreign productiv.

Variable	LaTeX	Description
`dtc`	dtc	Growth rate of C_tilda
`dtcf`	$dtcf$	Growth rate of C_tilda*
`dtca`	$dtca$	Growth rate of C_tilda over Home productiv.
`dtcaf`	$dtcaf$	Growth rate of C_tilda* over Foreign productiv.
`tca`	tca	log C_tilda over Home productiv.
`tcaf`	$tcaf$	log C_tilda* over Foreign productiv.
`ca`	ca	log C over Home productiv.
`caf`	caf	log C* over Foreign productiv.
`l`	l	log Home leisure
`lf`	lf	log Foreign leisure
`n`	n	log Home labor
`nf`	nf	log Foreign labor
`gdp_growth`	gdp_growth	Growth rate of GDP
`gdp_growthf`	$gdp\_growthf$	Growth rate of Foreign GDP
`diy`	diy	Growth rate of Home investment into Foreign capital
`dpy`	dpy	Growth rate of home imported consumption goods in X units
`dpixf`	$dpixf$	Growth rate of home imported capital goods in X units
`p_xf`	p_xf	log price to consumption ratio of Foreign consumption of Home good in X units
`p_iy`	p_iy	log price to capital ratio of Home investment into Foreign capital in X units
`p_py`	p_py	log price to consumption ratio of Home imported consumption goods in X units
`p_pixf`	p_pixf	log price to capital ratio of Home imported capital goods in X units
`sla`	sla	log SL (standard of livigns) over Home productivity
`slaf`	$slaf$	log SL* (standard of livigns) over Foreign productivity
`bh`	bh	log Home usage of Home government bonds
`bhf`	bhf	log Foreign usage of Home government bonds
`bf`	bf	log Home usage of Foreign government bonds
`bff`	bff	log Foreign usage of Foreign government bonds
`psic`	$psic$	log Home convenience function
`psicf`	$psicf$	log Foreign convenience function
`deltae`	$deltae$	expected change in exchange rates

Variable	LaTeX	Description
`ea`	ea	Home short-run shock
`eaf`	eaf	Foreign short-run shock
`ez`	ez	Home long-run shock
`ezf`	ezf	Foreign long-run shock
`eb`	eb	Relative bond shock

Parameter	Value	Description
α	0.300	Capital Income Share
β	0.970	Subjective discount factor
$beth$	1.000	1
δ_k	0.060	Capital depreciation rate
γ	10.450	Relative risk aversion
ψ	1.200	IES, Intertemporal Elasticity of Substitution
λ	0.920	Home bias in consumption
μ	0.018	Long run mean of productivity growth
ρ	0.990	Persistence of long run risk
τ	0.007	Cointegration parameter
λ_I	0.920	Home bias in investment
xi	1.000	1
θ	-0.018	(1-1/ies)/(1-gamma)
NN_tot	3.000	Total number of hours available
$\hat{N}$	1.000	Total number of hours worked at deterministic steady state
f	1.550	Consumption-labor elasticity
ϕ	0.200	Cointegration speed in GHH
phi_1	0.600	No longer used
phi_2	0.300	No longer used
φ	0.445	Consumption labor weight, consistent with Nbar
$switch\_olg$	0.000	Put zero
η_b	0.250	Elasticity of substitution between Home and Foreign bonds
$\bar{\psi}$	0.000	Constant within the convenience function
a_b	1.000	Home bias in bonds
$m1$	0.006	Used for SS of bonds
$m2$	0.006	Used for SS of bonds
$m3$	0.010	Used for SS of bonds
ρ_b	0.500	Persistence in bond shock
$m4$	0.097	m4
$m5$	0.003	m5
σ_a	0.038	St. dev. in Home short-run shock
σ_a^*	0.038	St. dev. in Foreign short-run shock
σ_z	0.005	St. dev. in Home long-run shock
σ_z^*	0.005	St. dev. in Foreign long-run shock
σ_b	0.010	St. dev. in relative bond shock

2.6 Appendix B. IRFs for CCHH (2018).

2.6.1 Ea shock

Figure 67: IRFs for CCHH. Home short-run shock (1).

Annual log deviations from steady state.

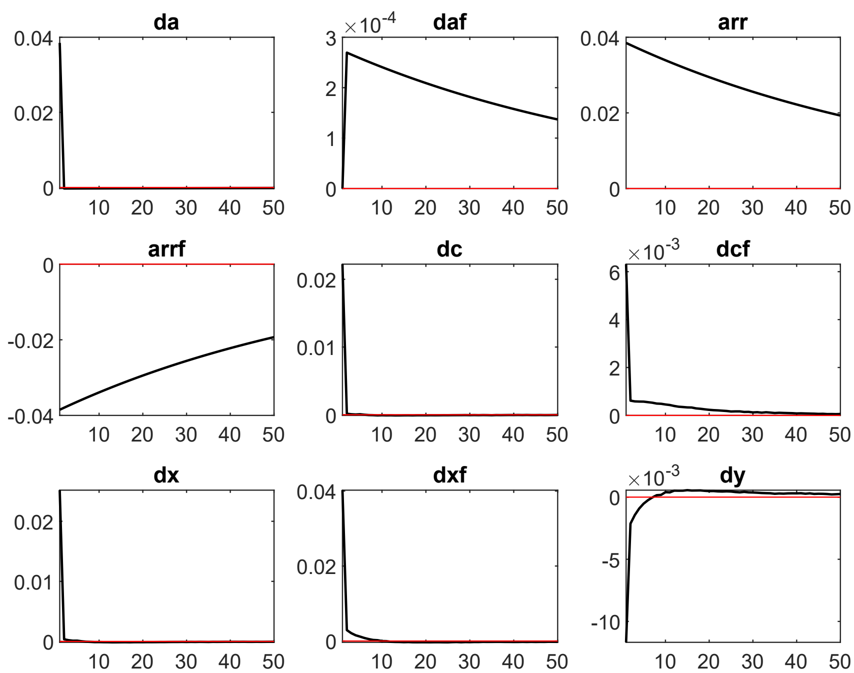


Figure 68: IRFs for CCHH. Home short-run shock (2).

Annual log deviations from steady state.

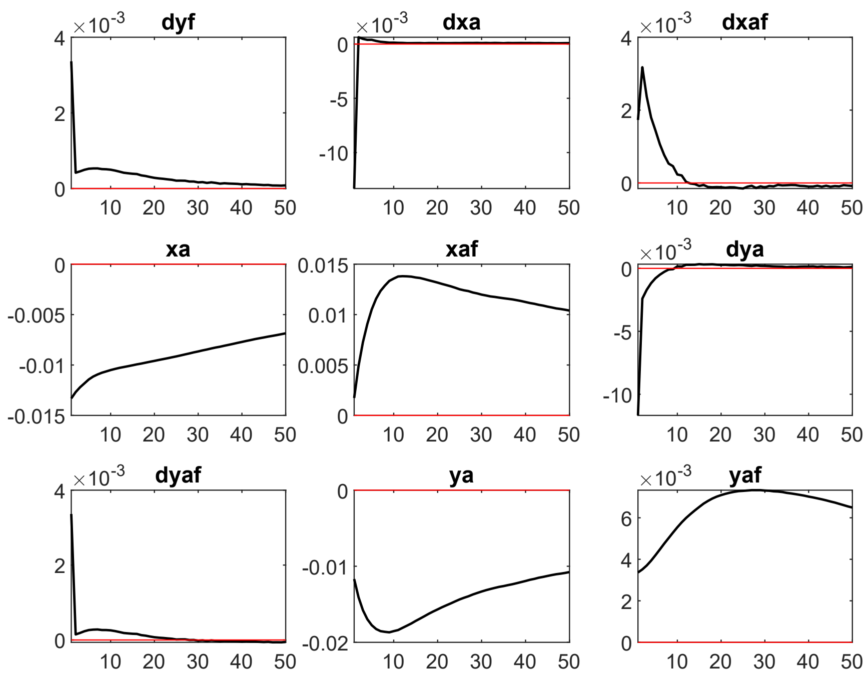


Figure 69: IRFs for CCHH. Home short-run shock (3).

Annual log deviations from steady state.

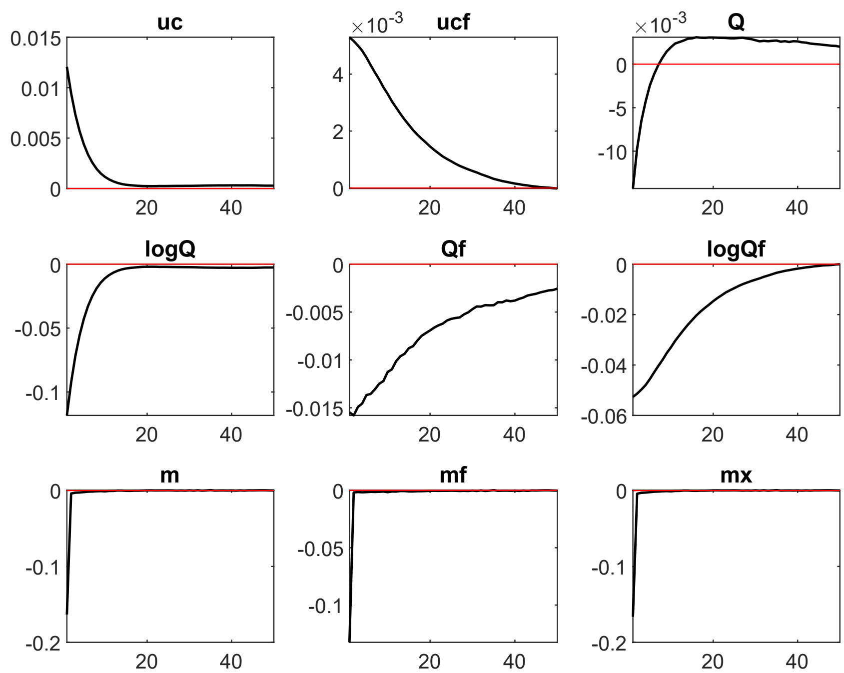


Figure 70: IRFs for CCHH. Home short-run shock (4).

Annual log deviations from steady state.

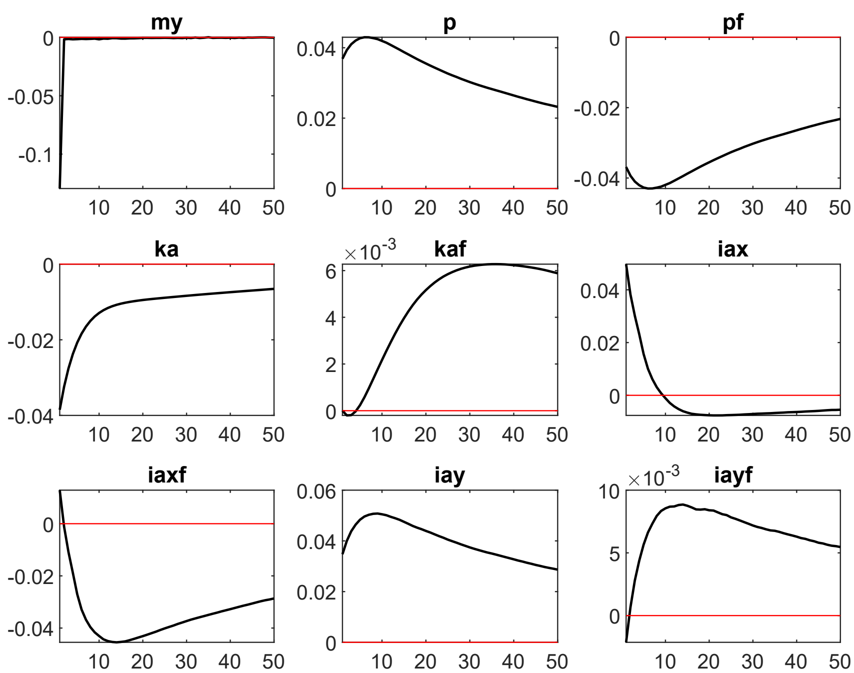


Figure 71: IRFs for CCHH. Home short-run shock (5).

Annual log deviations from steady state.

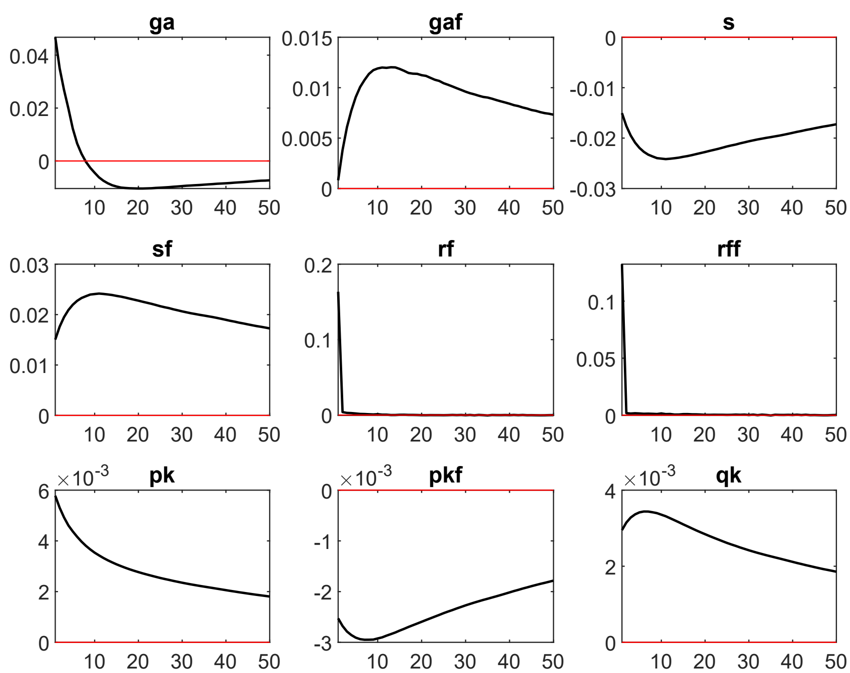


Figure 72: IRFs for CCHH. Home short-run shock (6).

Annual log deviations from steady state.

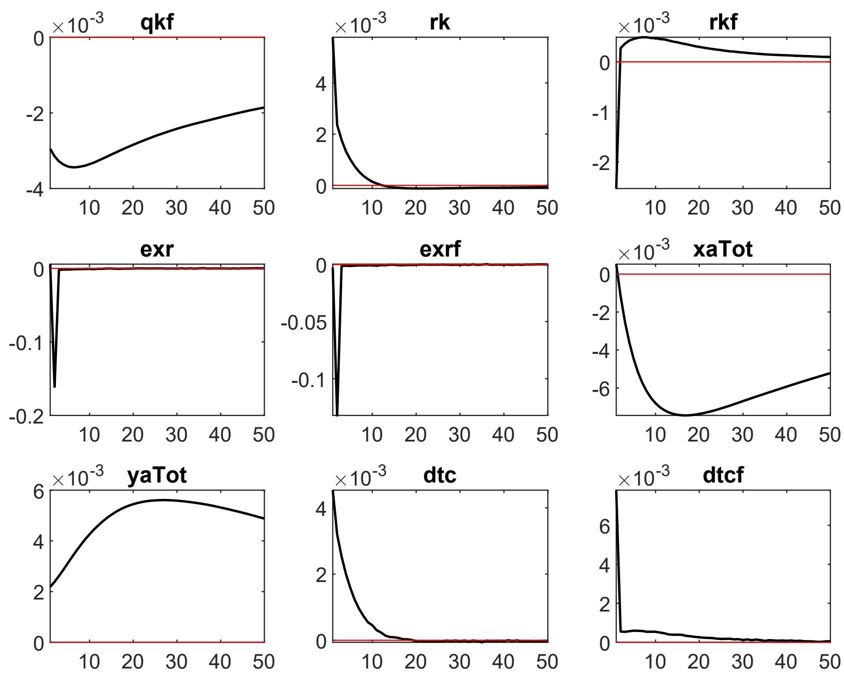


Figure 73: IRFs for CCHH. Home short-run shock (7).

Annual log deviations from steady state.

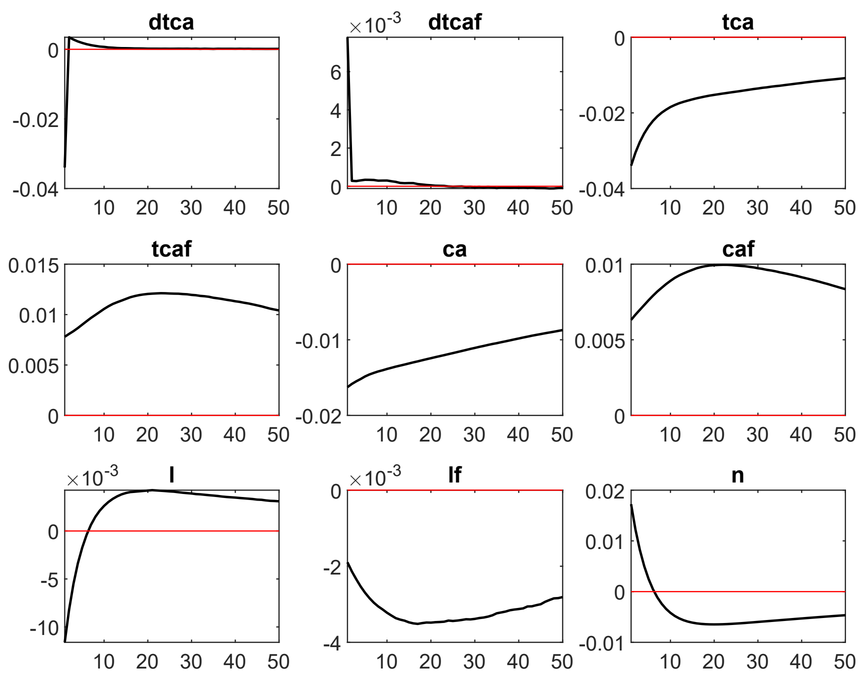


Figure 74: IRFs for CCHH. Home short-run shock (8).

Annual log deviations from steady state.

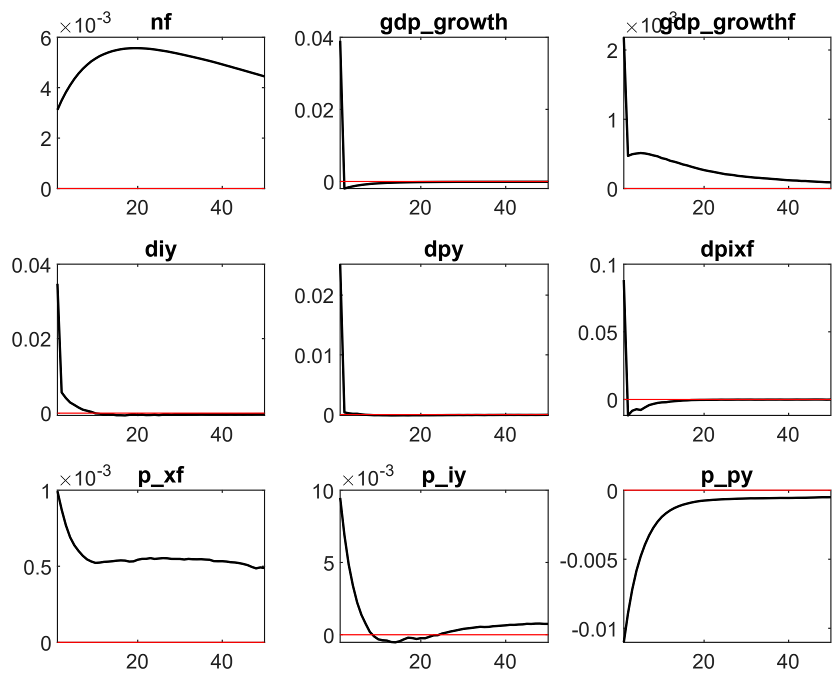
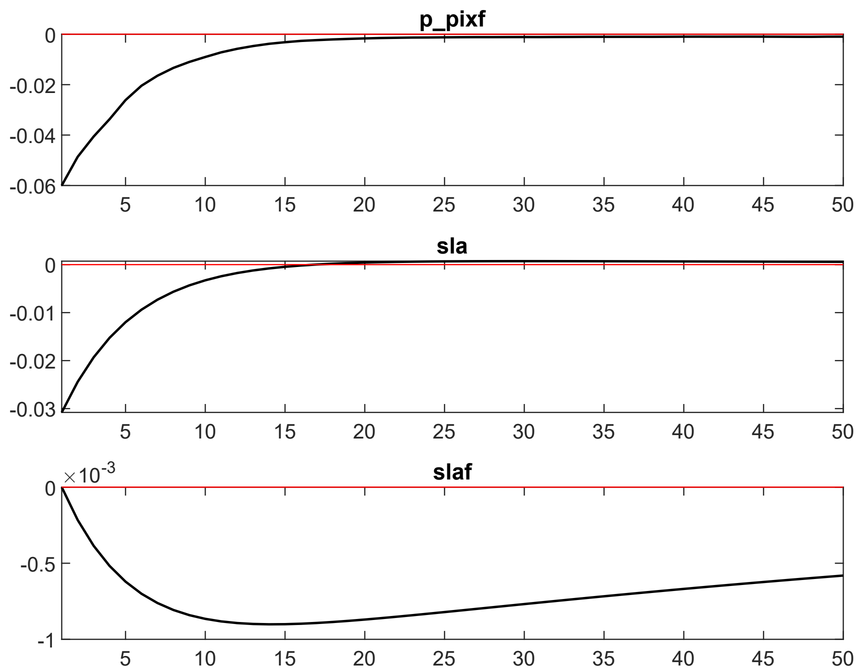


Figure 75: IRFs for CCHH. Home short-run shock (9).

Annual log deviations from steady state.



2.6.2 Ez shock

Figure 76: IRFs for CCHH. Home long-run shock (1).

Annual log deviations from steady state.

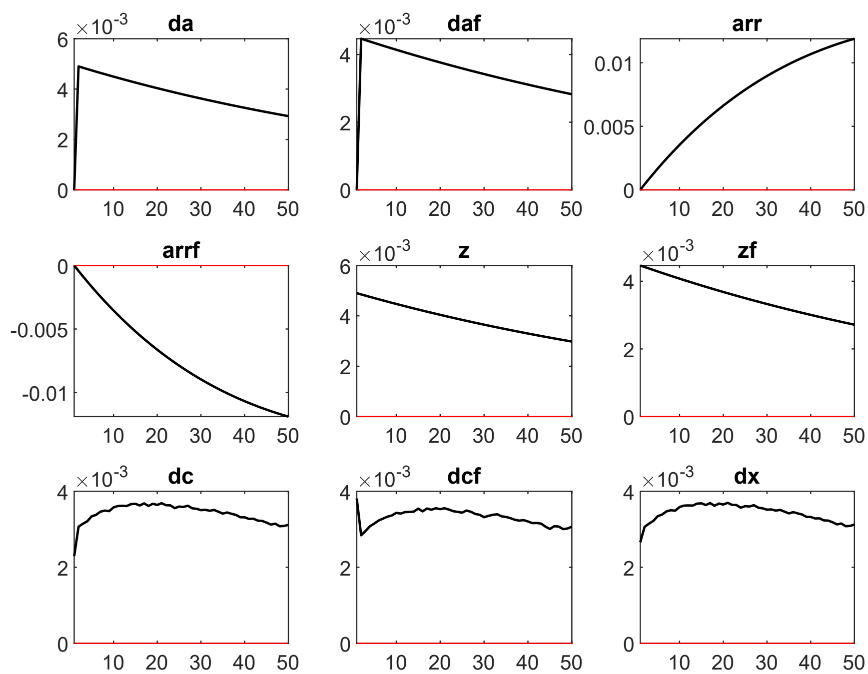


Figure 77: IRFs for CCHH. Home long-run shock (2).

Annual log deviations from steady state.

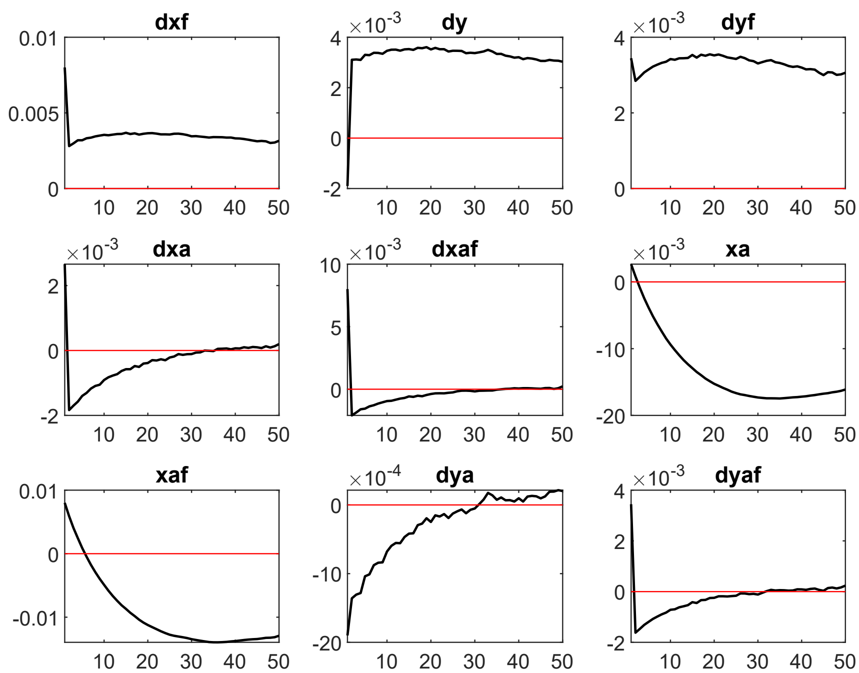


Figure 78: IRFs for CCHH. Home long-run shock (3).

Annual log deviations from steady state.

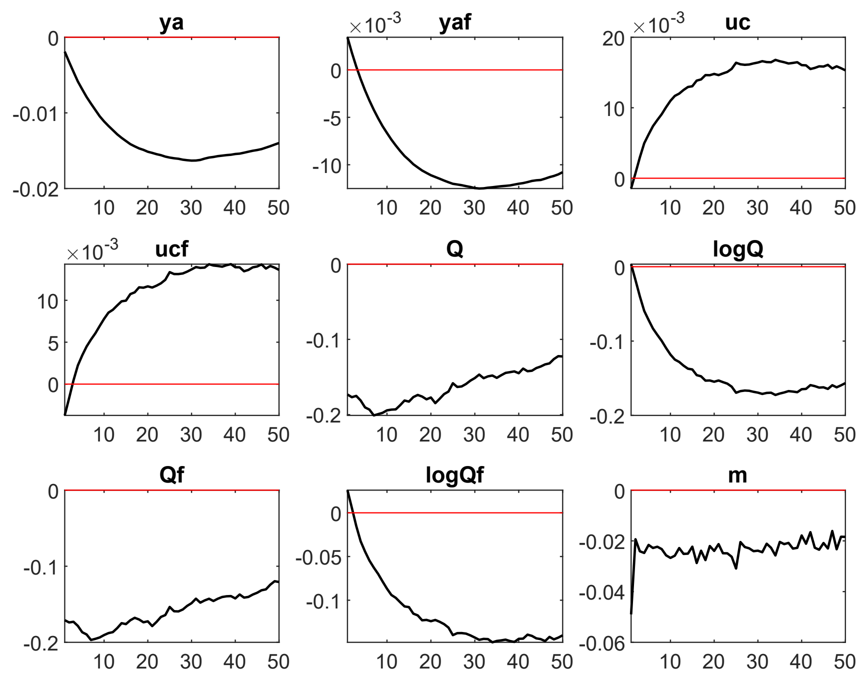


Figure 79: IRFs for CCHH. Home long-run shock (4).

Annual log deviations from steady state.

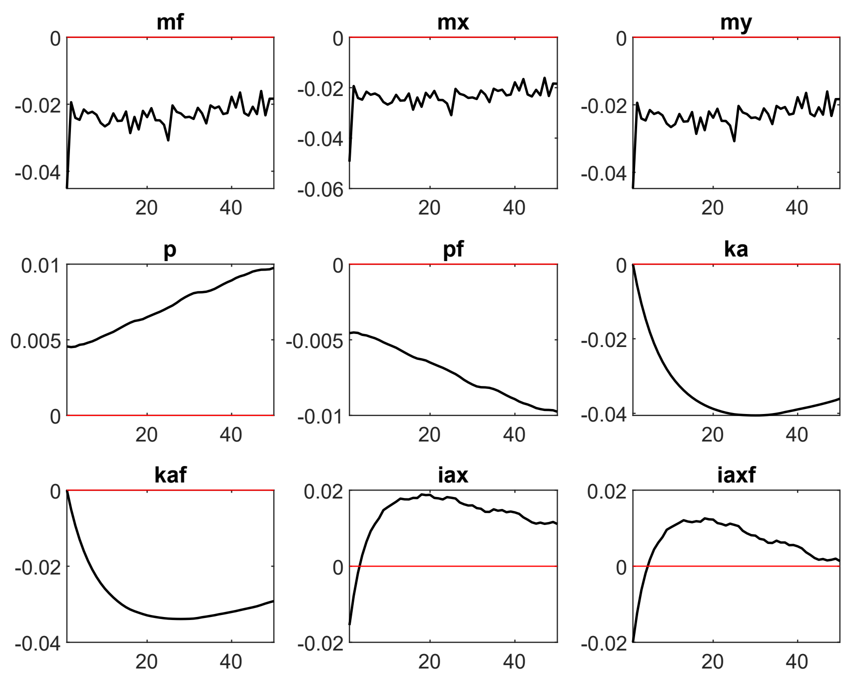


Figure 80: IRFs for CCHH. Home long-run shock (5).

Annual log deviations from steady state.

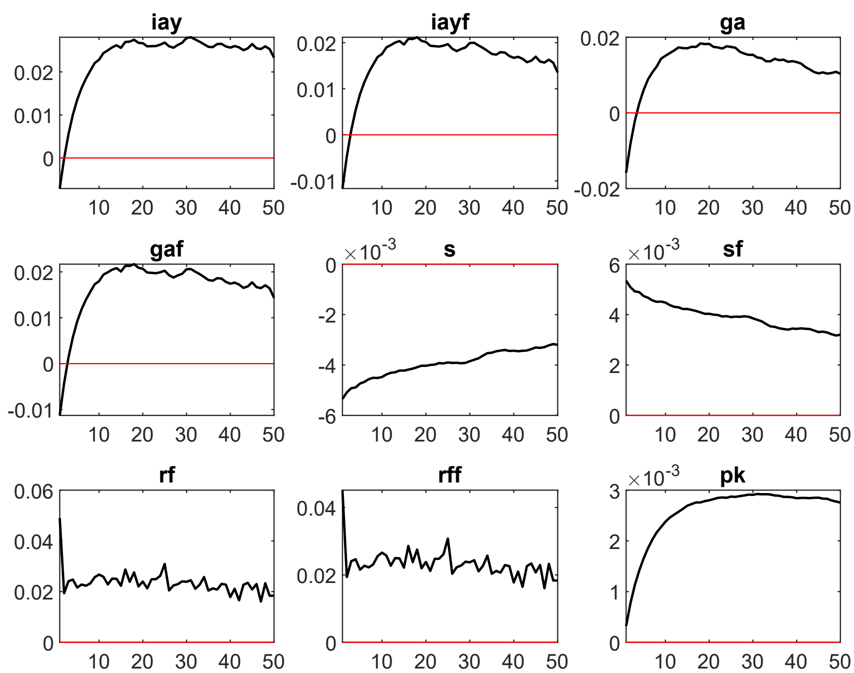


Figure 81: IRFs for CCHH. Home long-run shock (6).

Annual log deviations from steady state.

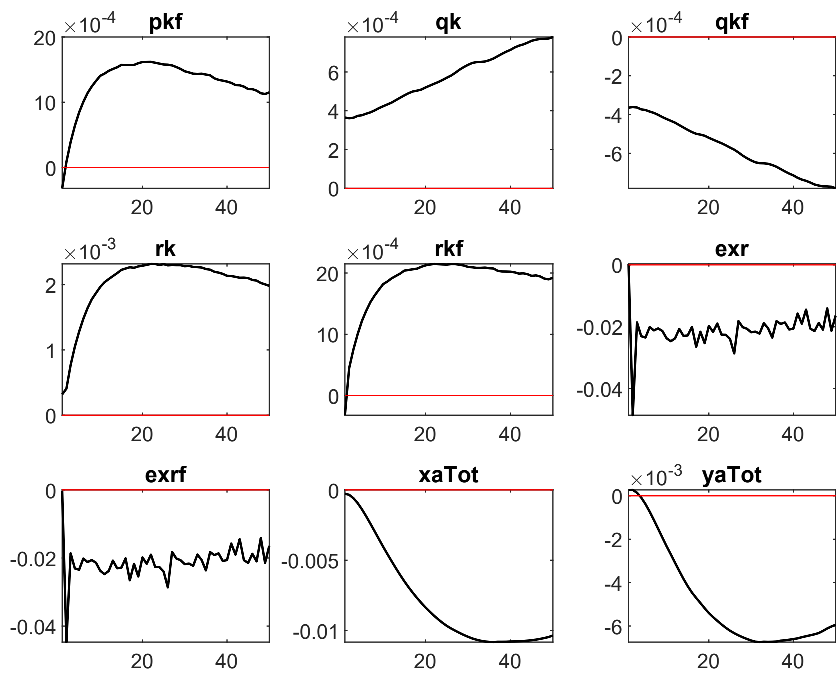


Figure 82: IRFs for CCHH. Home long-run shock (7).

Annual log deviations from steady state.

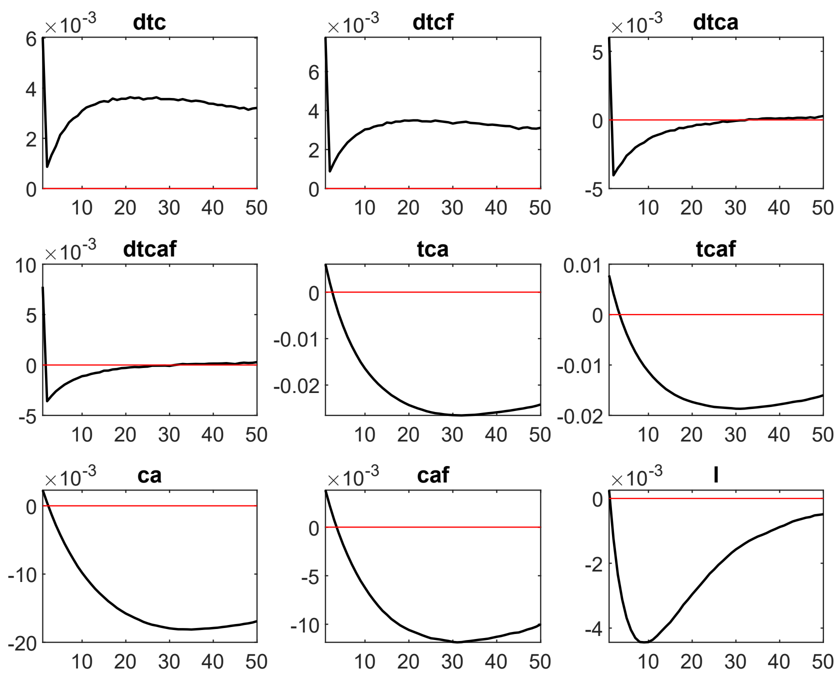


Figure 83: IRFs for CCHH. Home long-run shock (8).

Annual log deviations from steady state.

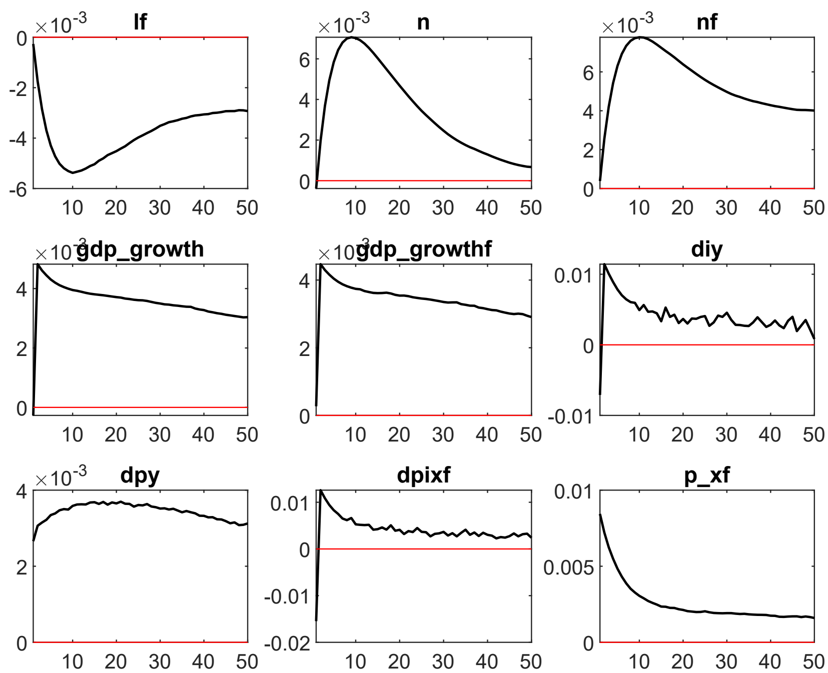
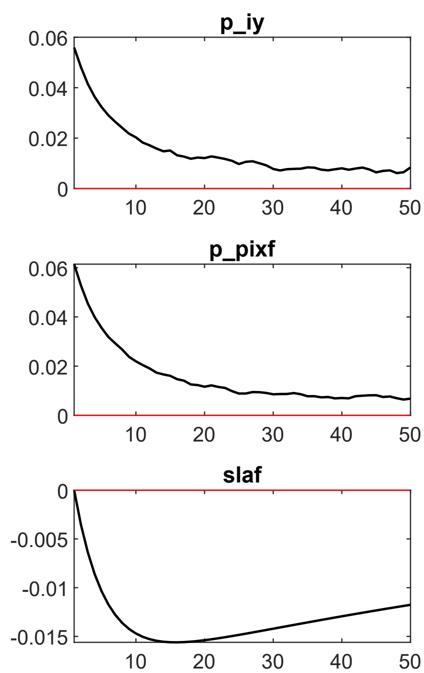


Figure 84: IRFs for CCHH. Home long-run shock (9).

Annual log deviations from steady state.



Appendix C. IRFs with temporary bond shocks.

2.6.3 Ea shock

Figure 85: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (1).

Annual log deviations from steady state.

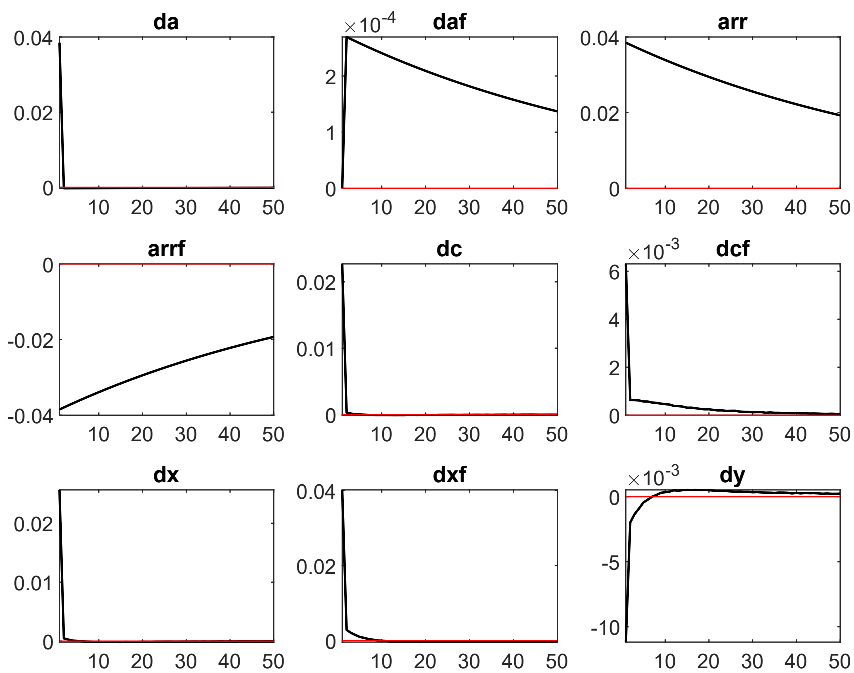


Figure 86: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (2).

Annual log deviations from steady state.

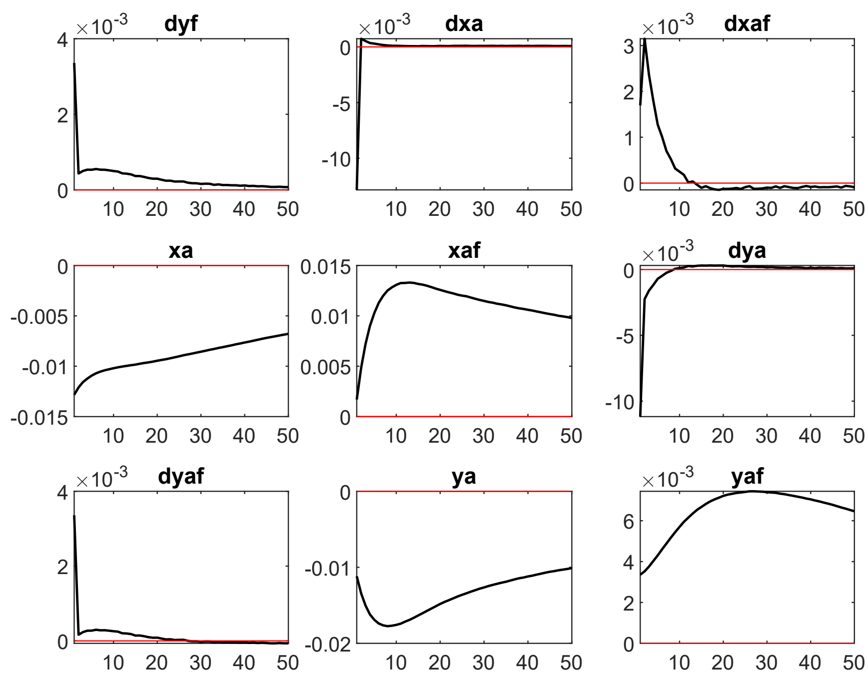


Figure 87: IRFs for baseline model. Temporary shocks. Home Short-run shock (3).

Annual log deviations from steady state.

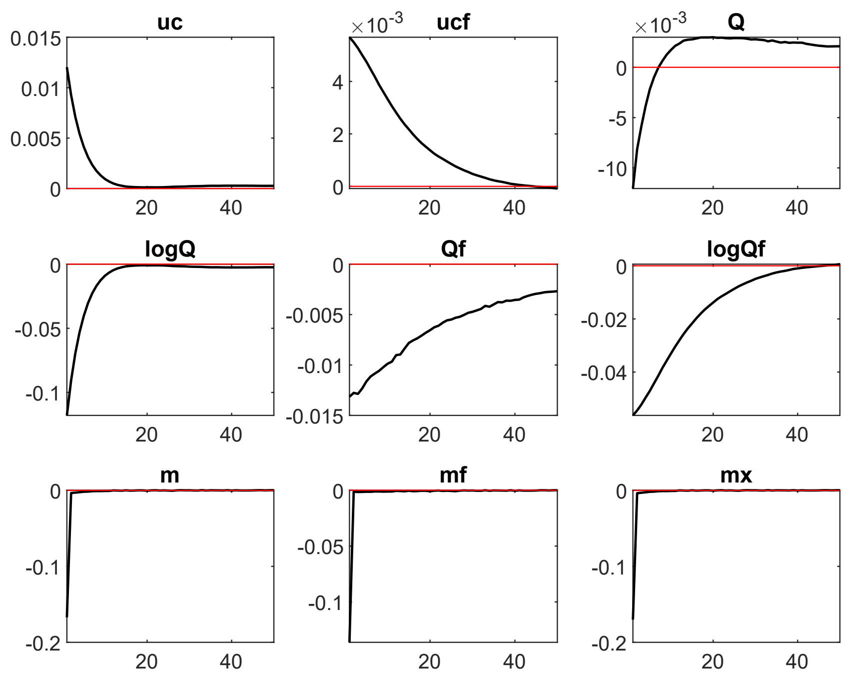


Figure 88: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (4).

Annual log deviations from steady state.

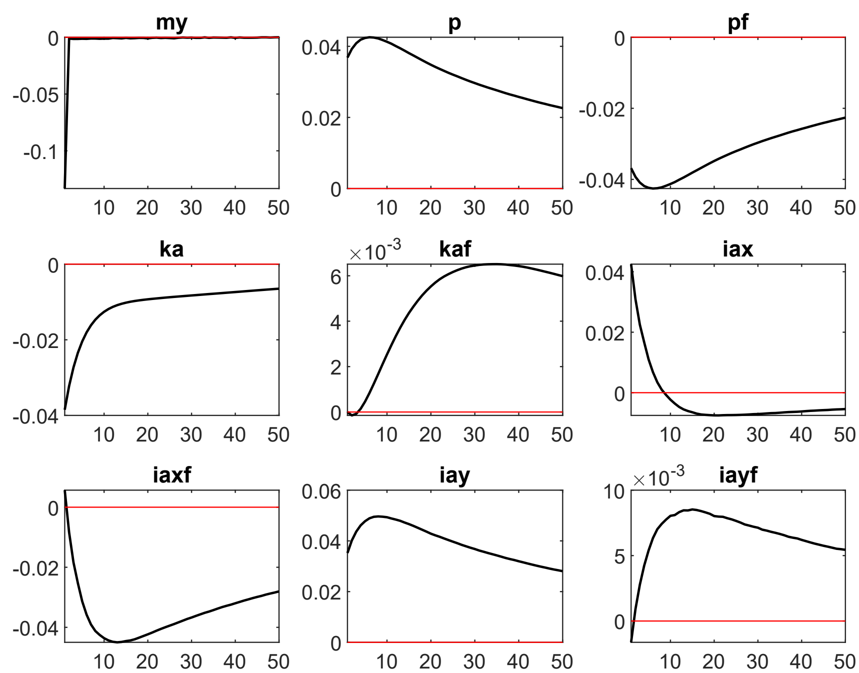


Figure 89: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (5).

Annual log deviations from steady state.

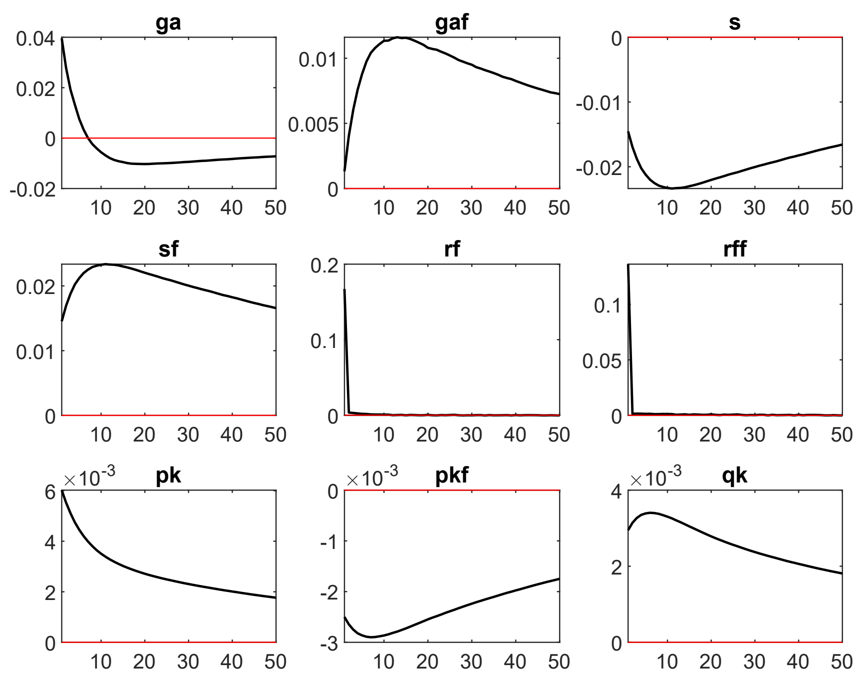


Figure 90: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (6).

Annual log deviations from steady state.

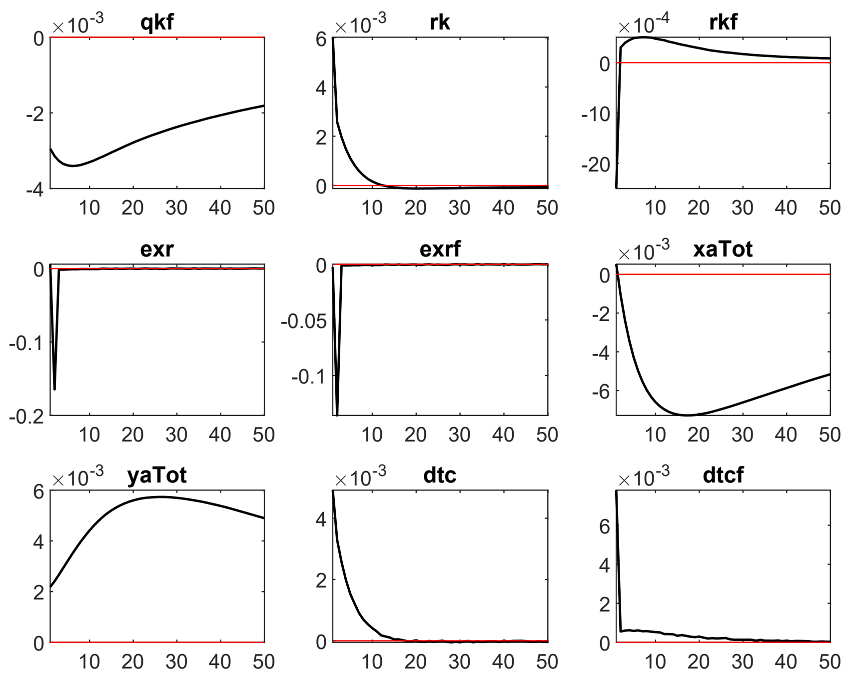


Figure 91: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (7).

Annual log deviations from steady state.

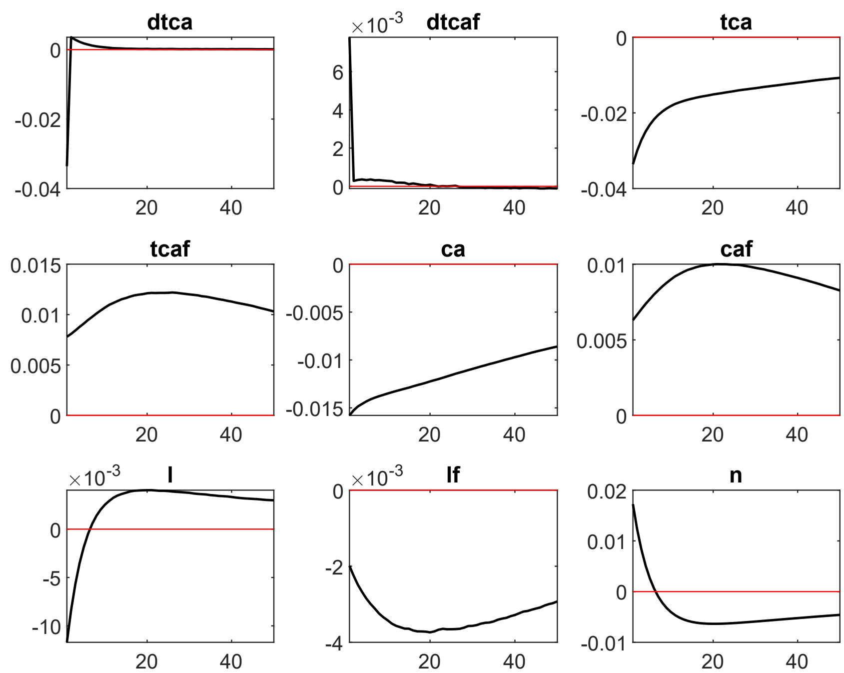


Figure 92: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (8).

Annual log deviations from steady state.

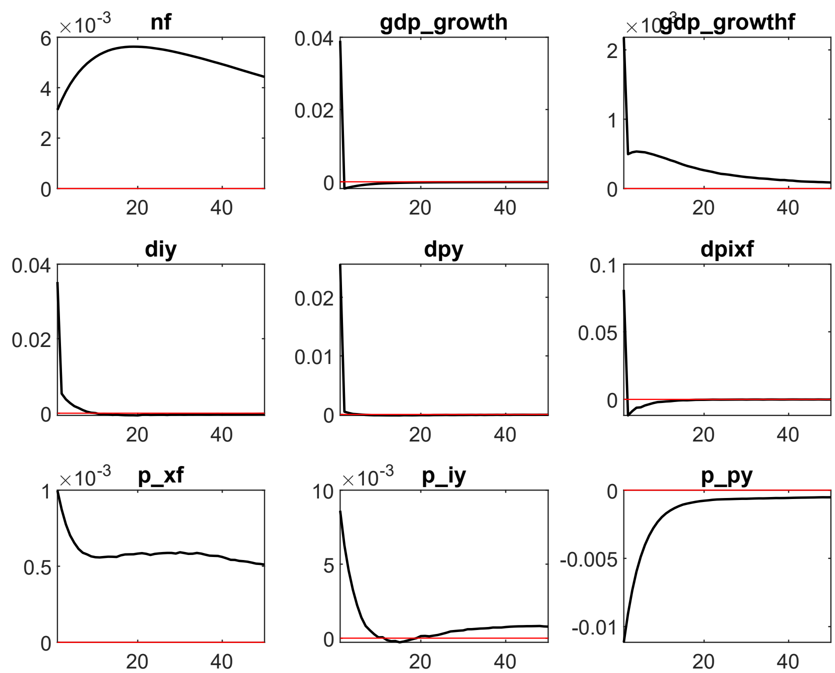
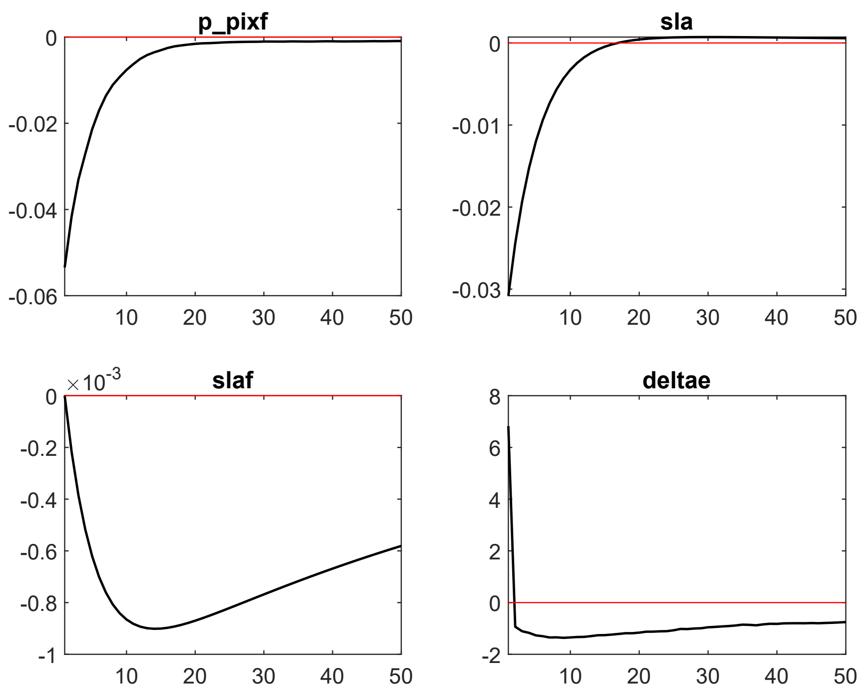


Figure 93: IRFs for baseline model. Temporary bond shocks. Home Short-run shock (9).

Annual log deviations from steady state.



2.6.4 Ez shock

Figure 94: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (1).

Annual log deviations from steady state.

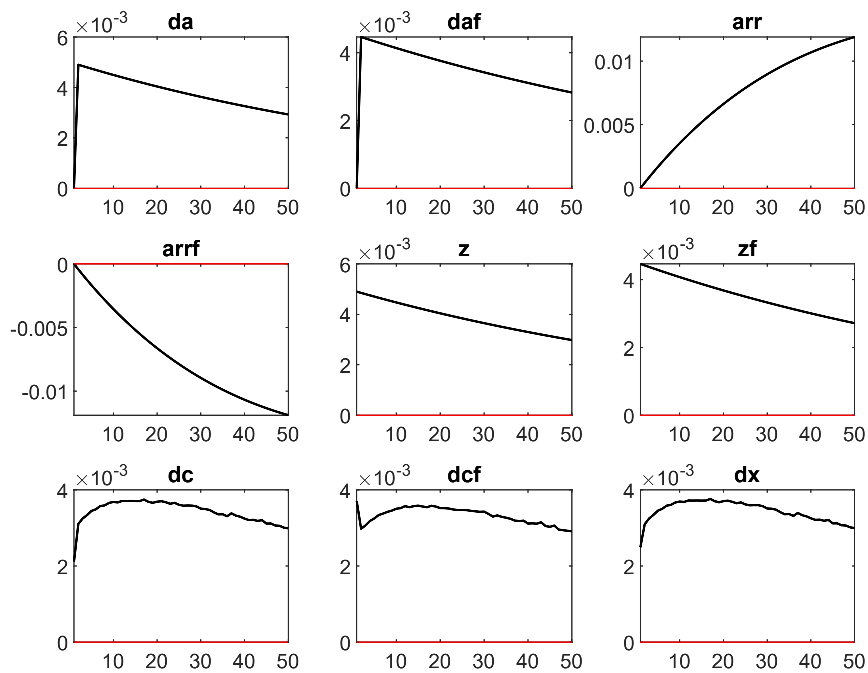


Figure 95: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (2).

Annual log deviations from steady state.

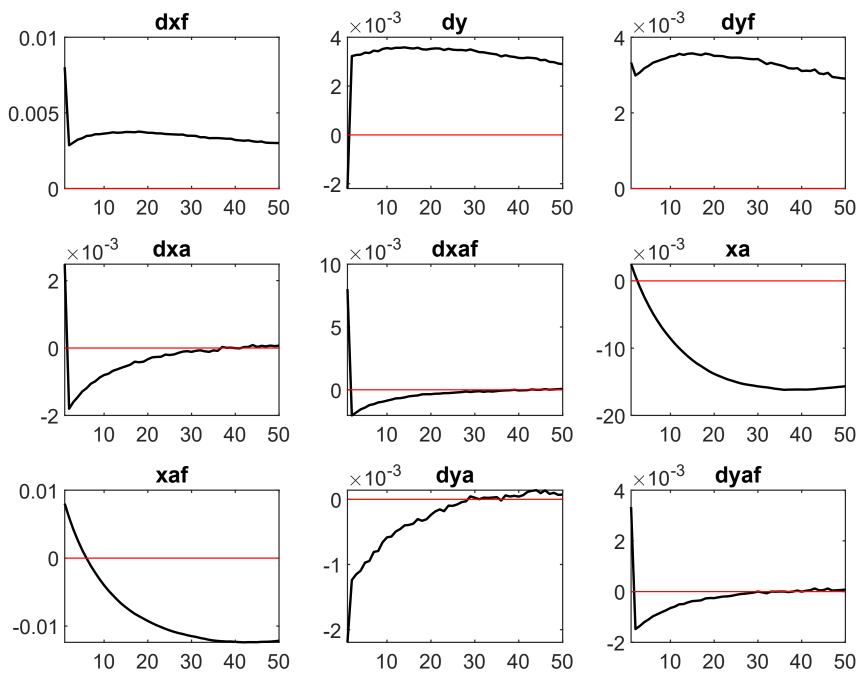


Figure 96: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (3).

Annual log deviations from steady state.

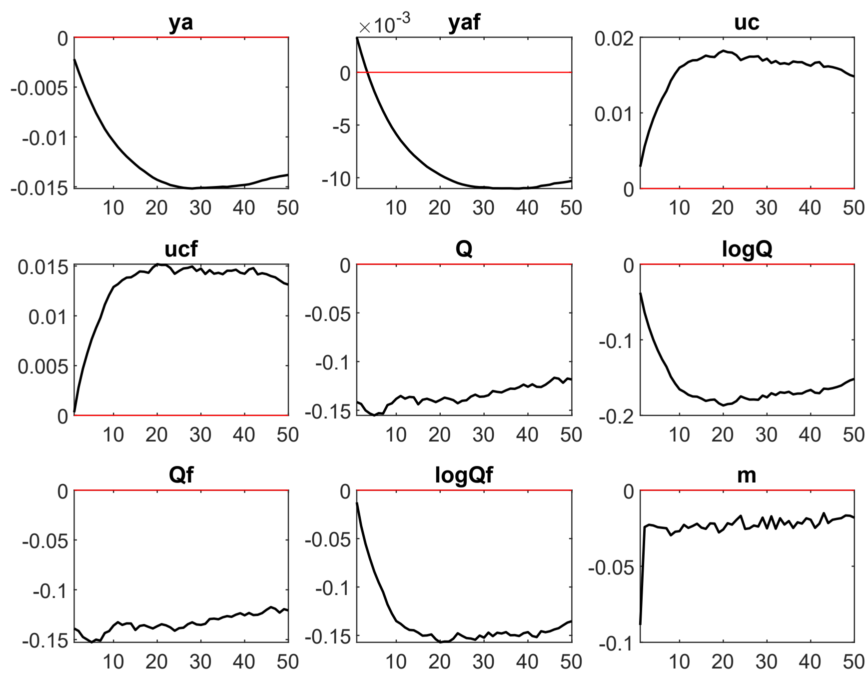


Figure 97: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (4).

Annual log deviations from steady state.

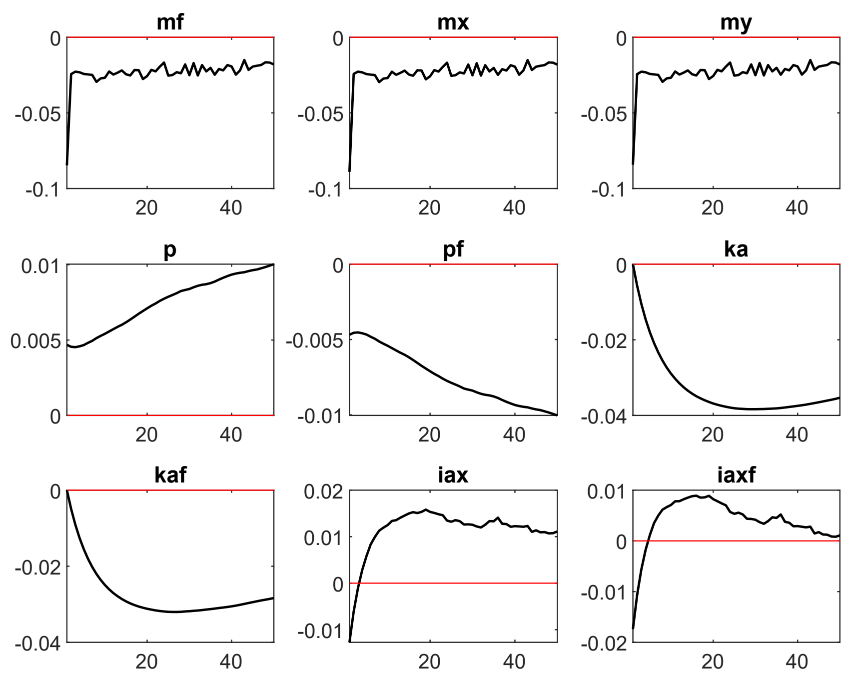


Figure 98: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (5).

Annual log deviations from steady state.

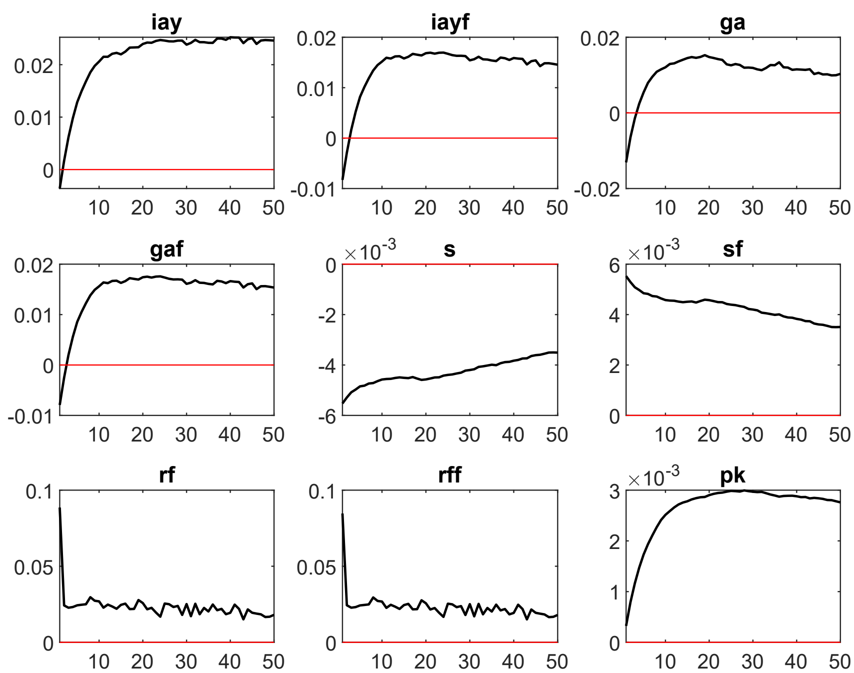


Figure 99: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (6).

Annual log deviations from steady state.

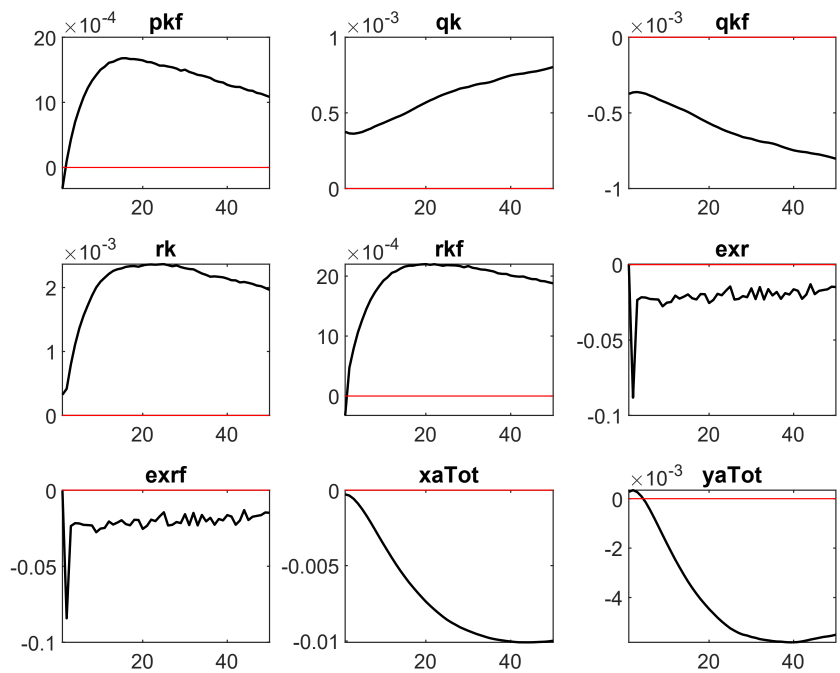


Figure 100: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (7).

Annual log deviations from steady state.

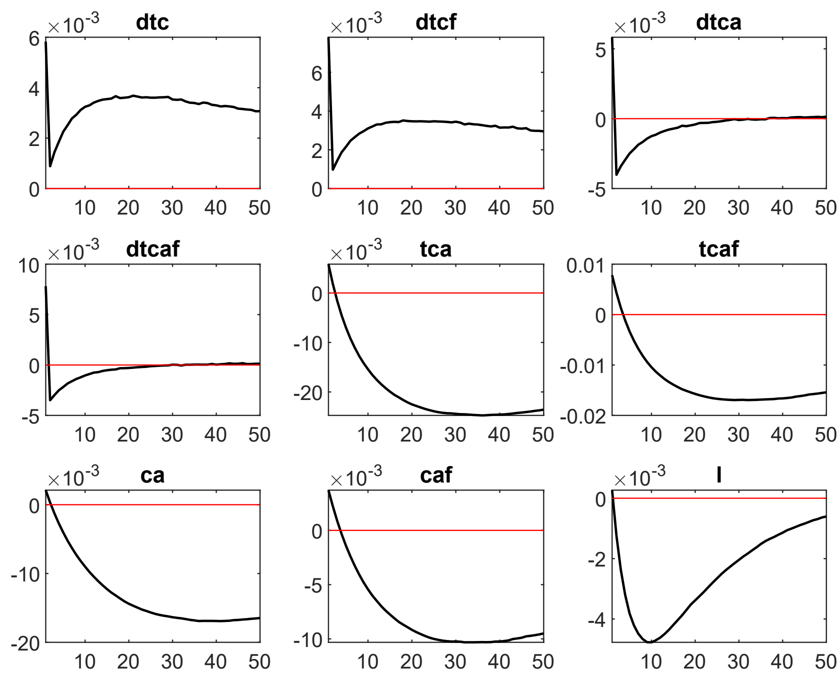


Figure 101: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (8).

Annual log deviations from steady state.

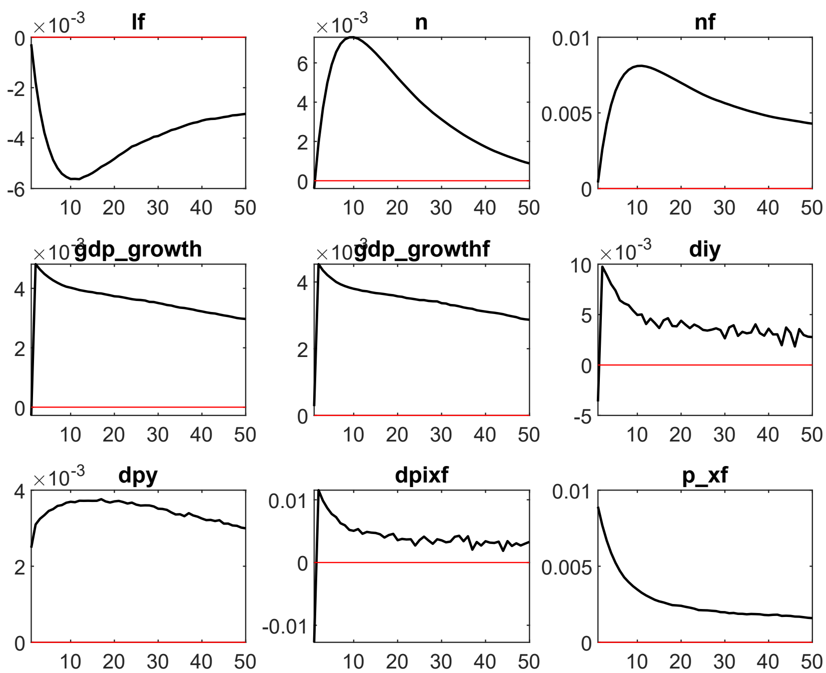


Figure 102: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (9).

Annual log deviations from steady state.

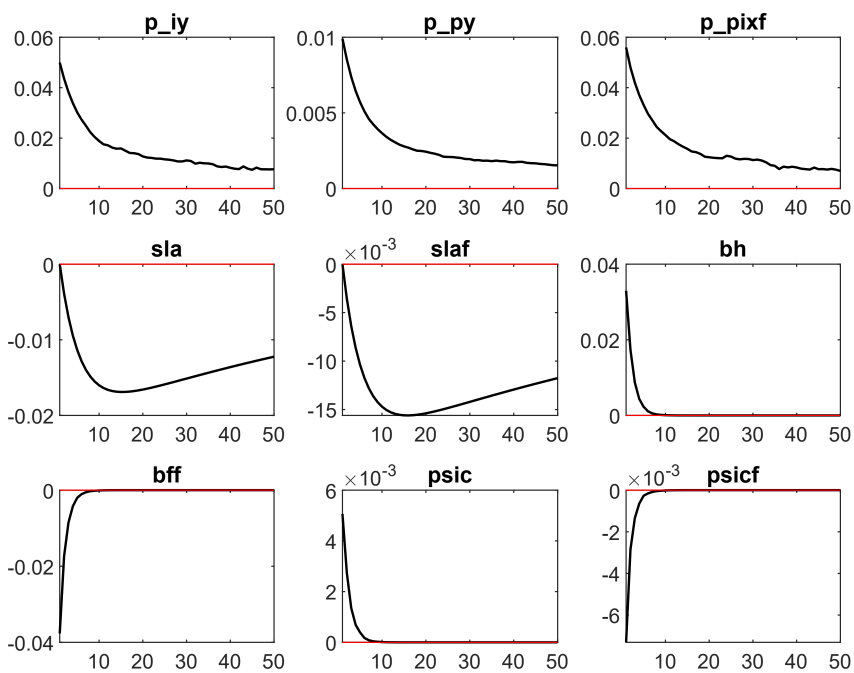
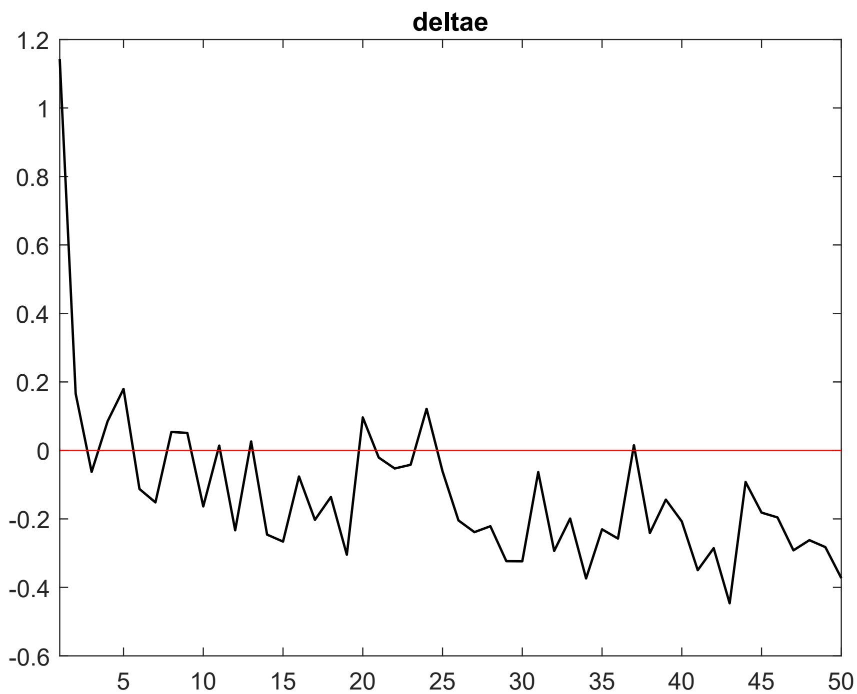


Figure 103: IRFs for baseline model. Temporary bond shocks. Home Long-run shock (10).

Annual log deviations from steady state.



2.6.5 Eb shock

Figure 104: IRFs for baseline model. Temporary bond shocks. Relative bond shock (1).

Annual log deviations from steady state.

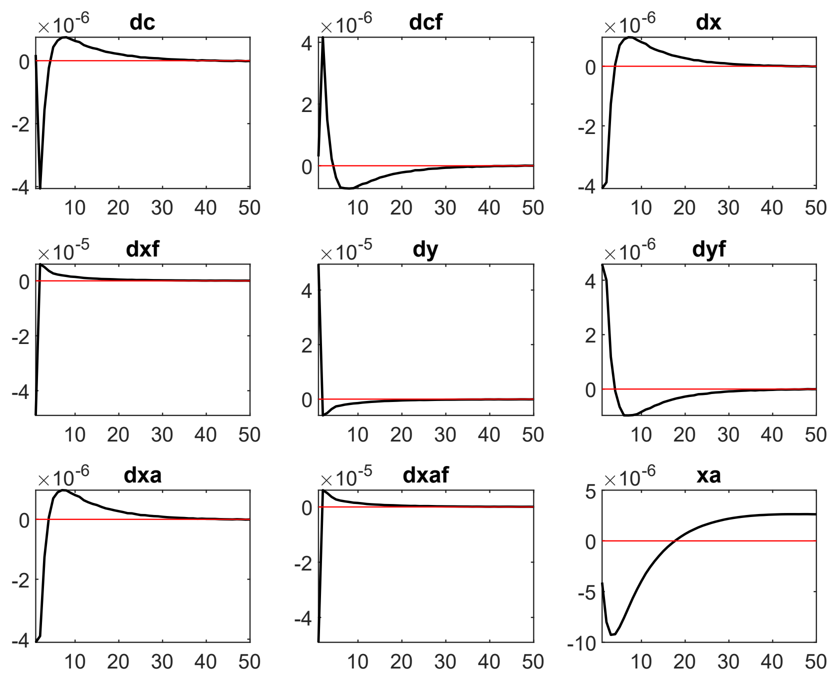


Figure 105: IRFs for baseline model. Temporary bond shocks. Relative bond shock (2).

Annual log deviations from steady state.

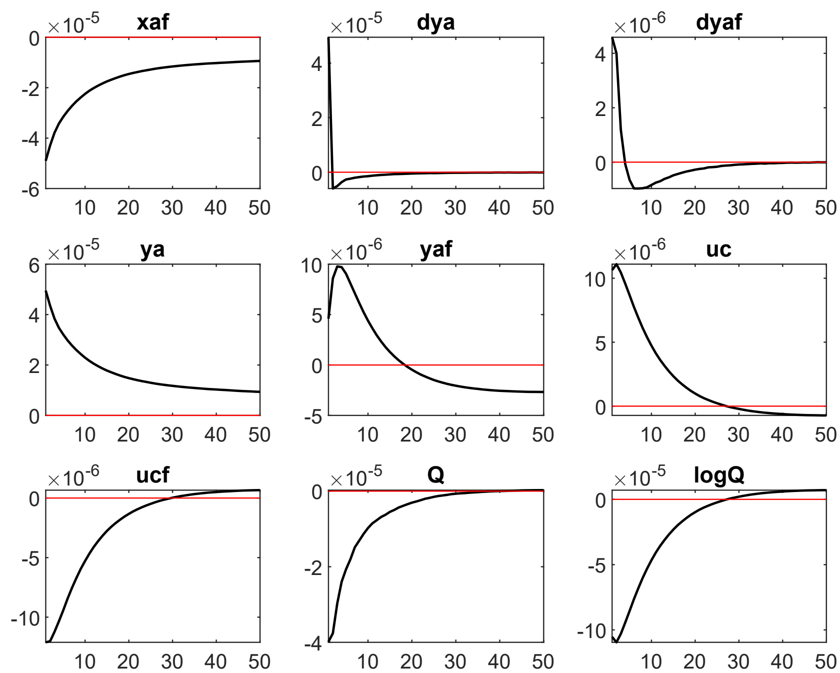


Figure 106: IRFs for baseline model. Temporary bond shocks. Relative bond shock (3).

Annual log deviations from steady state.

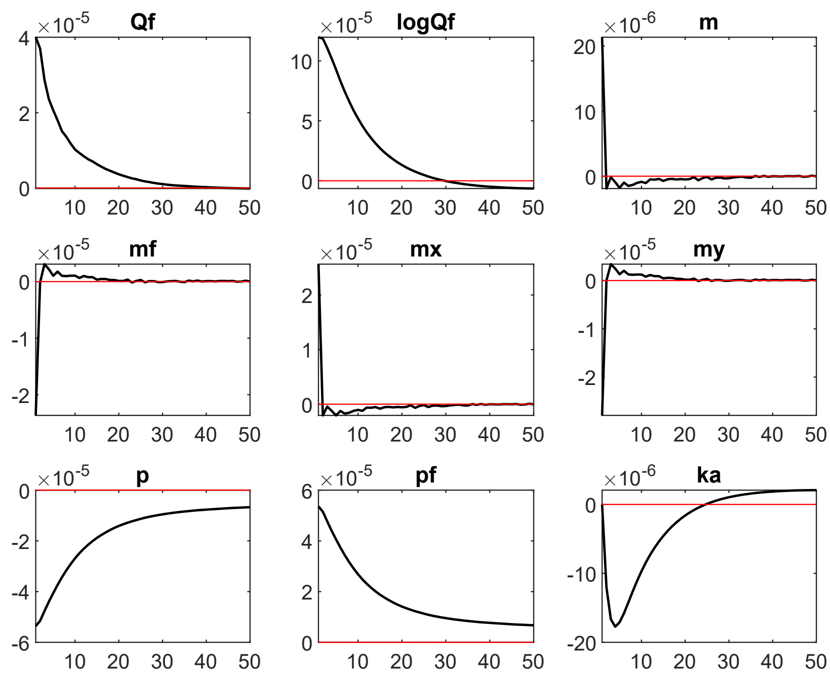


Figure 107: IRFs for baseline model. Temporary bond shocks. Relative bond shock (4).

Annual log deviations from steady state.

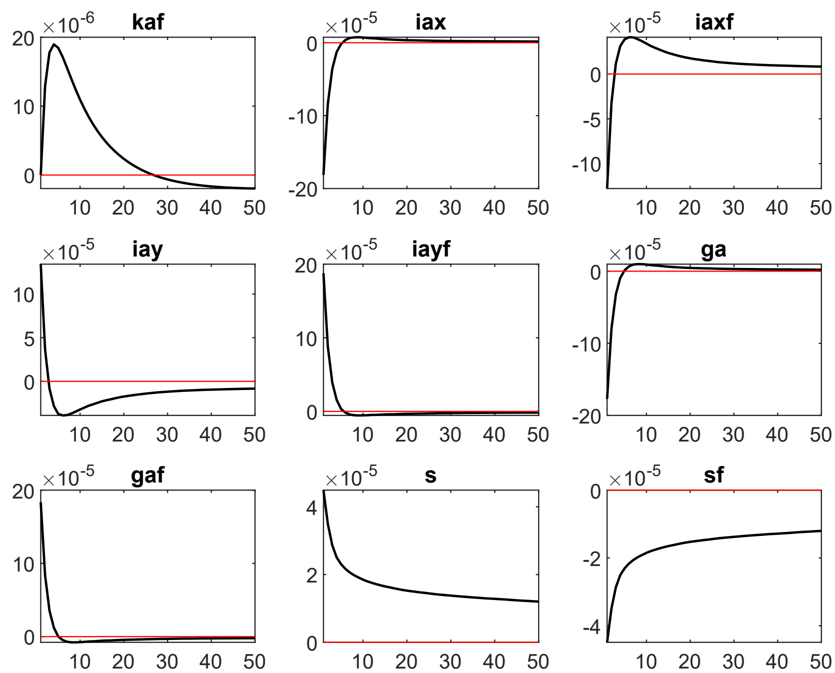


Figure 108: IRFs for baseline model. Temporary bond shocks. Relative bond shock (5).

Annual log deviations from steady state.

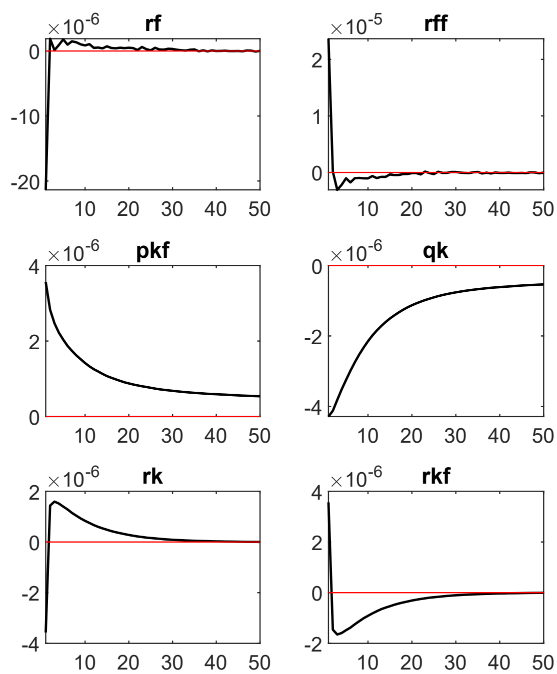


Figure 109: IRFs for baseline model. Temporary bond shocks. Relative bond shock (6).

Annual log deviations from steady state.

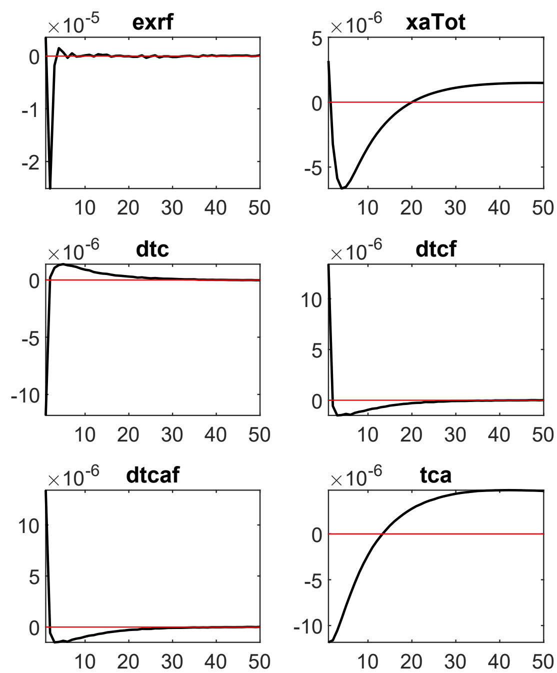


Figure 110: IRFs for baseline model. Temporary bond shocks. Relative bond shock (7).

Annual log deviations from steady state.

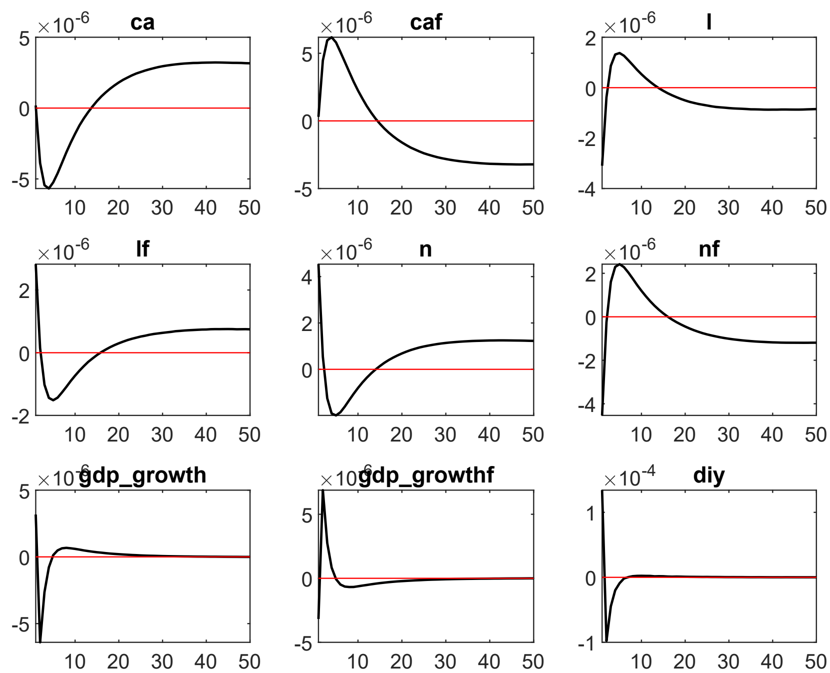


Figure 111: IRFs for baseline model. Temporary bond shocks. Relative bond shock (8).

Annual log deviations from steady state.

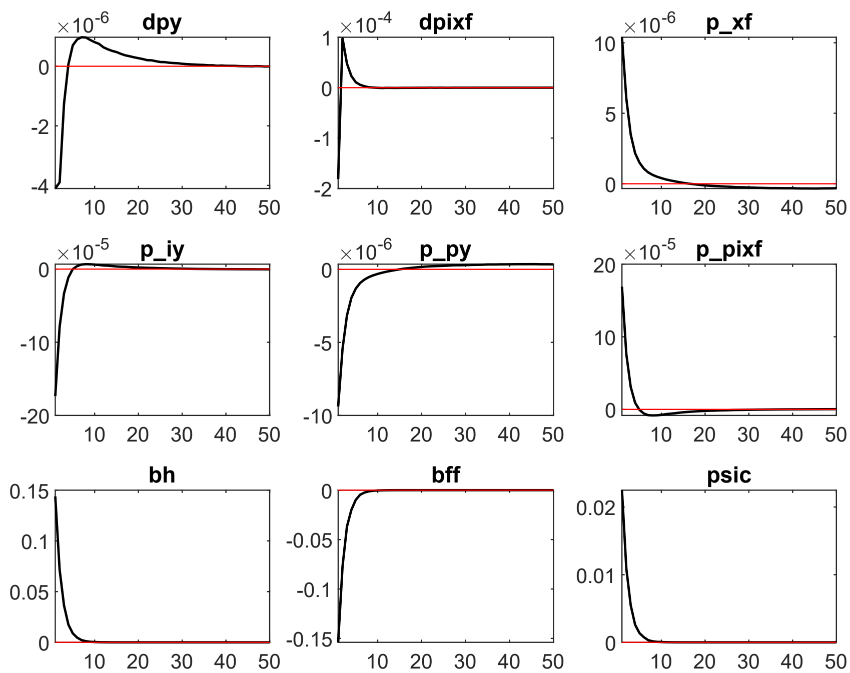
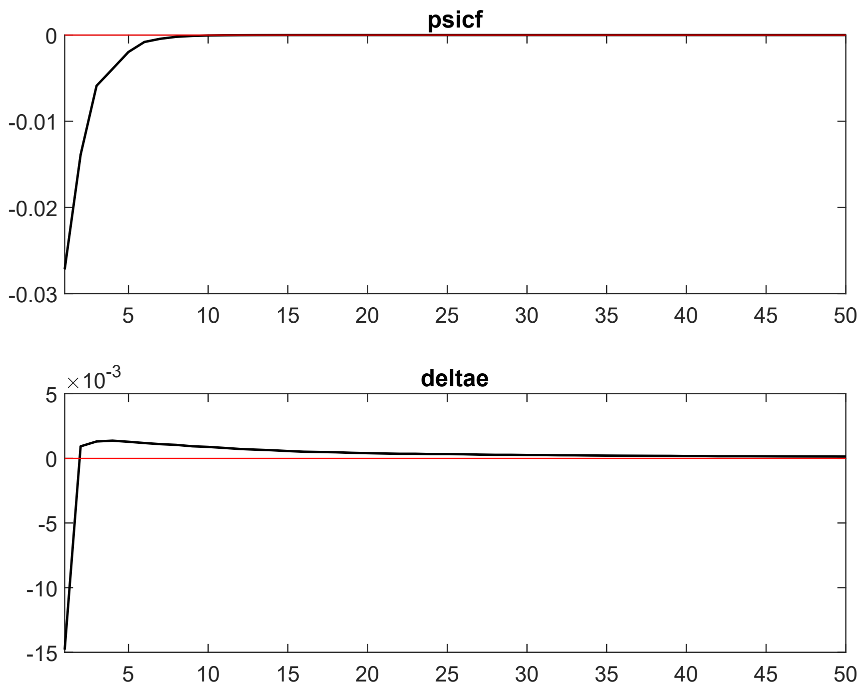


Figure 112: IRFs for baseline model. Temporary bond shocks. Relative bond shock (9).

Annual log deviations from steady state.



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3 Chapter 3. Populism, Financial Crises and Banking Policies: Economics and Psychology (joint with Donato Masciandaro)

3.1 Introduction

In light of the Great Depression, the Great Crisis and their aftermaths, the emergence of populism in the wake of financial crises has taken the stage in academic and public debates. Events - and descriptive analyses too, see Appendix One - seem to point to a link between financial crises on the one hand and populist consensus on the other. As such, a question naturally arises: Do the banking policies that the populist parties implement or suggest in the face of such a crisis trigger or enhance the consensus on their relevance among citizens?

The answer is far from obvious. For instance, the populist banking policies introduced in response to the 2008-2009 bailout dilemma were quite heterogeneous, ranging from "no taxpayers' money to banks" to "save banking deposits whatever it takes". In other words, a sort of "sight-unseen consensus" paradox emerges in such situations. This calls for an investigation of the demand for populism when the economic policy under discussion is a bank-bailout strategy that leads politicians to intervene in some way, eventually resulting in a conflict between traditional parties and new, radical political forces, such as populist parties.

Our starting point is the extant literature on the political consequences of financial crises (Funke et al. 2016, Mian et al. 2014, De Bromhead et al. 2018). This literature sheds light on the nexus between these crises and their political after-effects, and focuses on the fact that the citizens seem to be particularly attracted to the political agenda of populist parties. In this perspective, populism is a consequence of political and economic cycles (Guiso et al. 2017, Algan et al. 2017, De Vries 2018, Di Tella and Rotemberg 2018, Mosimann et al. 2019). Notably, this view can be considered together with two other general economic explanations: populism caused by trade shocks (Autor et al. 2016, Colantone and Stanig 2016) and populism caused by socio-economic inequalities (Goodwin and Heath 2016, Inglehart and Norris 2016, Dorn et al. 2018, Bischi et al. 2020).

Other strands of literature are also useful for exploring the drivers of populism and shedding light on the mechanisms through which individual decision making is influenced by psychological factors (Nowakowski 2020). This research pays particular attention to citizens' groups. First, several papers recognize the fact that populists use myopic, short-term solutions that benefit certain subgroups of the population. Such policies are often harmful in the long run (Sachs 1989, Dornbusch and Edwards 1991, Acemoglu et al. 2013, Chersterley and Roberti 2018). Second, empirical evidence supports the association between wealth groups and populism. Moriconi et al. (2018) show that the inflow of less educated immigrants is associated with an increase in votes that favour nationalistic positions and that this association is stronger for non-tertiary educated voters. Giebler and Regel (2018) find that the "Poors" vote more for right-wing populists, as these individuals are more likely to be unemployed and have less education. Moreover, from a theoretical point of view, Bischi et al. (2020) show that fear of immigration can drive people to support populism. Third, and more generally, studies in social psychology underline that individual voting can be affected by group affiliation through group norms, information and concepts of identity (Tajfel 1982, Huckfeldt and Sprague 1995, Gerber and Roger 2009).

Given the relationship between financial crises and populist consensus, a key question emerges: Is there a role for the policies that the populist parties suggest and/or implement in response to such crises? The answer is unclear. In fact, evidence suggests that as the negative effects of financial crises are generally severe, politicians tend to intervene by changing the policy design (Saka et al. 2020) and/or the corresponding institutional setting (Masciandaro and Quintyn 2016). These actions are likely to be politically motivated (Dalla Pellegrina and Masciandaro 2008, Saka et al. 2020). Nevertheless, populist parties adopt heterogeneous positions, especially with regard to the design of bailout policies in the aftermath of financial turmoil. In some cases, they favour generous bailout policies – as in Poland in 2015; in other situations, they adopt a position against the bailout solution proposed by the incumbent, traditional parties – as in Italy in 2017 (for further details on these two opposite cases see Appendix Two). With respect to the surge of populist parties on the right, policy heterogeneity seems to characterize their socio-economic agendas during elections (Roth et al. 2018).

Our paper aims to offer theoretical answers to the above questions by shedding light on the links between specific populist banking policies and political consensus, and by exploring the relevance of general economic and psychological drivers. Our reasoning is as follows. Envision a country that is hit by a systemic banking shock. In this country, a mainstream party and a populist party are in electoral competition. The two parties propose different platforms to address the crisis. The mainstream party is the classical centre-right or centre-left party, and it follows moderate economic policies. The populist party pushes for a sub-optimally high or low policy depending on its political positioning – what matters is that those policies are not welfare maximizing.

The citizens decide which proposal they support by balancing the costs and benefits of their choice both economically and psychologically. On the one hand, the individual choice is heavily influenced by the respective wealth group. As such, this is a behavioural decision – it is not only economic but also driven by emotions. In this regard, what other group members do matters for the individual. On the other hand, any wealth group has a reference point, which depends on group information. Therefore, the wealth group's reference point is influenced by news about immigration, welfare plans, and housing plans. This, in turn, generates "democratic rioting". This mechanism moves the reference point and generates fuel for the populist vote, and the political consensus on specific bailout policies becomes dependent on a number of issues that have nothing to do with the policies themselves. In other words, the consensus on

specific banking policies becomes a general political manifestation of anger and frustration.
The remainder of the paper is organised as follows. Section 2 presents how the economy works, including the different options in terms of policy design. Section 3 describes how the political consensus on the banking policy depends on both economic and psychological drivers. We offer our conclusions in Section 4.

3.2 Banking Crises and Populist Versus Mainstream Policies: Economics and Psychology

We assume, first, that populists enter the electoral competition by supporting short-term rather than long-term policies. In order to highlight this special characteristic of populist policies in our framework, we assume that populists want a sub-optimal level of public bailout for banks in order to differentiate themselves from the optimal level proposed by the mainstream party. Our framework allows for sub-optimally low or sub-optimally high bailout policies. Some populist parties choose high public spending to reward specific social and economic groups, and as a tool to address voters' demands (Ahlquist et al. 2020). Other populists fight the banks as part of the "corrupt" elite and may want to offer them the lowest bailout possible.
Second, we assume that individuals who decide to vote for the populist party do so by balancing the costs and benefits both economically and psychologically. Individual choice is heavily influenced by the respective wealth group. Indeed, we assume that the psychological benefits and individual costs of voting for populists are different for poor and rich individuals. We model the psychological benefit so that each citizen needs to be angry in order to perceive it and it grows proportionally with that anger. Individuals are angry if they believe they deserve more than they get on a welfare basis. This happens when policy expectations are different from the group-specific reference point. Intuitively, each group may perceive this to be true for a variety of reasons related to immigration, unfair or absent welfare programs, or a lack of economic opportunities. Notably, the causes of such a perception can be completely orthogonal to the specific policy on which the individual will vote.
Third, we know that populists tend to blame economic and political elites. In our framework, this means that the populist rhetoric incentivizes each person in the two groups to consider that group's features. For example, the poor may represent the lower 70 % of the wealth distribution, while the rich are the elite in terms of wealth. Our key assumption is that individual agents' votes are influenced by group behaviour from a psychological standpoint.
Our approach defines populist policies as short-term, suboptimal policies that are driven by anti-elite (i.e. redistributive) motivations. This approach is based on Golder (2016), who suggests that "the precise content of the populist message is context-dependent" but it always goes against the established power structures, and on Guiso et al. (2017), who propose that the left or right orientation of a populist party depends on the political opportunity space. Moreover, our

approach is compatible with all types of non-mainstream parties (e.g. populists, extremists, anti-system actors). This allows us to be as general as possible in building a model that links populism with specific economic policies – in our case, the orientation towards bank bailouts.

Our model builds a macroeconomic framework and a political economy decision for the citizens of the economy. Within our macroeconomic framework, there is an optimal bailout policy after the banking shock. Each citizen works the same hours but has a different amount of wealth than she or he had in the past. This implies that every citizen compares herself or himself to one of the two wealth groups: rich and poor [22]. The assigned group matters in terms of the psychological benefit derived from voting for populists. In short, each citizen has a probability of voting for the populists that depends on three features: whether that citizen is angry with the mainstream party, whether that citizen compares herself or himself to the rich or the poor, and the individual costs of voting for the populists. Psychology drives the first two motivations, while economics explains the third.

We assume that an aggregate negative banking shock generates a positive probability of voting for a populist party by acting on the demand for populism, given a fixed supply of populism. A generic populist party offers an alternative to a classical party that represents the optimal policy choice. Our approach bridges a political economy framework and a macroeconomic framework – the negative banking shock makes the government introduce a proportional tax to fund the banking system's bailout. The extent of the intervention is to be decided through the electoral competition. We assume that this will be the only policy dimension on which to vote (Persson and Tabellini 2002).

In this model, monetary and fiscal policy interact but voters only choose the latter. This setup replicates a common institutional setting seen in the advanced economies starting in the 1980s – a monetary dominance regime (Masciandaro and Romelli 2015). In such a regime, monetary policy is in the hands of an independent central bank, while the government controls fiscal policy.

3.2.1 Players

The economy consists of heterogenous agents: the government, the central bank and the banking system (Masciandaro and Passarelli 2019) [23]. For the sake of simplicity, we assume that the population size is normalized to one, such that total and per capita amounts are the same for all variables. Moreover, we assume that there is only one representative bank in the economy[24].

[22]In contrast to Masciandaro and Passarelli (2019), wealth composition does not matter here.

[23]Alternatively, as in Gertler et al. (2017), we can assume that each household (family) consists of a continuum of members who can be either workers or bankers. Workers supply labour and earn wages for the household, while bankers manage a financially risky business and transfer the relative earnings back to the household. The number of bankers in each household is heterogeneous.

[24]This implies that all banks are homogeneous and that the macro-banking outcome is simply the sum of micro-level optimizing behaviour.

We take the bank profits as exogenous, thereby distinguishing between normal times and extraordinary times. In normal times, the bank works properly – the government does not need to issue debt and, consequently, there is no need to introduce taxation to service such debt.
Extraordinary times come when a banking crisis occurs and the government is forced to intervene. The fiscal policy design involves two decisions: one regarding the bailout amount, and one regarding how to finance the bailout given the central bank's decisions in terms of fiscal monetization and the presence of a monetary dominance regime. Consequently, the central bank's choices will be in line with its inflation goal.
The government introduces an income tax to repay debt and interest. The citizens make decisions about labour and consumption given the tax policy. The government's choice of a bailout policy will reflect the trade-off between minimizing tax distortions and smoothing out the monetary and financial externalities that a bailout policy can trigger.
This is where the nature of the government in charge becomes relevant. In fact, if the incumbent government chooses a sub-optimal bailout policy (i.e. a policy that is different from the social planner optimization), that choice will decrease welfare. For example, if the bailout rate is too high, the economy will likely suffer an inflation cost (a monetary externality) and/or higher moral hazard risks (a financial externality).
Finally we study the possibility of a populist consensus can strengthen a populist government in charge, but it can also influence the choice of a traditional incumbent government. Recently (Kishishita and Yamagishi 2021) it has been explored the propagation of populist policies in different countries through an external contagion channel, when an interaction between domestic and foreign policies is active. Here we add the possibility of an internal contagion channel, through the interaction between alternative domestic parties.

3.2.2 Policy design

The citizens are risk neutral, and they draw utility from consumption and disutility from labour. They use their net labour income and their financial assets to buy a single consumption good. We assume heterogeneity in the composition of their portfolios, while labour income is the same for all individuals. These assumptions enable us to zoom in on the macroeconomic consequences of financial inequality, all else equal. Individual utility is linear [25]:

$$c - U(l) \tag{53}$$

The budget constraint of a citizen who owns an average portfolio is:

$$c = l^*(1-\tau) + w + \beta(1+\lambda)\pi(1+i(1-\delta)) \tag{54}$$

[25] Linear utility helps us with a simpler solution at a low cost, as we do not model intertemporal consumption choice in this paper.

where l^* is the optimal labour supply, labour productivity is normalized to one and $l(1-\tau)$ is the after-tax (net) labor income. w is the average amount of wealth in the economy.
$U(l)$ is an increasing and convex effort function. After observing τ, each citizen chooses how much to work to maximize (1). The optimality condition yields the citizen's labour-supply function:

$$L(\tau) = U_l^{-1}(1-\tau) \tag{55}$$

$L(\tau)$ is decreasing in the tax rate: $L(\tau)_\tau < 0$. The optimal labour supply depends on the specific functional form of $U(l)$, which depends on the selected tax policy: $l^* = L(\tau)$.
As labour is the only factor of production, the labour supply represents the total income: $y = L(\tau)$. Therefore, income and the labour supply in equilibrium will depend on the tax policy.
In extraordinary times (i.e. when a banking crisis occurs), the government faces a trade-off: let the bank fail or rescue it. In the latter case, the government issues public debt for the same amount as the bailout, and sells it to either citizens or the central bank. The government defines the bailout policy, β , such that the saved amount is $\beta\pi(1+\delta)$. Note that the bailout policy determines how painful the banking shock is for individuals. The government budget constraint is:

$$\beta(1+\lambda)\pi(1+i(1-\delta)) = \tau y \tag{56}$$

where τ is the tax rate, y is the income of the citizens before taxes, i is the interest paid on the government bonds, and $\delta \in [0,1]$ is the central bank's purchase, which represent fiscal monetization. The interest rate on bonds is determined according to a standard no-arbitrage condition with respect to a perfect, long-term, risk-free interest rate. As usual, it is a parameter.
For any unit of debt issued, the government repays $1 + i(1-\delta)$ in the next period. The cost of debt $i(1-\delta)$ is negatively associated with fiscal monetization, as the more the central banker is conservative (i.e. low δ) in a monetary dominance setting, the smaller the portion of the debt purchased by the central bank will be. The government fully internalizes the consequences of the monetary dominance regime in defining the bailout policy,β , by considering the fiscal monetization parameter. Therefore, the overall policy design is: $\tau = T(\beta, \delta)$.
Finally, we consider the macroeconomic relevance of both financial and monetary externalities. The financial externalities depend on the bailout policy, β , and are increasing and convex in the amount of lost bank liabilities:

$$FE(\beta) \equiv \frac{\epsilon}{2}[(1-\beta)(1+\lambda)\pi]^2 \tag{57}$$

Monetary externalities are assumed to increase with fiscal monetization:

$$ME(\beta,\delta) \equiv \frac{\varphi}{2}\delta^2\beta(1+\lambda)\pi \tag{58}$$

In summary, citizens draw utility from consumption and disutility from labour, financial and monetary externalities. These costs are spread equally among citizens, so that the indirect utility function, $V(\beta, \delta)$ of a citizen with an average portfolio is:

$$V(\beta, \delta) = C(\beta, \delta) - U(l^*) - FE(\beta) - ME(\beta, \delta) \tag{59}$$

We assume a generic probability distribution of wealth for the citizens. If the bailout policy, β , is implemented, the value of the citizen's average portfolio is influenced as follows:

$$\beta\pi(1 + \lambda) + \beta(1 + \lambda)\pi(1 + i(1 - \delta)) + w \tag{60}$$

The first term is the value of the citizen bank share and bank deposits. The second term is the interest payment on government bonds, while the third term is the average wealth, w . Individual portfolios differ from the average portfolio. We assume that the differences in individual portfolios reflect only differences in the amount of initial wealth, w^j , as we are only interested in dividing the population into two broad groups (rich and poor). The bailout option and the fiscal monetization influence both the average portfolio value and the individual portfolio value through two channels: the value of the bank's liabilities and the interest payments on public bonds.
The choice of β determines how relevant the shock is for individuals. It is a de facto wealth shock that affects the citizens (i.e. the voters). A higher bailout rate implies not only a lower wealth shock for the citizens but also higher costs of externalities.
The optimal policy is derived as follows. The social planner considers the relation between the tax policy, $\tau = T(\beta, \delta)$, and the labour supply in order to maximize the social-welfare function, $V(\beta, \delta)$ by choosing the policy strategy regarding the banking policy, β^* and the monetary policy δ^* . Given the government's budget constraint (2) and the labour supply (3), the budget constraint becomes:

$$\beta(1 + \lambda)\pi(1 + i(1 - \delta)) = \tau L(\tau) \tag{61}$$

This gives, in implicit form, the relationships between the tax policy on the one hand and the bailout and fiscal monetization policies on the other hand. In fact, by differentiating (9) and introducing the labour supply elasticity, $n(\tau) \equiv -\frac{\tau L_\tau}{L}$ to highlight the tax-distortion effect, we obtain:

$$T_\beta = \frac{(1 + \lambda)\pi(1 + i(1 - \delta))}{l^*(1 - \eta(\tau))} > 0 \tag{62}$$

$$T_\delta = \frac{\beta(1 + \lambda)\pi i}{l^*(1 - \eta(\tau))} > 0 \tag{63}$$

According to equation 10, a higher bailout percentage implies a higher tax rate owing to the larger amount of debt and interest. By the same reasoning, higher

fiscal monetization reduces the tax rate (equation 11).
Using the social-welfare function of the citizens with average portfolios (8), the two optimality conditions are:

$$V_\beta = C_\beta(\beta,\delta) - FE_\beta(\beta) - ME_\beta(\beta,\delta) \leq 0 \tag{64}$$

$$V_\delta = C_\delta(\beta,\delta) - ME_\delta(\beta,\delta) \leq 0 \tag{65}$$

where strict inequality implies the corner solution (i.e. $\beta^* = 0$ or $delta^* = 0$).
When setting the banking bailout policy, the social planner accepts a trade-off between two public goals: externality smoothing and tax-distortion minimization. The social planner solution becomes the benchmark for evaluating the government's actual choices. For example, if the bailout is too high, taxes are high, thereby reducing the indirect utility. At the same time, financial and monetary externalities grow significantly.
By solving the FOC system (12-13) and using (2, 6-7), we obtain the socially optimal choices:

$$\beta^* = 1 - \frac{1}{\epsilon(1+\lambda)\pi}[\frac{\eta}{1-\eta}(1+i(1-\delta^*)) + \delta^{*2}\frac{\varphi}{2}] \tag{66}$$

$$\delta^* = \frac{\eta}{1-\eta}\frac{i}{\varphi} \tag{67}$$

3.3 Consensus Mechanism: Democratic Rioting and Populism

Now the bailout policies can be associated with political consensus by mimicking a voting procedure (Masciandaro and Passarelli 2019). Citizens vote on the proposals for different bailout percentages[26]. Every citizen, j, has an indirect utility:

$$V^j(\beta, \delta) = V(\beta, \delta) + w^j - w \tag{68}$$

which is given by the citizen with the average portfolio plus or minus his or her individual wealth.

We assume that these differences matter only because they induce the creation of two groups broadly defined by wealth: rich and poor. In other words, wealth is the only feature that defines the group's reference point for political issues. Emotionally, the poor do not compare themselves with the elite or vice versa.

The citizens express their consensus by voting and there is only one policy dimension on which to vote (Persson and Tabellini 2002)[27]. Voting on such a decision is suitable for creating a public debate and channelling attention, thereby cementing collective emotions around the issue. As we already mentioned, the monetary policy decision is made by an independent central bank that chooses the optimal level of inflation defined by (15). We assume that there is no strategic choice of δ in anticipation of the popular consensus. The central bank addresses the banking crisis in a way that is consistent with its mandate. The citizen is voting only on β . Thus, we use the notation $V^j(\beta)$ For simplicity, agents in each group are assumed to have the same wealth among themselves, which is lower for the poor agents:

$$V^r(\beta) > V^p(\beta)$$

The two group sizes are λ^r and λ^p , such that $\lambda^r + \lambda^p = 1$ and $\lambda^r < \lambda^p$. Now, in order to highlight the specialness of the populist policy, we assume that the mainstream party proposes the optimal bailout policy, β^* , while the populists prefer a bailout policy where $\beta \neq \beta^*$. This assumption is coherent with the populists presenting a different policy than the traditional parties, and it should be modelled on the specific populist party and political system.

Citizens decide whether to vote for the populist party by balancing the economic and psychological costs and benefits of this choice. The individual costs of voting for the populists consist of a component common to all groups, $\mu > 0$, and a group-specific random variable, $\epsilon^{i,j}$ with uniform distribution with a mean of zero and a density of $\frac{1}{2\sigma^i}$ [28].

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[26] In contrast to Masciandaro and Passarelli (2019), we do not use the median voter theorem, as we are considering a framework for which a probability of voting for the populists emerges. This framework will not deliver a clear winner in an electoral competition, but rather a proxy of the support for populists.

[27] We can assume that the bailout decision is, by far, the most important political issue on which the two parties compete.

[28] The total cost of voting for the populists should satisfy: $\Delta V(\beta)\Delta\beta = (\lambda^r + \lambda^p)\mu + \iint_{i,j} \epsilon^{i,j} didj$.

The individual benefit of voting for populists comes from the expression of emotions in a way that has a public impact. Importantly, the individual benefit of voting for populists increases as the size of the individual's group increases. This is an indirect, public display of emotions. Therefore, the more it is shared by group members, the more it pleases the individual. In the words of Passarelli and Tabellini (2017), "the psychological benefit of a public display of anger is stronger if the emotion is more widely shared" and is related to being treated unfairly.
The individual benefit crucially depends on the presence of anger among citizens in the groups. Anger is defined as $a^i \equiv A^i(\beta)$:

$$a^i = \frac{1}{2}max[0, R^i - V^i(\beta)]^2 \tag{69}$$

$V^i(\beta)$ is the group's indirect utility and R^i is the group's reference point, which defines what the group expects in term of indirect utility. For example, an individual who is part of the poor group is angry if $a^p > 0$. This happens only if the poor expect a different indirect utility than the one they get.

In summary, individual j in group i votes for the populists if the benefits are greater than the costs:

$$p^i\lambda^i a^i - \mu - \epsilon^{ij} \geq 0 \tag{70}$$

If we assume a uniform distribution for $\epsilon^{i,j}$, the probability of voting for a populist party is:

$$p^i = Pr(\epsilon^{ij} \leq p^i\lambda^i a^i - \mu)p^i = \frac{1}{2} + \frac{p^i\lambda^i a^i - \mu}{2\sigma^i} \tag{71}$$

Solving for the probability, we have:

$$p^{*i} = \frac{\sigma^i - \mu}{2\sigma^i - \lambda^i a^i} \tag{72}$$

For individual j in group i , the probability of voting for the populists is higher when the individual cost of voting for the populists is lower, the anger of group is higher and the variance in group-specific costs is lower. This formula defines our model of consensus and highlights the importance of the psychological drivers, all else equal. The equilibrium probabilities for both groups allow for multiple equilibria: a suboptimal policy can be relevant (regardless of the proposal) depending on which perceptions are in action, country by country and period by period, given the economic features of the proposed policy.
The above link between consensus on the one side and economic and psychological drivers on the other allows us to analyse different political positions on a bank-bailout policy.

3.3.1 The Votes of the Poor and the Rich

Equation (20) describes support for populists in economies hit by banking shocks. Individuals have a different probability of voting for populists depending on their wealth group, which is assumed to be related to their economic costs and the psychological benefit of voting fir populists. Two dimensions must be taken into account: the individual costs of voting for populists, $\epsilon^{i,j}$ and anger, a^i .

Consider a scenario in which the poor have less variance in the individual costs of voting populist ($\sigma^p < \sigma^r$) and the same anger as the rich ($a^p = a^r > 0$). This assumes that the poor have more homogeneous costs relative to the rich. Intuitively, the rich may have more extreme individual costs (positive or negative) of voting for populists. For example, a populist regime may choose a part of the economic elite of a country to become even more powerful through government backing in business ventures or it may crush the same ventures to capitalize on a political opportunity.

We know that the equilibrium probability of voting for populists,

$$\frac{\partial p^{i*}}{\partial a^i} > 0$$

grows with the group's anger. More anger makes everyone in a wealth group more willing to vote for the populists because the psychological benefits are greater.

The poor have a higher probability of voting for the populists because the smaller σ^i is, the bigger $\frac{\partial p^{i*}}{\partial a^i}$ is. The effect of anger on the probability is greater when group i is more homogeneous.

Consider now a scenario in which the variance in the individual costs of voting for populists are the same ($\sigma^p = \sigma^r$), while the levels of anger a^i differ. Anger emerges when the group's reference point, R^i differs from the group's indirect utility:

$$R^i \neq V^i(\beta)$$

$$a^i = \frac{1}{2} max[0, R^i - V^i(\beta)]^2 > 0$$

The probability that individuals in group i will vote for the populists is greater than zero.

Intuitively, anger may originate from different sources. For example, bias against immigrants and ignorance of actual public finance decisions are more probable among the poor than among the rich. R^p differs more with respect to indirect utility than R^r does. Hence $a^p > a^r$, ceteris paribus.

In summary, both the rich and the poor may have probabilities of voting for the populists that are greater than zero. For a single group to do so, that group's anger must be sufficiently large. For the sake of the following discussion, we

will assume the more likely situation is the one in which the poor have a higher probability of voting for populists because they have higher anger and lower variance in the individual costs of voting populists.
This scenario seems to be more in line with the empirical evidence. Dorn et al. (2018) show that poorer German counties in the period 1990-2014 had higher shares of votes for extremist parties. Guiso et al. (2017) and Algan et al. (2017) show that economic insecurity is a dominant driver of populist voting, which is in line with the fact that the poor are much more likely to be affected by economic hard times than the rich elite. Moreover, Funke et al. (2016) find that there is a rise in extremist right-wing parties after a systemic banking shock. In the same vein, De Bromhead et al. (2018) describe the emergence of right-wing parties during the Great Depression.

3.3.2 Anger and Its Drivers

Anger arises from a difference between what the agents in a group think they deserve, R^i , and what they get, $V^i(\beta)$. This difference can be described as part of the broad, socio-economic conditions of the two groups and their sense of entitlements. In order to be specific and better understand the model, we need to more accurately define R^i .
We assume that the reference point for individual j in group i is group specific:

$$R^i \equiv V^i(\hat{\beta}) \tag{73}$$

$\hat{\beta}^i$ is the subjective fair policy for group i and it is derived from a modified social welfare optimization in which group i has a self-serving bias. This means that the group sees itself as more deserving than the other group. Intuitively, this is the bailout policy that group prefers.
Let us consider the case in which the populists claim a bailout policy higher than the optimal policy through a self-serving bias that over-represents each of the groups:

$$\hat{\beta}^i = argmax W^i(\beta) \tag{74}$$

$$\hat{\beta}^i = argmax \sum_k \pi^{ik} V^k(\beta) \tag{75}$$

$$\pi^{ii} = \lambda^k(1 + v^i) \tag{76}$$

$$\pi^{ik} = \lambda^k(1 - v^i), i \neq k \tag{77}$$

π^{ii} is the weight assigned by group i to itself, v^i is the self-serving bias of group i , and π^{ik} is the weight assigned by group i to group j . Intuitively, this means that group i gives itself more social weight with respect to the other group[29].
Why does a self-serving bias, v^i , emerge? It is caused by shocks to the sense of entitlement caused by news about immigration, welfare plans, or housing plans.

[29] It is worth noting that lower weights, π^{ii} and higher weights, π^{ik} will instead deliver a reference point lower than the optimal. This is related to the case in which populists propose a suboptimally low bailout rate.

A group's self-serving bias grows when its participants feel entitled to a better public policy for various reasons, such as when they blame immigration or the other group for getting too much public attention and resources. Self-serving bias acts as a wedge between the indirect utility of voters and their reference points.

Evidence indicates that a self-serving bias may be caused by immigration. Guiso et al. (2017) find that hatred of immigrants affects voting decisions in favour of populists. Dennison and Geddes (2018) find a correlation between the salience of immigration (from the pan-European Eurobarometer survey) and the polling of anti-immigration parties in most western European countries after 2005 (salience is defined as the indication of the most important issue affecting the individuals and/or the country).

Moriconi et al. (2018) find that inflows of less educated immigrants are positively associated with increases in votes for nationalistic positions, and that this effect is stronger among non-tertiary educated voters and in response to non-European immigrants. Moreover, self-serving bias may be higher among poor people due to their higher exposure to the presence of immigrants in public spaces (Card et al., 2012). Through our lens, this means that inflows of less educated immigrants increase the self-serving bias of both the rich and the poor, but with a stronger effect on the poor, as these inflows cause greater aggrievement and lead to a higher probability of voting for populists in this group.

3.3.3 Populist Threat Equilibrium

The possibility of a populist consensus can not only strengthen a populist government in charge but also influence the choice of a traditional incumbent government. We derive a new equilibrium probability, $\hat{\pi}^i$ and show that it is a function of the policy $\hat{\pi}^i = P^i(\hat{\beta})$. We call this equilibrium the Populist Threat Equilibrium (PTE), as it emerges from a government that considers the emergence of the populist party as an alternative to the traditional one.

The government trades off the social-welfare effects of the policy against the consequences of the probability of voting for populists. Specifically, let

$$W(\beta) = \sum_{i=1}^{2} \lambda^i V^i(\beta) \tag{78}$$

be the standard Benthamite social-welfare function. A benevolent social planner sets the policy to maximize:

$$W(\beta) - \sum_{i=1}^{2} \lambda^i P^i(\beta) \tag{79}$$

where the general welfare loss increases as the number and size of groups voting populists rise. Note that:

$$p^i = \frac{\sigma^i - \mu}{2\sigma^i - \lambda^i a^i} \tag{80}$$

Hence, we see that:

$$p^i = \frac{\sigma^i - \mu}{2\sigma^i - \lambda^i A^i(\beta)} = P^i(\beta) \tag{81}$$

Specifically, if group i is angry, then:

$$P^i_\beta(\beta) = -\frac{\lambda^i}{\sigma^i - \mu}[P^i(\beta)]^2(R^i - V^i(\beta))V^i_\beta(\beta) \tag{82}$$

$$P^i_\beta(\beta) = -\phi^i(\beta)V^i_\beta(\beta)$$

Given the definition of a^i , as the policy becomes more favourable to that group (i.e. if $V^i_\beta(\beta) > 0$), anger is reduced ($-(R^i - V^i(\beta))V^i_\beta(\beta) < 0$) as is the probability of voting for the populists. Therefore, if the policy becomes more favourable to an angry group, then $P^i_\beta(\beta) < 0$.
A Populist Threat Equilibrium (PTE) consists of a vector of subjectively fair policies $\{\hat{\beta}^i\}$ and corresponding reference utilities $\{R^i\}$, a vector of probabilities of voting for the populists, $\hat{p}^i$ and a policy, $\hat{\beta}$ such that:

- Fair policies maximize the modified social-welfare functions of each group, $W(\beta) = \sum_k \pi^{ik} V^k(\beta)$;
- Within each group i, all members optimally define a probability of voting for the populists given the equilibrium policy, $\hat{\beta}$, the group's reference utility, $\{R^i\}$, and the equilibrium participation of the other group's members, p^{i*} ;
- The government's policy maximizes the social-welfare function inclusive of the cost of voting for the populists (29), taking as a given the groups' reference utilities $\{R^i\}$ and given how the policy affects equilibrium participation through (32).

The equilibrium policy maximizes (29), yielding:

$$W_\beta(\beta) - \sum_{i=1}^{2} \lambda^i P^i_\beta(\beta) = 0 \tag{83}$$

A benevolent government trades off the direct welfare effects of the policy, $W_\beta(\beta)$, against the disruptions caused by the populist vote. Given (30) and (31), the optimality condition can be rewritten as:

$$\sum_{i=1}^{2} \lambda^i [1 + \Phi^i(\beta)] V^i_\beta(\beta) = 0 \tag{84}$$

where $\Phi^i(\beta) > 0$ if $a^i > 0$, and zero otherwise. Equation (32) provides the full characterization of the equilibrium policy, $\hat{\beta}$.

All in all, a PTE policy solves a modified social planner problem in which each group i receives the extra weight $\Phi^i(]hat\beta) \geq 0$. If the extra weight differs between the rich and the poor, then there is a suboptimal choice of $\hat{\beta}$. Moreover, only aggrieved groups get extra weight in the welfare function – they exert some influence over policy.
More generally, a group's political influence reflects the following features. First, more homogeneous (low σ^i) and larger (high λ^i) groups are more influential in voting for populists. Second, a more pronounced self-serving bias (high v^i) implies that group members become angry more easily and, hence, are more prone to vote for populists.

3.3.4 Banking Recessions and Populist Consensus

Finally, our framework makes it possible to compare banking recessions and normal recessions. In order to do so, we start with the extant literature on the specialness of banking (financial, balance sheet, bubbly) recessions (Jorda et al. 2015). The main results of this research can be summarized as follows: all recessions are not created equal: the post-recession losses (PRL) are not random; and the PRL are more prolonged and painful with a financial crisis (PRFC) as the driver, while the PRFC is more prolonged and painful with a credit boom as the driver.
Therefore, we assume that a financial recession has a stronger impact on the banking system. We define $\hat{\beta} = \beta(1-F)$, where F is a positive wedge between financial and normal recessions. This setup means that a financial recession creates a stronger shock to the banking system, all else equal.
Anger increases, as the indirect utility is lower than before:

$$a^i = \frac{1}{2} max[0, R^i - V^i(\hat{\beta})]^2$$

We know that $a^i_\beta < a^i_{\hat{\beta}}$ for i = rich, poor. Intuitively, both the rich and the poor are angrier during a financial recession than a normal recession. This outcome is consistent with Funke et al.'s (2016) results indicating that financial recessions lead to greater consensus regarding extreme parties than normal recessions.

3.4 Conclusion

Populism can have plenty of general economic and psychological explanations, including cyclical recessions and unemployment, trade shocks, hatred of immigrants, and demand for redistribution. In this paper, we highlighted another potential channel: the general motivations mentioned above can lead citizens to start a democratic riot by supporting the banking policies that populist parties propose for a bailout intervention after a systemic banking crisis.
The consensus decision is influenced by the citizens' wealth group and it is genuinely behavioural. Therefore, the public support for bailout policies becomes highly dependent on a number of different motivations that have nothing to do with the bailout policies as such. The democratic riot channel can explain the

sight-unseen consensus in favour of populist banking policies, which are far from homogeneous.

This analysis can be further enriched in several directions:

a) Monetary-stability risks and citizen heterogeneity. Monetary instability is widely assumed to be a social cost that is borne equally by all individuals. If we were to associate monetary instability with specific idiosyncratic risks, we would assume that citizens can be also heterogeneous in their ability to address such risks through hedging, with some individuals bearing – or feeling that they bear – higher costs due to monetary instability (i.e. inflation-adverse citizens). Allowing for this kind of heterogeneity could lead to further differentiation between traditional and populist parties.

b) Income and citizen heterogeneity. Labour income is assumed to be the same for all individuals. In the presence of income heterogeneity, the distributional effects are likely to increase. Moreover, income heterogeneity can be correlated with other forms of asset heterogeneity. This can lead to additional interesting trade-offs.

c) Public debt, tax pressure and interest rates. In the focal context, government debt is only issued to address the pandemic-related recession, taxes are only raised to service that debt and the interest-rate is consistent with the long-term, risk-free interest rate. These are three simplifying assumptions. The insertion of initial taxation and initial debt into the framework would increase its complexity but probably not have substantial consequences for the overall rationale. In contrast, interest-rate endogeneity that depends on the stock of debt is likely to exacerbate the policy trade-offs and, consequently, the relevance of the political distortions.

d) Traditional parties. The traditional party's behaviour is assumed to be perfectly consistent with socially optimal planning. This assumption has been used to disentangle the differences between traditional parties and populist parties in the clearest way. However, we also discussed the possibility of a populist consensus that could influence the choice of a traditional incumbent government. In this perspective, the possibility of competitive, suboptimal policies between traditional and populist parties can lead to other intriguing trade-offs. Among these trade-offs, in principle we can include the possibility to consider the interactions between domestic traditional parties, domestic populist parties and foreign populist parties, mixing what we defined the internal and external channels of populist contagion.

e) Central bank and monetary policy. The central bank regime and the monetary policy are assumed to be perfectly consistent with socially optimal planning. We also assume that all parties – including the populist parties – do not discuss these features. This assumption can be modified in two ways. On the one hand, some researchers argue that the rise of populism may harm the consensus in favour of central bank independence and monetary policies consistent with such a regime (De Haan and Eijffinger 2017, Goodhart and Lastra 2017, Rajan 2017, Rodrik 2018). From an empirical point of view, the relationship between one aspect commonly attributed to populism – namely, nationalism – and central bank independence has been empirically examined (Agur, 2018), while the relationships between both right- and left-leaning populism and central bank independence have been discussed from a theoretical perspective (Masciandaro and Passarelli 2019). On the other hand, it is natural to wonder whether cases of political and/or bureaucratic capture could trigger deviations in the concrete monetary policy action from the (supposed) long-sighted perspective, such as those documented in the historical case of political pressure for partisan monetary policies (Abrams 2006).

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Appendix 1. The Relationship between Financial Imbalances and Votes for Populist Parties: Some Descriptive Analyses

Here we analyse the relationship between financial variables and political outcomes in order to descriptively assess whether imbalances in financial and banking industries has been correlated with voters' behaviour during elections.

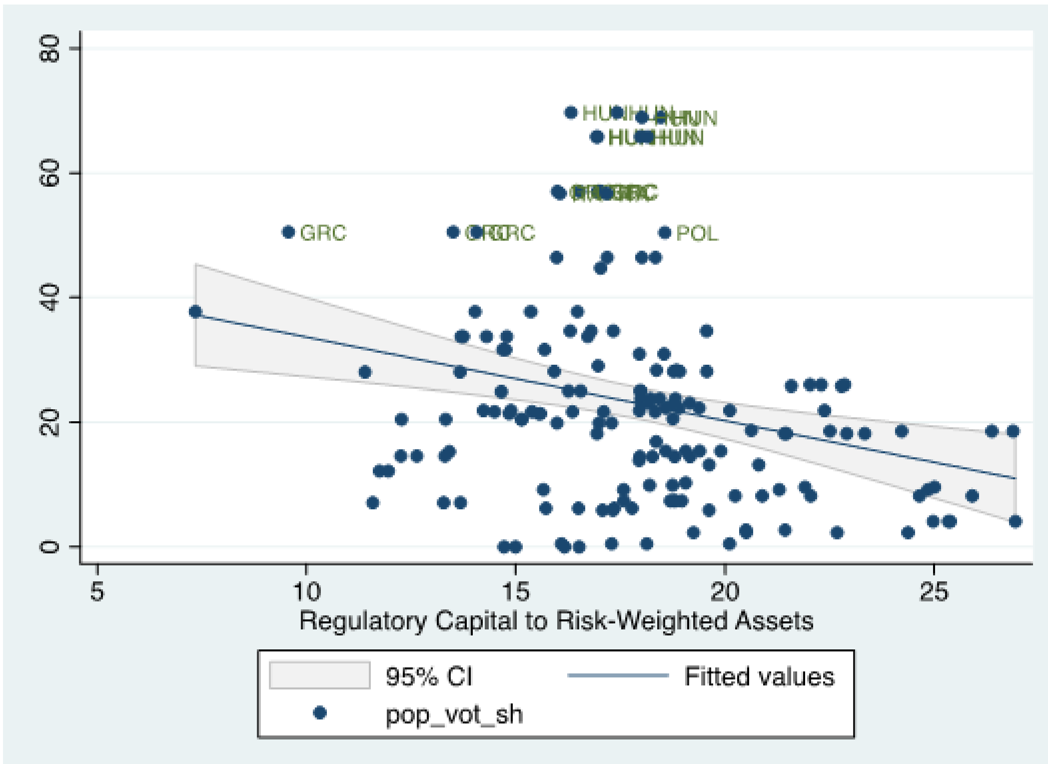
We use data related to political outcomes from the Timbro Authoritarian Populism Index (TAP), an initiative run by the free-market think tank Timbro. We consider the share of votes for populist parties during every election from 2010 to 2019. The index reports for each year the shares of votes for populist parties in the previous election. The dataset contains longer series, but we are constrained by the availability of financial data. The index heavily relies on secondary sources[30] and, to the greatest extent possible, it follows typical and existing categorizations. In general, it is not as difficult to categorize political parties as one might expect. Despite some disagreement on labels, there is a general consensus among scholars in this regard.

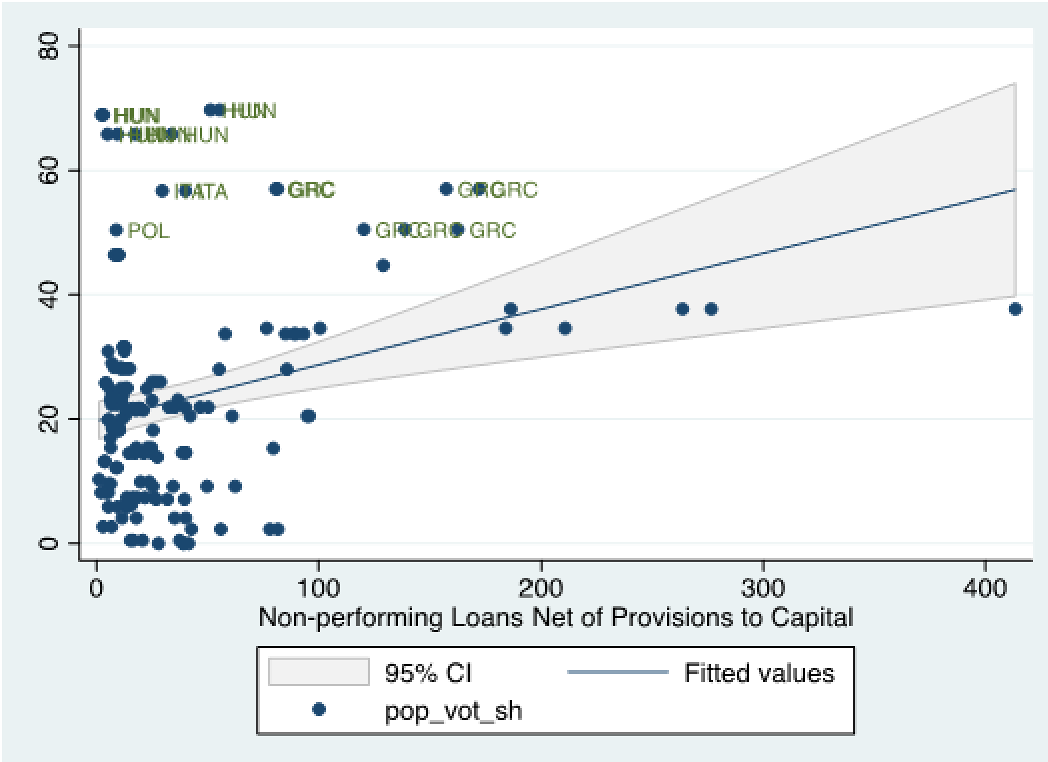
We retrieved financial data from the International Monetary Fund's Financial Soundness Indicator. Specifically, we rely on three variables: regulatory capital to risk-weighted assets, star non-performing loans (NPLs) net of provisions to capital, and NPLs to total gross loans. We chose these variables because, when considering the economy as a whole, capital- and asset-related variables may serve as proxies for financial soundness, while NPLs may serve as a proxy for financial imbalances or turmoil. On the one hand, higher regulatory capital and assets would allow firms to better absorb negative financial shocks, thereby limiting spillovers to the financial and/or banking system. On the other hand, larger shares of NPLs weaken firms' abilities to absorb such negative shocks, thereby leading to bankruptcies, losses for banks and, eventually, to financial crisis. Therefore, as our theoretical model starts from the assumption that financial and banking imbalances increase the share of votes for populist parties, we expect a negative correlation between capital- and asset-related variables and shares of votes for populist parties, and a positive correlation between the NPL variables and shares of votes for populist parties.

Figures 1 shows the relationships between regulatory capital to risk-weighted assets and the shares of votes for populist parties in elections in several European countries and the UK. We also plot fitted values and the 95 % confidence interval. The analysis shows a negative correlation between the proxy for financial stability and the shares of votes for populist parties. Therefore this descriptive evidence is in line with the assumption that financial imbalances and the rise of populist parties are associated. Figures 2 and 3 show the positive relationship

[30] These sources include scholarly literature on the European party system; ideological labels from internet sources, such as parties-and-elections.eu and Wikipedia; and the Chapel Hill Expert Survey (CHES), a quantitative summary of where parties belong on the left-to-right spectrum combined with additional dimensions that serve to identify right-wing populists (but not left-wing populists) using, for instance, views on minority rights, immigration and multiculturalism.

between NPLs and shares of votes for populists. Being NPLs a standard metrics for financial imbalances, also this evidence is consistent with the view that financial instability and consensus for populist parties are associated.

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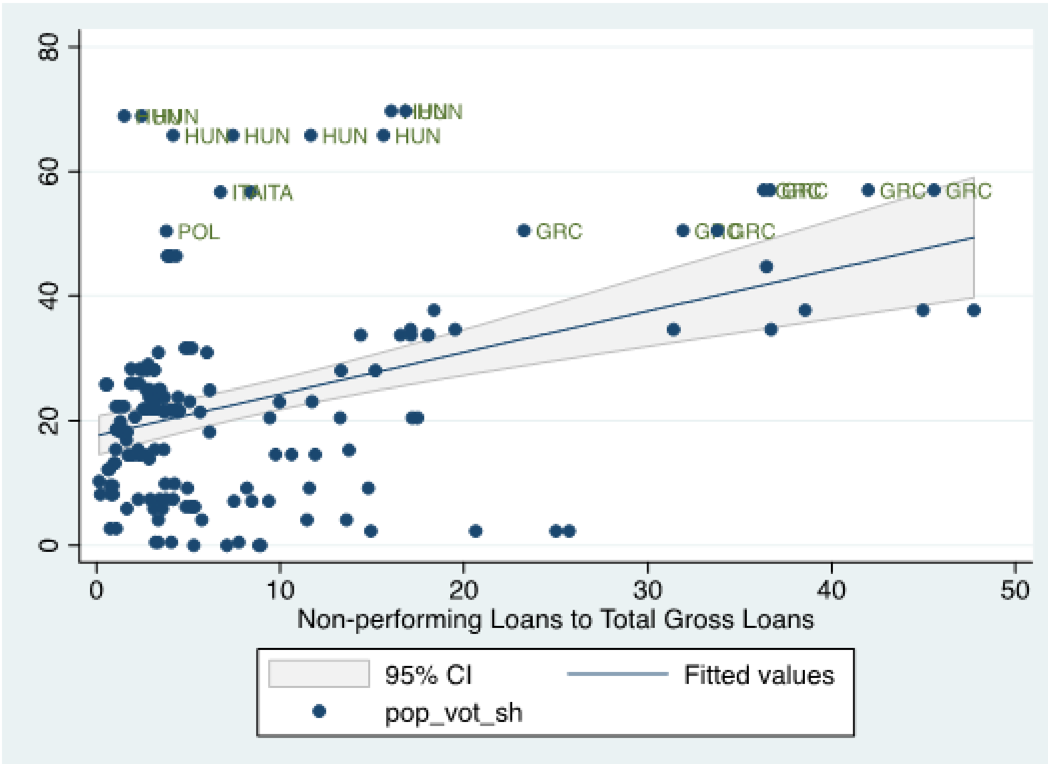

Note: for the sake of completeness, we checked the same associations changing the definitions of the relevant variables (see below): financial imbalances and populist consensus follow to go hand in hand.

3.4.1 All available years (2012/2019)

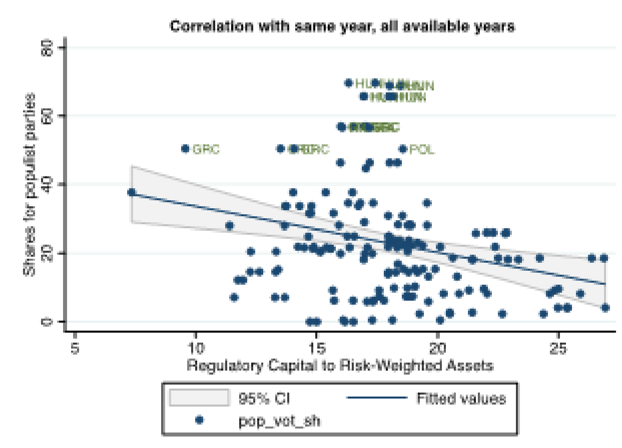

Figure 113: Correlation between shares for populists and current regulatory capital to risk-weighted assets.

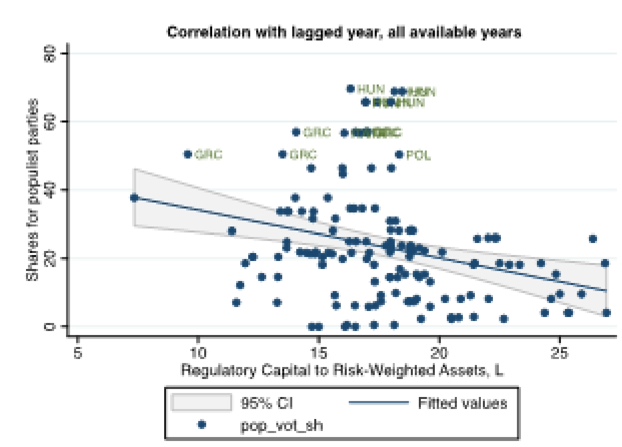

Figure 114: Correlation between shares for populists and lagged regulatory capital to risk-weighted assets.

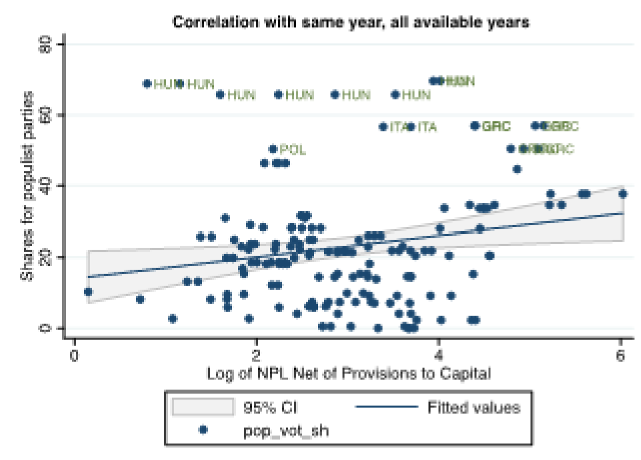

Figure 115: Correlation between shares for populists and current log of NPL net of provision to capital.

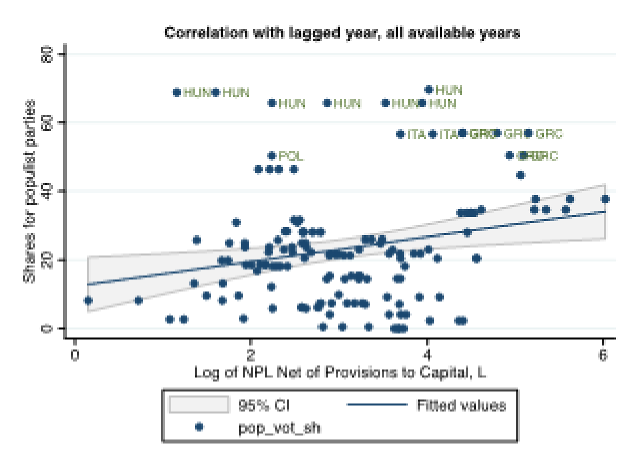

Figure 116: Correlation between shares for populists and lagged log of NPL net of provision to capital.

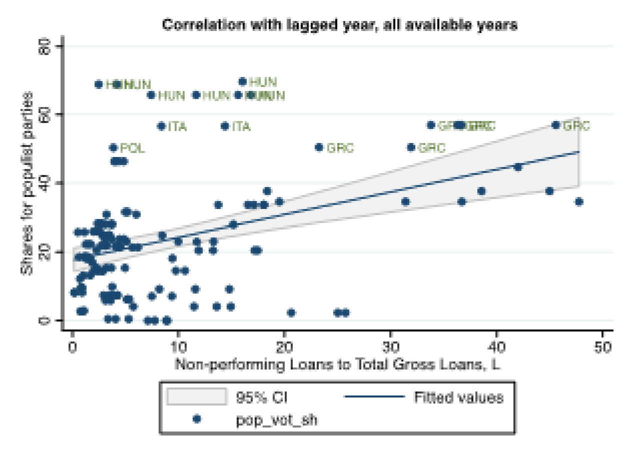

Figure 117: Correlation between shares for populists and current NPL to total gross loans.

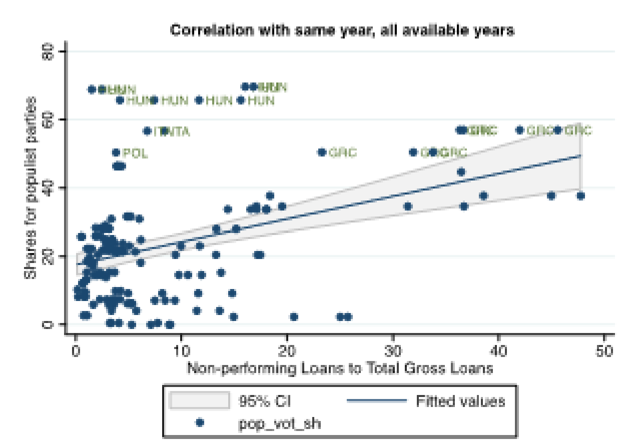

Figure 118: Correlation between shares for populists and lagged NPL to total gross loans.

3.4.2 Only election years

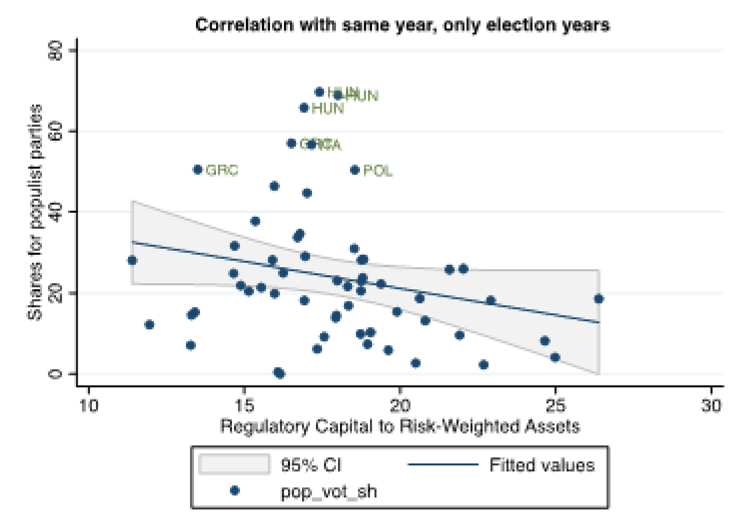

Figure 119: Correlation between shares for populists and current regulatory capital to risk-weighted assets.

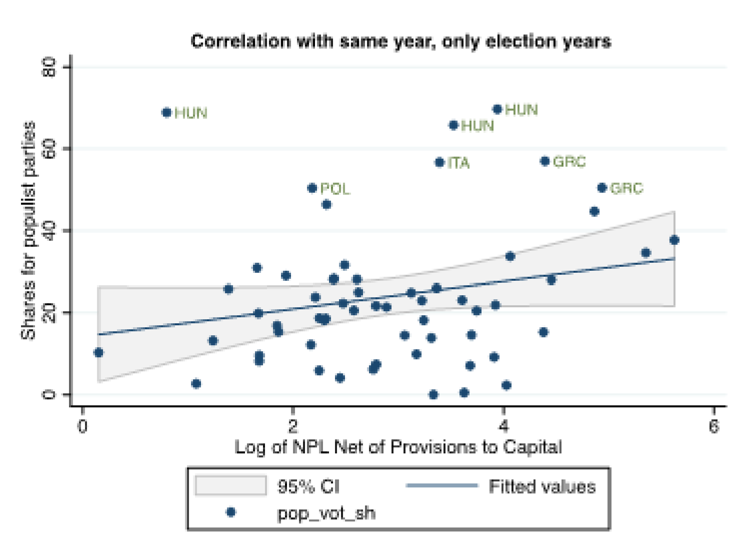

Figure 120: Correlation between shares for populists and current log of NPL net of provision to capital.

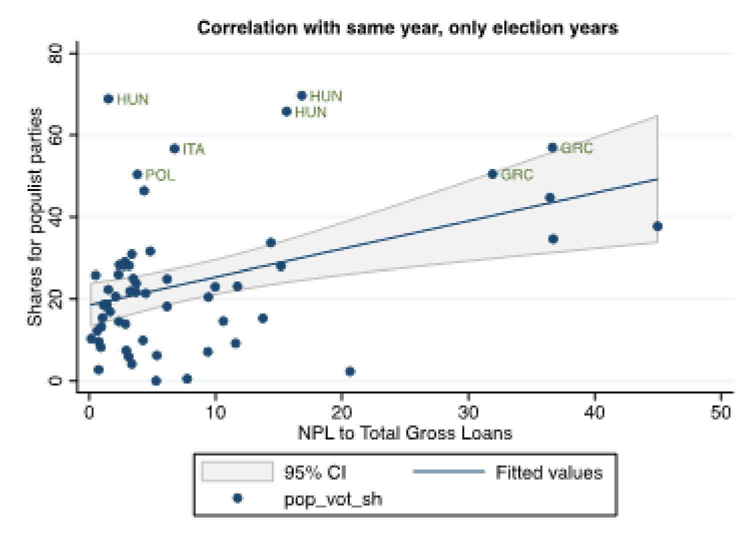

Figure 121: Correlation between shares for populists and current NPL to total gross loans.

Appendix 2. Populism and banking policies: Poland vs Italy

In this appendix, we consider two examples of how populist parties took advantage of popular anger originating from banking crises and used it for their own propaganda. Specifically, we first consider the 2015 Swiss franc (CHF) revaluation in Poland. Thereafter, we shed light on how the Five Star Movement (the main Italian populist party) first opposed the banking bailouts of the banche venete when it was part of the opposition, and then approved interventions to save Carige Bank and the Popular Bank of Bari in 2019 when it was part of the government.

Poland

On January 15, 2015, the Swiss National Bank (SNB) suspended its exchange rate floor of 1.20 EUR/CHF and allowed the CHF to appreciate. The move came in response to strong exchange-market pressure on the CHF and growing domestic criticism of the peg. The SNB's announcement caught financial-market participants and policy makers in Switzerland and abroad by surprise. In the initial hours following the decision, the exchange rate became so volatile that Swiss banks temporarily stopped converting CHF into EUR. Several major currency brokers incurred huge losses and some went bankrupt.

Immediately after the CHF shock, Poland saw some scattered protests among CHF borrowers. Nonetheless, the centre-right coalition government was initially reluctant to offer any meaningful support for CHF borrowers. The issue gained momentum during the May 2015 presidential campaign. In August 2015, during the summer campaign season for the October elections, the PO (the ruling party) introduced a bill that offered to the Polish households in smaller homes the opportunity to convert their CHF mortgages into loans denominated in Polish zloty (PLN). The bill proposed that the resulting adjustment costs would be shared roughly equally between borrowers and lenders.

The main opposition parties, the PiS and the Democratic Left Alliance, responded by proposing a more generous conversion scheme. They presented an amended bill in parliament that broadened eligibility for loan conversion and significantly increased the costs for banks. The incumbent PO lost the October 25, 2015, election by a wide margin, and its vote share fell by 15 percentage points from the 2011 elections. The PiS rose to power with 38 % of the popular vote (an increase of 8 percentage points relative to 2011).

Alquist, Copelovitch and Walter (2020) use a survey undertaken before the 2015 elections and an innovative research design to show that political parties can exploit external economic shocks, that voters form preferences based on the parties' policy promises and that these preferences translate into voting behaviour. Polish voters repaying CHF-denominated loans were directly exposed to the CHF shock, favoured generous bailout policies and were more likely to switch their votes to the opposition party that offered such policies (i.e. the PiS). This stood in contrast to the policy preferences of a demographically similar group (i.e. those who no longer had CHF-denominated loans), who were far less supportive of government intervention. Those without any exposure to currency borrowing were less likely to have an opinion and less supportive of government intervention. Nevertheless, using simple information experiments, these researchers found that voters' opinions were malleable at the margin in ways that increased support for pro-borrower intervention. Among the unexposed, those supporting the most government intervention also tended to support the populist-right PiS and hold more anti-immigrant views.

Italy: The case of the Five Star Movement

The Five Star Movement, an anti-establishment party in Italy, consistently criticized bank bailouts carried out by governments led by the Democratic Party (PD) and used this issue as a main point in its agenda. In 2016, the government bailed out the Monte dei Paschi di Siena bank. Luigi di Maio, the leader of the movement and Italy's foreign minister, criticized the decision, claiming that the movement would have never spent public funds to save banks. In 2017, former minister Barbara Lezzi led other members of parliament in throwing false banknotes during the approval of a law allocating EUR 4.7 billion to save two Venetian banks (Banca Popolare di Vicenza and Veneto Banca) and to avoid bail-in. They claimed that taxpayers' money should not be spent to save banks and accused the ruling PD of colluding with the financial establishment. Moreover, the government's decision saved depositors and holders of senior bonds, while junior holders were penalized. Although this difference was the result of the nature of the specific bonds, many party members exploited it by claiming that the government had penalized citizens in favour of the establishment.

The movement's approach to bank crises changed drastically when, in March 2018, the party won the election (although did not have a majority) and formed a government in coalition with the right-wing sovereign party "Lega". In 2019, this "yellow-green" government saved the commercial Carige Bank by collateralizing bonds for EUR 300 million. It also ring-fenced EUR 1 billion to cover potential future capital injections. The government justified this decision by saying that it was necessary to guarantee the daily functioning of the bank and, therefore, to protect thousands of depositors and creditors.

When confronted with the fact that it had implement the same policies as previous governments, the party claimed that the goals were completely different. According to party members, the government led by the PD saved Venetian bankers while shareholders and holders of junior bonds lost all of their funds. In contrast, the party claimed, the government had safeguarded citizens' savings in the Carige Bank case.

When the Popular Bank of Bari experienced financial turmoil in 2019, the party cooperated with the PD to introduce measures to save the bank and avoid a bail-in. Some analysts believe that this decision was necessary for the party, as the Apulia region, where the bank was headquartered, was home to an important electoral constituency for the movement. The government decided to invest around EUR 1.5 billion using two government-controlled public companies that

took control of the bank. In addition, another public company bought EUR 2 billion in NPLs for EUR 500 million.
When the party explained this decision on its blog, it highlighted that the decision would have the following effects: honest citizens would be saved; no mercy would be given to the managers responsible for the bankruptcy; Italy would have a public investment bank, thereby aligning itself with other European countries; the government would encourage the Bank of Italy to prosecute the managers responsible; and the government would ask the parliamentary commission responsible for banks to share the full names of the debtors responsible for the bankruptcy. These claims reveal the populist and anti-establishment nature of the movement. Although the party explained the reasons for its decisions and claimed that the way it saved the banks in turmoil differed from the methods used by previous governments, the tools it used and the effects were in line with those of previous governments.