Global Interest Rates, Monetary Policy, and Currency Returns

Charles Engel, Kenneth D. West, and Mian Zhu
University of Wisconsin

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

V. Effects of monetary policy shocks

VI. Conclusion

I. Introduction

- Do monetary policy shocks influence real exchange rates through some channel other than their direct effect on real interest rates?

- In addition to direct effects on interest rates, perhaps policy also affects exchange rates by affecting risk premia, or liquidity premia, or expectational or informational biases.

- Our aim is to consider how monetary policy shocks affect real exchange rates, allowing for an additional, unmodeled channel that might reflect risk premia, liquidity premia, expectational biases, or something else

    - preview of technique and data: regression analysis of bilateral US rates, developed countries, 1981-2007

- We are motivated by two parallel literatures on exchange rates (references below)

    - A macroeconomic literature that studies monetary policy using VARs or calibrated DSGE models, and considers an interest rate → exchange rate channel

    - A finance literature that studies interest parity using regressions or calibrated models, and considers a risk premium → exchange rate channel

•Finance literature is often motivated by the "forward premium anomaly":

•on average, high interest rate currencies tend to appreciate relative to low interest rate currencies

•Classic paper is Fama (1984). To exposit, write the (expected) *excess return* on foreign bonds, which we call λ_t, as:

$$\lambda_t \equiv i_t^* - i_t^{US} + E_t s_{t+1} - s_t,$$

where:

•i is a nominal interest rate, "*" denotes a foreign country

•s is the nominal exchange rate measured as log(USD/FCU); larger s means depreciation of the US dollar

$\lambda_t \equiv i_t^* - i_t^{US} + E_t s_{t+1} - s_t$

====

•Note for future reference that (expected) excess returns can also be written in real terms: upon subtracting foreign minus U.S. inflation from $i_t^* - i_t^{US}$ and adding the same quantity to $E_t s_{t+1} - s_t$ we obtain

$$\lambda_t \equiv r_t^* - r_t^{US} + E_t q_{t+1} - q_t,$$

where r is the ex-ante real rate and q is the real exchange rate.

- •An increase in q means a real depreciation of the U.S. dollar.

•Our analysis uses real q, but the literature on the foreign premium anomaly typically uses nominal s, so for the moment I will work in nominal terms

$\lambda_t \equiv i_t^* - i_t^{US} + E_t s_{t+1} - s_t$, an increase in s_t means an depreciation of the dollar

======

•If (a)expectations are rational, and (b)excess returns are constant–a leading case is uncovered interest parity, under which λ_t=0–then

$$E_t s_{t+1} - s_t = \text{const.} + i_t^{US} - i_t^*.$$

Then a regression of Δs_{t+1} on a constant $i_t^{US} - i_t^*$ will yield, in population, a slope coefficient of 1.

•But instead such a regression often, perhaps typically, yields a negative slope coefficient.

•If the slope coefficient is negative in population, then with some algebra, this can be shown to imply that in certain precise senses movements in expected nominal exchange rates are dominated by movements in λ_t.

- A large literature in finance interprets movements in λ_t as a reward for risk
    - recent papers include Bansal and Shaliastovich (2008), Colacito (2008), Lustig and Verdelhan (2007), and Verdelhan (2010).
    - this literature generally models real endowment economies and hence do not speak directly to our topic (monetary policy and exchange rates)
        - exceptions that we know of are quite stylized and do not tie well to the monetary policy literature (West and Cho (2003), Alvarez et al. (2009))
- A smaller literature has argued that movements in λ_t reflect expectational or informational biases in $E_t s_{t+1}$ (e.g., Frankel and Froot (1987), Bachetta and van Wincoop (2008)), again in frameworks without monetary policy

- In some research, λ_t reflects liquidity, or transaction or portfolio costs, either

  - to explain the foreign premium anomaly, abstracting from monetary policy (e.g., Bachetta and van Wincoop (2010))

  - as a convenient device to insure a steady state, in models that indeed allow for monetary policy (e.g., Bergin (2006)). So far as we know such papers have not offered an analysis of the dynamics of λ_t, perhaps because it is understood that this convenient device leads to trivially small movements in λ_t (e.g., Kollman (2004))

- Lastly, many, many papers have either
  - introduced exogenous variation in λ_t (e.g., Kollman (2004), Bergin (2006))
  - assumed uncovered interest parity (i.e., $\lambda_t \equiv 0$) (e.g., Dornbusch (1976), Clarida et al. (2002))
- Clearly exogeneity or absence of λ_t precludes study of whether one channel for monetary policy to affect exchange rates is via λ_t

•We take as established that movements in λ_t seem to be large.

•We do not take a stand on the economic sources of such movements–risk aversion, transactions costs, expectational or informational biases, measurement error–and merely refer to λ_t as the *excess return*.

•We ask how real exchange rates and excess returns respond to monetary policy shocks

- Some of our results are consistent with earlier literature
    - Holding excess returns constant, a monetary contraction (increase in real interest rate) in the U.S. relative to the foreign country leads a fall (appreciation) in the real exchange rate q_t. This is consistent with standard sticky price models that assume uncovered interest parity.
    - Such a monetary contraction is associated with a fall in λ_t, which is consistent with the forward premium anomaly
- Other results, and in particular the dynamic response of λ_t, are surprising, and do not seem to be foretold with the models described above. Specifically, λ_t falls and then rises. In a risk premium model for λ_t, this means that a surprise monetary contraction initially makes foreign bonds less risky but then makes them more risky.
- Overall, however, monetary shocks explain only a small part of the movement in q and λ.

•Caveat: this is a preliminary draft.

•We do not interpret our results in light of a specific macro model.

•We study real exchange rates q and real interest rates r; nominal exchange rates and interest rates will be incorporated in a future draft.

•Other omissions to be rectified in future drafts include: no standard errors on the central estimates, some roundabout steps taken in implementation, and limited evidence on robustness across alternative specifications.

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

V. Effects of monetary policy shocks

VI. Conclusion

II. Analytical framework

•We defined λ_t, the excess return on foreign bonds, as:

$$\lambda_t \equiv i_t^* - i_t^{US} + E_t s_{t+1} - s_t,$$

where i and s are a nominal interest and exchange rates

•Recall that upon subtracting foreign minus U.S. inflation from $i_t^* - i_t^{US}$ and adding the same quantity to $E_t s_{t+1} - s_t$ we obtain

$$\lambda_t \equiv r_t^* - r_t^{US} + E_t q_{t+1} - q_t,$$

where r is the ex-ante real rate and q is the real exchange rate.

- •An increase in q means a real depreciation of the U.S. dollar.

$\lambda_t \equiv r_t^* - r_t^{US} + E_t q_{t+1} - q_t$

=======

•Assume for the moment that the excess return λ_t, the real interest differential r_t^{US}-r_t^* and the real exchange rate q_t are stationary, with unconditional means, $\bar{\lambda}$, $\bar{r}$ and $\bar{q}$. We can rearrange the above as

$$q_t - \bar{q} = -(r_t^{US} - r_t^* - \bar{r}) - (\lambda_t - \bar{\lambda}) + E_t(q_{t+1} - \bar{q})$$

Solving forward and using $\lim_{j\to\infty} E_t(q_{t+j} - \bar{q}) = 0$, we obtain

$$q_t - \bar{q} = -\sum_{j=0}^{\infty} E_t(r_{t+j}^{US} - r_{t+j}^* - \bar{r}) - \sum_{j=0}^{\infty} E_t(\lambda_{t+j} - \bar{\lambda})$$

or

$$q_t - \bar{q} \equiv - R_t - \Lambda_t.$$

$\lambda_t \equiv r_t^* - r_t^{US} + E_t q_{t+1} - q_t$, λ_t is excess return, r is real interest rate, q is real exchange rate

$$q_t - \bar{q} = -\sum_{j=0}^{\infty} E_t(r_{t+j}^{US} - r_{t+j}^* - \bar{r}) - \sum_{j=0}^{\infty} E_t(\lambda_{t+j} - \bar{\lambda}) \equiv - R_t - \Lambda_t.$$

==========

•Does monetary policy work through

•the long run real interest rate (i.e., present value of one period real interest differentials) R_t

or

•the *level* excess return (i.e., present value of one period excess returns) Λ_t?

•Our analysis of our monthly data proceeds in steps:

1a: Estimate Taylor rule to obtain series of monetary policy shocks

1b: VAR to compute $\hat{R}_t$

2: VAR in monetary policy shocks, $\hat{R}_t$ and q_t to compute impulse responses

Some details:

1a. Estimate country by country Taylor rules, using an unemployment based measure of the output gap. Let $\hat{v}_t^{US}$ and $\hat{v}_t^*$ denote the residuals from estimated Taylor rules.

1b. For each bilateral US-foreign pair, estimate R_t from a VAR in relative nominal interest rates, relative inflation rates, relative output gaps, the real exchange rate, and(U.S. dollar) commodity price inflation. From this VAR, use standard projection formulas to estimate model consistent values of $E_t(r_{t+j}^{US}-r_{t+j}^{*} - \bar{r})$ for each j, and then sum these over j to calculate $\hat{R}_t$.

2. Estimate a VAR in $\hat{v}_t^{US}-\hat{v}_t^*$, q_t and $\hat{R}_t$, treating $v_t^{US}-v_t^*$ as contemporaneously exogenous. Compute and report impulse responses to the monetary shock. Responses of Λ_t are constructed from the identity $q_t - \bar{q} = -R_t - \Lambda_t$.

As described below, we conducted a modest amount of sensitivity analysis to sample period and detrending method.

$$q_t - \bar{q} = -\sum_{j=0}^{\infty} E_t(r^{US}_{t+j} - r^{*}_{t+j} - \bar{r}) - \sum_{j=0}^{\infty} E_t(\lambda_{t+j} - \bar{\lambda}) \equiv -R_t - \Lambda_t.$$

==========

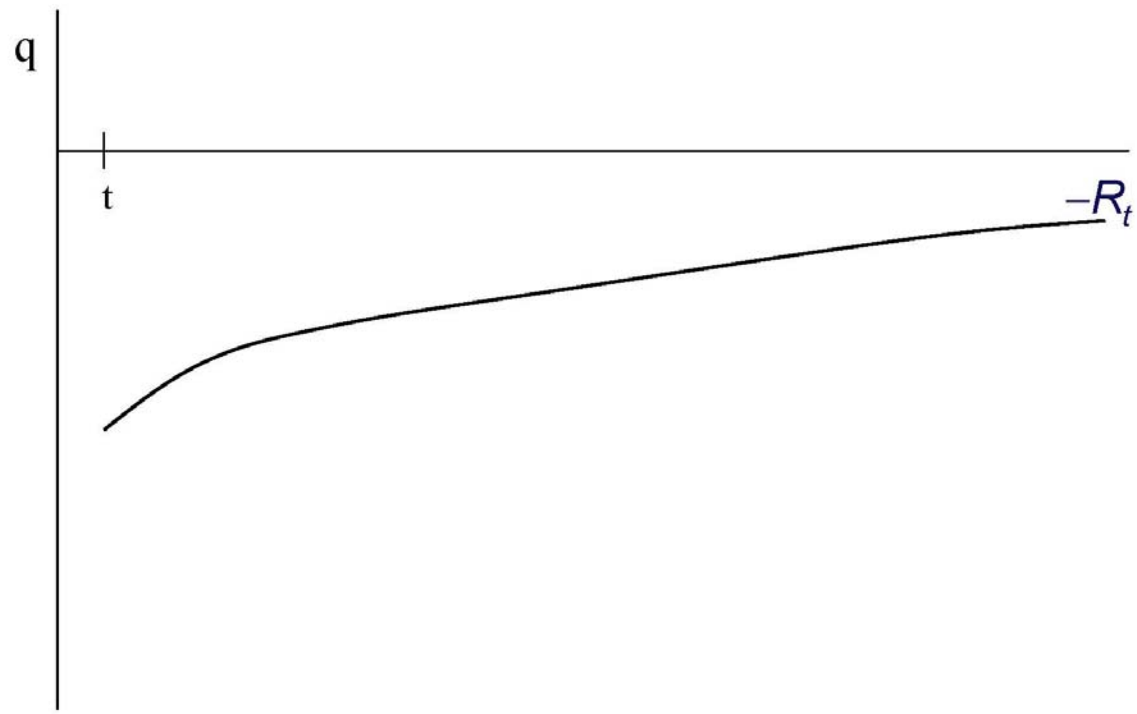
•To preview the results: Dornbusch's famous overshooting paper considers the exchange rate effects of a one-time change in the money supply.

If U.S. money supply contracts once-and-for all in Dornbusch's model at time t, R_t rises:

> •r^{US}_t-r^{*}_t increases, and then r^{US}_{t+j}-r^{*}_{t+j} stays above $\bar{r}$ but converges toward that level as prices adjust.

•Since R_t rises, the real exchange rate q_t falls (a U.S. real appreciation.) There is no effect of monetary policy on Λ_t. In Dornbusch, uncovered interest parity holds so $\Lambda_t \equiv 0$.

•Graphically, this pattern is:


q
t
$-R_t$

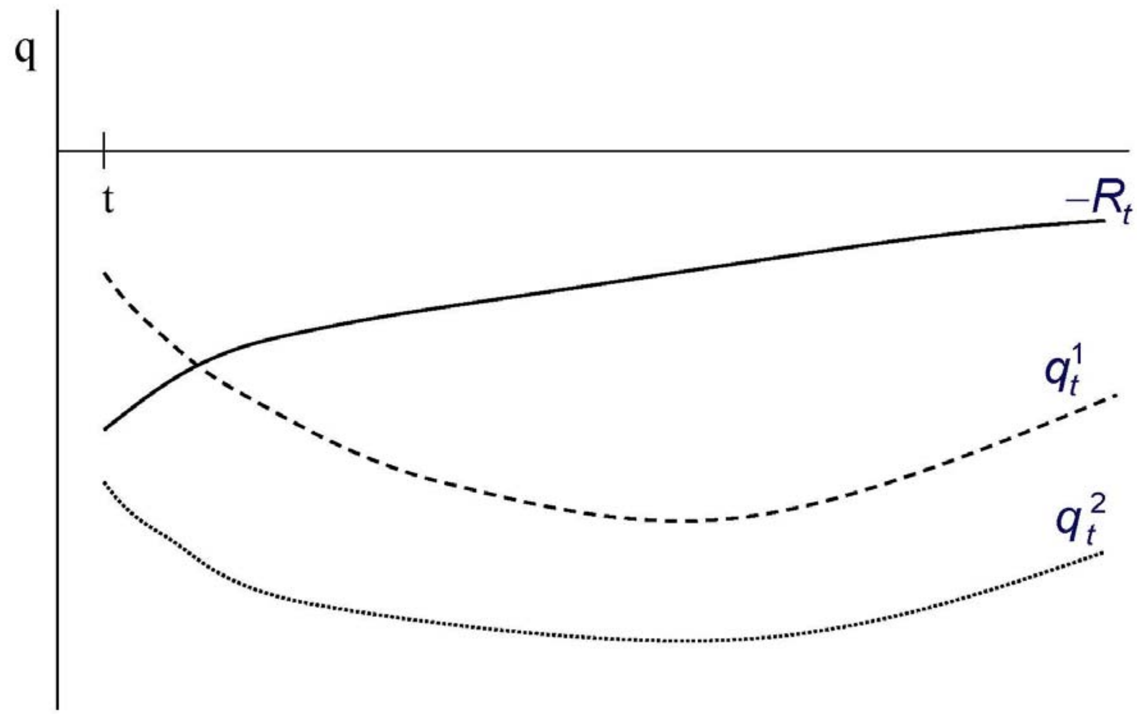
•In our data, the real exchange rate does not have this type of impulse response function to a U.S. monetary contraction.

- •We measure a monetary contraction as a deviation from the monetary policy rule. That is, it is an interest rate that is higher than predicted from a fitted Taylor rule.

•When there is a surprise U.S. relative to foreign monetary contraction we indeed find that $-R_t \equiv -\sum_{j=0}^{\infty} E_t(r_{t+j}^{US} - r_{t+j}^{*} - \bar{r})$ behaves as in the previous graph. It jumps at the time of the shock, and gradually returns to its mean.

But the real exchange rate does not follow this pattern. Monetary policy affects $\Lambda_t \equiv \sum_{j=0}^{\infty} E_t(\lambda_{t+j} - \bar{\lambda})$.

Our impulse response functions look like:


q
t
$-R_t$
q_t^1
q_t^2

•In some cases, the effect of monetary shocks on Λ_t makes the real appreciation less than the R_t effect, in some cases it amplifies the R_t effect.

•There is a tendency to see continued appreciation after the initial shock. This is closely related to the forward premium anomaly.

•In all cases, Λ_t eventually makes the real appreciation greater than it would be from the R_t effect alone. We will remark below that the dynamic pattern is not one that follows naturally from risk premium based models of Λ_t

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

V. Effects of monetary policy shocks

VI. Conclusion

III. Data and details of specification

- U.S. relative to six other countries:

  Canada
  Japan
  Switzerland
  U.K.
  Eurozone (aggregate of France, Germany, and Italy)
  All countries (aggregate of all 7 countries)

- Monthly data 1981:1-2007:6. We stop when the first signs of the crisis hit.

nominal exchange rates:	noon buying rates, last day of month, NY
nominal interest rates:	Eurocurrency, average of bid and asked, last day of the month
unemployment rates:	OECD
price level, inflation:	CPI
commodity prices:	non-fuel commodity dollar index from IFS

- Recall our procedure:

  1a: Taylor rule

  1b: VAR to compute $\hat{R}_t$

  2: VAR to compute impulse responses

- Discuss each in turn

1a: Taylor rule specification (temporarily dropping “US” and “*” superscripts)

•Country by country least squares estimation of

$$i_t = \text{const.} + \gamma_{i\pi}\pi_{at} + \gamma_{iy}ygap_t + \gamma_{ii}i_{t\text{-}1} + v_t$$

where

π_{at} = annual inflation = $\pi_t+\pi_{t\text{-}1}+....+\pi_{t\text{-}11}$

$ygap_t$ = unemployment based measure of the output gap described below

•Kozicki and Tinsley (2009) argue that in the US, an unemployment based measure is better than an output based measure

$$i_t = \text{const.} + \gamma_{i\pi}\pi_{at} + \gamma_{iy} ygap_t + \gamma_{ii} i_{t\text{-}1} + v_t$$

==========

Step 1a, Taylor rule, continued

•Possible drift in the rule (changing inflation target, for example) crudely captured with sample splits (see below)

•residual of foreign rule subtracted from residual of US rule to obtain $\hat{v}_t^{US}$-$\hat{v}_t^{*}$

Step 1a, Taylor rule, continued: Output gap

•In all the results reported in the paper

$$ygap_t = -(u_t - \bar{u}_t),\ \bar{u}_t = (1/12)\sum_{j=1}^{12} u_{t-j+1}$$

•We also experimented with setting the number of terms in the moving average for $\bar{u}_t$ to 3 and 60 (instead of 12), and changing the first term from u_t to a moving average of 3 or 12 terms:

$$ygap_t = -[(1/c_u)\sum_{j=1}^{c_u} u_{t-j+1} - \bar{u}_t],\ \bar{u}_t = (1/c_n)\sum_{j=1}^{c_n} u_{t-j+1},$$

$$c_u < c_n,\ c_u = 1, 3, \text{ or } 12,\ c_n = 3, 12, 60$$

•The specification presented invariably produced $\hat{\gamma}_{i\pi}/(1-\hat{\gamma}_{ii})>1$ and $\hat{\gamma}_{iy}>0$.

Step 1b, VAR to construct $\hat{R}_t$

•VAR in relative nominal interest rates, relative inflation rates, relative output gaps, the real exchange rate, and the (dollar) commodity price inflation: 3 lags of all variables

Step 2, VAR to compute responses to monetary policy shock

•VAR in relative monetary policy shock $\hat{v}_t^{US}$-$\hat{v}_t^{*}$, real interest rate q_t and long run real interest differential $\hat{R}_t$: 3 lags

•For impulse responses, we treat v_t^{US}-v_t^{*} as contemporaneously exogenous (i.e., v_t^{US}-v_t^{*} is ordered first; the order of the second two variables is irrelevant.)

•we calculate the impulse response of q_t, R_t and Λ_t to a one unit shock to v_t^{US}-v_t^{*}, with the response of Λ_t constructed using $q_t - \bar{q} = -R_t - \Lambda_t$

•we only report point estimates; standard errors are not yet available

•We also completed a set of results that allowed for time trends (rather than constant means); results did not differ much.

•We also completed a set of results that allowed for a one-time shift in monetary policy, and consequently a shift in the VAR that generates R_t as well. See p17 of the paper for dates. While Taylor rule parameters sometimes were different in the two regimes (and sometimes not), the qualitative character of the response of the real exchange q_t to a monetary shock $\hat{v}_t^{US}$-$\hat{v}_t^*$ was unchanged.

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

V. Effects of monetary policy shocks

VI. Conclusion

IV. Taylor rule estimates

- i_t = const. + $\gamma_{i\pi}\pi_{at} + \gamma_{iy} ygap_t + \gamma_{ii} i_{t\text{-}1} + v_t$

- In all 7 countries,

    - $\hat{\gamma}_{i\pi}/(1\text{-}\hat{\gamma}_{ii}) > 1$, $\hat{\gamma}_{iy} > 0$;

    - $\hat{\gamma}_{iy}/(1\text{-}\hat{\gamma}_{ii})$ perhaps is larger than expected, assuming an Okun's law coefficient of about 2

Estimated Taylor rules: $i_t = \text{const.} + \gamma_{i\pi}\pi_{at} + \gamma_{iy} ygap_t + \gamma_{ii} i_{t\text{-}1} + v_t$

	$\gamma_{i\pi}$	γ_{iy}	γ_{ii}	$\gamma_{i\pi}/(1\text{-}\gamma_{ii})$	$\frac{1}{2}\gamma_{iy}/(1\text{-}\gamma_{ii})$	$\gamma_{iy}/(1\text{-}\gamma_{ii})$
U.S.	0.058	0.343	0.955	1.26	1.39	3.78
	(0.027)	(0.064)	(0.013)			
Canada	0.045	0.307	0.973	1.64	2.81	5.63
	(0.024)	(0.058)	(0.014)			
Japan	0.016	0.163	0.986	1.11	2.86	5.73
	(0.015)	(0.080)	(0.008)			
Switzerland	0.060	0.109	0.953	1.27	0.59	1.17
	(0.025)	(0.069)	(0.017)			
U.K.	0.081	0.315	0.947	1.54	1.50	2.99
	(0.028)	(0.078)	(0.018)			
Eurozone	0.157	0.256	0.908	1.71	0.70	1.39
	(0.039)	(0.128)	(0.022)			
All Foreign	0.123	0.464	0.938	1.97	1.86	3.73
	(0.029)	(0.113)	(0.016)			

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

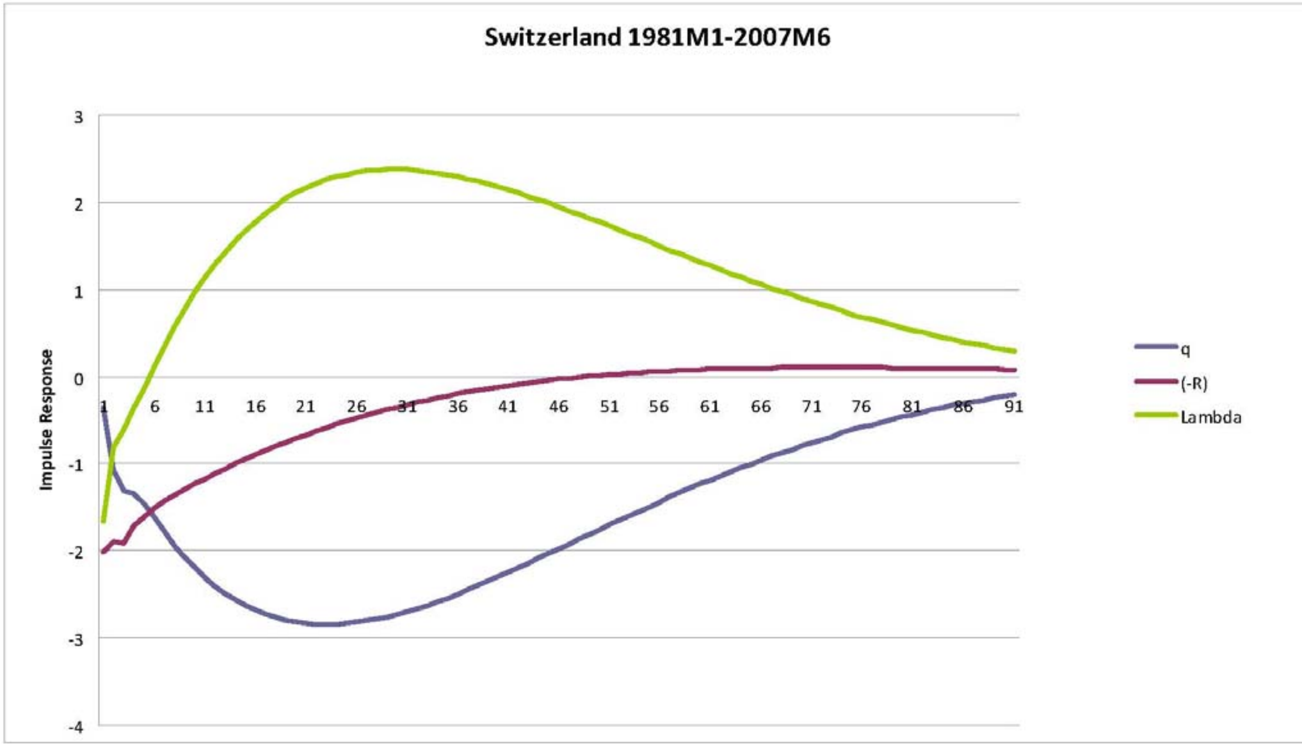
V. Effects of monetary policy shocks

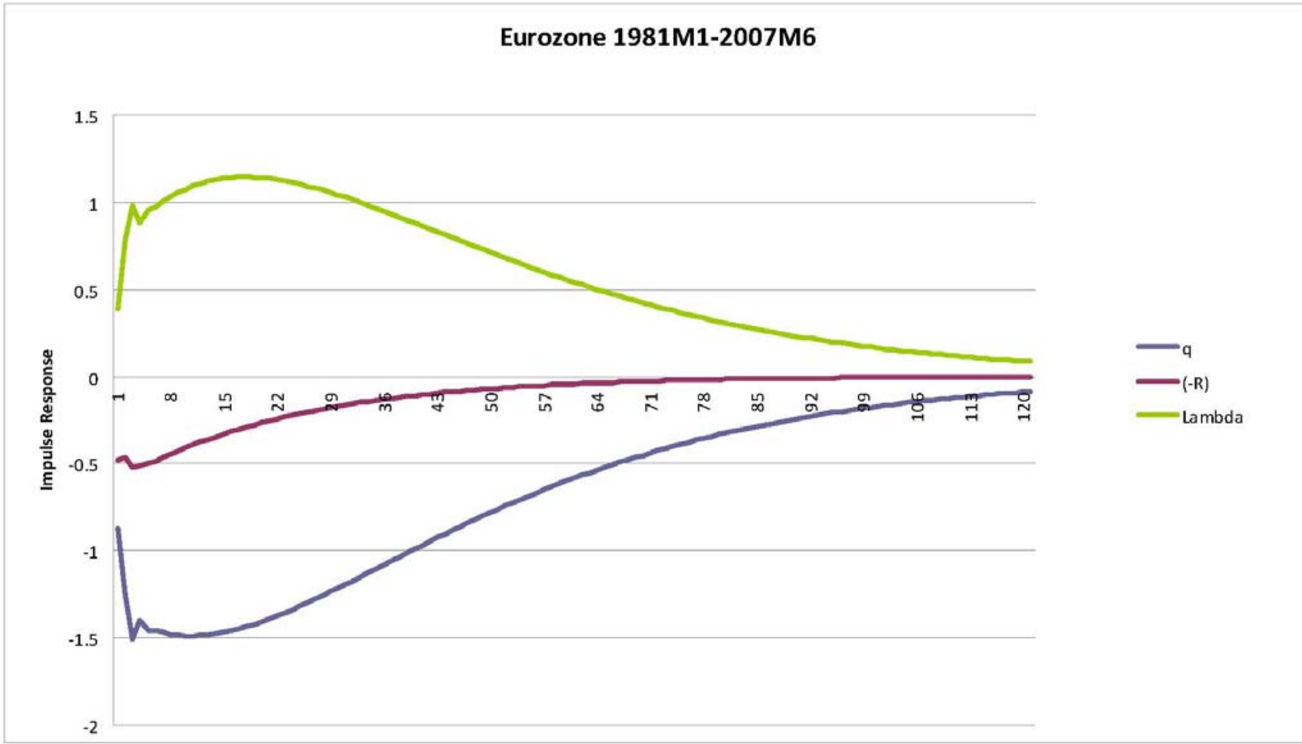
VI. Conclusion

V. Effects of monetary policy shocks

We compute impulse responses to a 1% increase in v_t^{US}-v_t^{*}–i.e., a contractionary monetary policy shocks in which the US nominal interest rate increases by 1% relative to foreign interest rate

Two representative plots of, one for Switzerland, one for the Eurozone:


Switzerland 1981M1-2007M6
Impulse Response
3
2
1
0
-1
-2
-3
-4
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
76
81
86
91
q
(-R)
Lambda


Eurozone 1981M1-2007M6
Impulse Response
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
113
120
q
(-R)
Lambda

•These two graphs demonstrate common features of all of the impulse response functions to an increase in v_t^{US}-v_t^*. Consider the responses of R_t, Λ_t and q_t in turn

•Response of the long run real interest rate R_t to a contractionary monetary policy shock

- •R_t always increases on impact.

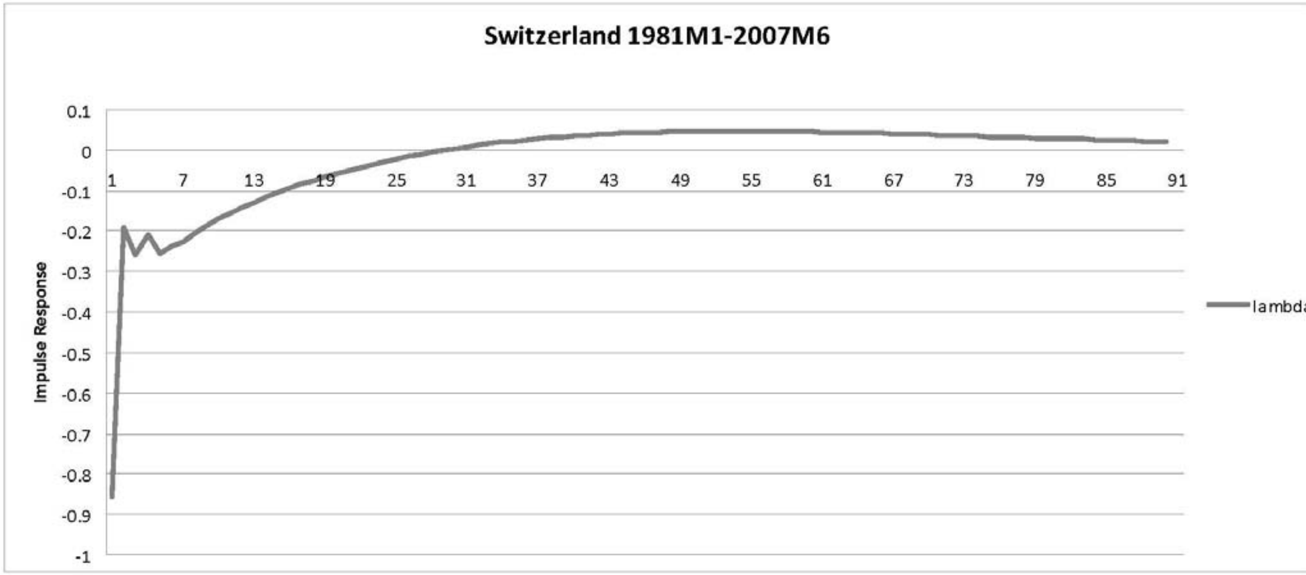
- •The impulse response function for R_t converges more or less monotonically.

•Response of the level risk premium Λ_t to a contractionary monetary policy shock

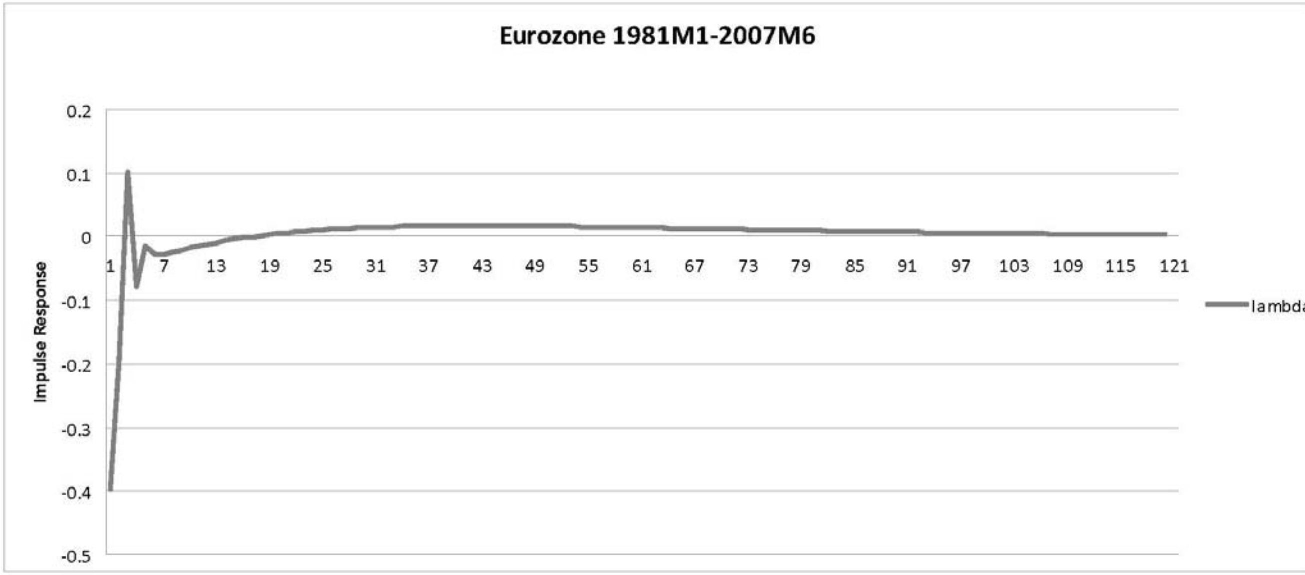
- •The impulse response function for Λ_t is always non-monotonic, with a hump shape. With one exception (Japan), it initially increases then falls.

- •This means that λ_t has a negative response on impact (consistent with the forward premium anomaly): a surprise increase in US interest rates relative to foreign rates causes the excess return to fall. λ_{t+j} also responds negatively for a number of months. But for large j, λ_{t+j} responds positively. That is, at longer horizons, foreign bonds have a higher excess return Pictures for Switzerland and Eurozone:

Response of λ_t



Response of λ_t



λ_t initially responds negatively, but for large j, λ_{t+j} responds positively.

=====

- Response of the level excess return Λ_t to a contractionary monetary policy shock (cont'd)

  - If λ_t is a risk premium, then the risk premium on foreign bonds falls for a few months, then increases.

  - Related to Engel (2010). Is this a risk premium? What type of shock makes foreign assets less risky in the short run and riskier at more distant horizons?

- Common features of all of responses to an increase in v_t^{US}-v_t^* (cont'd)

- Response of the real exchange rate q_t to a contractionary monetary policy shock

  - As a result of these reactions we see delayed overshooting (the currency continues to appreciate after the initial shock) and always at some horizon the impact on the real exchange rate exceeds the effect coming from R_t alone.

  - Mean reversion is slow: time to return half way from peak is typically around 3-4 years, and the peak itself takes a year or two to attain. This is similar to the estimates in Steinsson (2007).

  - A peak response taking a year or two is broadly consistent with the response of nominal exchange rates to a monetary policy shock in Faust and Rogers (2003).

•Concise indication of robustness of results across samples and detrending methods:

Impact response of λ_t to the monetary policy shock

	No Break or Trend (Baseline)	Sample Split	Time Trend
Canada	-0.5069	-0.3870	-0.5110
Japan	0.2011	0.1638	0.1987
Switzerland	-0.8573	-0.8570	-0.8353
U.K.	-0.4099	-0.3752	-0.4106
Eurozone	-0.3963	-0.4556	-0.4047
All	-0.2954	-0.2677	-0.3098

$q_t - \bar{q} \equiv - R_t - \Lambda_t.$
====

•We find that for some currencies (Japan, eurozone, all countries combined) Λ_t rises on impact when v_t^{US}-v_t^* rises. (That is, level excess return on foreign bonds rises.) This works to amplify the effect of the change in R_t, which increases. The point estimates are broadly similar, and (roughly) indicate that a 1% monetary contraction leads to:

- •impact: q_t falls (appreciates) by 0.9%, R_t rises by 0.7 %, Λ_t rises by 0.2%.

- •24 months out: q_t falls by 1.6%, R_t rises by 0.2 %, Λ_t rises by 1.4%.

•We find for some other currencies (Canada, Switzerland, and the U.K.), Λ_t falls on impact when v_t^{US}-v_t^* rises. (That is, the level excess return on foreign bonds falls.) This works to offset the effect of the change in R_t, which increases. The point estimates vary substantially across the three currencies. For the U.K., responses are:

- •impact: q_t rises (depreciates) by 0.1%, R_t rises by 0.6 %, Λ_t falls by 0.7%.

- •24 months out: q_t falls by 1%, R_t has returned to baseline, Λ_t rises by 1%.

•We do not offer a theory of this behavior.

•We note that there is strong similarity in certain aspects of the impulse response functions across all currencies:

- •R_t rises and converges nearly montonically
- •On impact, λ_t falls.
- •A hump-shaped impulse response function for Λ_t.

•Since the pattern is qualitatively the same across countries, perhaps there is a story that holds quite generally. While fluctuations in risk premia might be part of the explanation, we think it is unlikely that a standard risk premium model alone will do the job.

•In any event the fraction of the variance of q that is due to monetary policy shocks is quite small, typically less than 5% at any horizon (not reported in the paper).

I. Introduction

II. Analytical framework

III. Data and details of specification

IV. Taylor rule estimates

V. Effects of monetary policy shocks

VI. Conclusion

VI. Conclusion

- We find that monetary shocks influence real exchange rates through two channels, interest rates and excess returns.

    - The interest rate channel works in a familiar direction (e.g., Dornbusch (1976)): a surprise tightening of U.S. rates works to increase real interest rates in the U.S. relative to abroad, in both the short and the long run, and thus to exchange rate appreciation in both the short and long run

    - Such a surprise tightening also leads to excess returns falling initially. This is consistent with the foreign premium anomaly, and reinforces the effect through the interest rate channel. Eventually, however, excess returns rise, thus offsetting the familiar interest rate channel.

- Further research is required to establish the precision and robustness of these results, and then to explain the economic forces that explain the pattern:

- What is ill understood is the extent to which those excess returns represent a liquidity premium, slow adjustment of portfolios, some deviation from rational expectations, risk premia, or something else.