The Dollar During the Great Recession: US Monetary Policy Signaling and The Flight To Safety

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2. This belief was also echoed during the Global Financial Crisis when the US engaged in UMP.

3. *"I heard two related complaints at international meetings and through the media: First, that the United States was engaging in 'currency wars'..by choosing policies that would weaken the dollar and thereby unfairly increase US competitiveness at the expense of trading partners."*

   (Ben Bernanke, "Federal Reserve Policy in an International Context", IMF Jacques Polak Annual Research Conference, 2015)

Summary of Key Findings

- We document that US monetary policy easings had the opposite effect during the Great Recession – i.e the USD appreciated rather than depreciate.
- We attribute this to calendar-based forward guidance that signaled economic weakness which resulted in a flight-to-safety effect and lower expected inflation in the United States.
- We also document an interesting cross-currency heterogeneity; a surprise US rate cut induced a larger appreciation of the dollar against currencies that tend to depreciate by more when US real output growth is low.
- We build a partial equilibrium model that can reconcile these results.

Agenda

- Empirical strategy
- Main empirical results
- Decomposing the channels
- Theoretical explanation
- Conclusion

Empirical Strategy

High-frequency identification: Kuttner (2001); Gürkaynak, Sack, and Swanson (2005); Gertler and Karadi (2015); Swanson (2018)

$$\text{Exchange rate: } \Delta s_{t+1} = \alpha^s + \beta^{\Delta s_{t+1}} \Delta \tilde{f}_{t+1} + error_{t+1}$$

- 2SLS regression
- $\tilde{f}_{t+1}$ is the foreign minus US 2 to 10 year forward rate

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$$\text{Other variables: } x_{t+1} = \alpha^{x} + \beta^{x_{t+1}} \Delta f^{US}_{t+1} + error_{t+1}$$

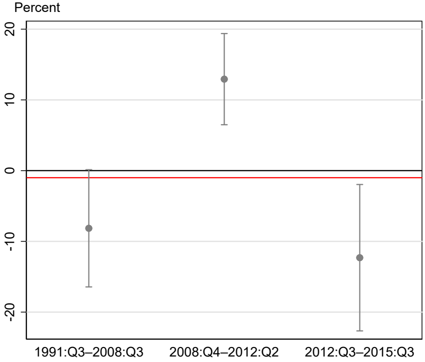
Data and Sample

- Quarterly frequency
- Full sample 1990–2015; Focus on the Global Recession period of 2008:Q4–2012:Q2
- Dollar's value against currencies of 9 developed economies: Australia, Canada, Switzerland, euro area, Japan, Norway, New Zealand, Sweden, UK

Details

Main Result

Figure: Response of Dollar Against All Currencies to US Monetary Policy Surprises

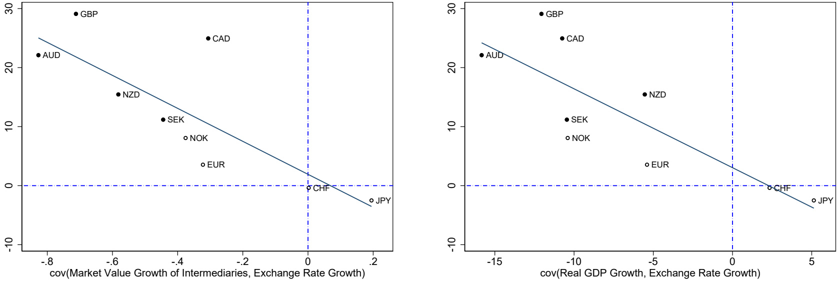


Note: 90% confidence intervals.

- During the Global Recession, the dollar *appreciated* in response to a Fed easing.
- This behavior is different from prior and subsequent time periods.

Main Result: Cross-currency heterogeneity

Figure: Cross-Currency Heterogeneity in Response to US Monetary Policy Surprises

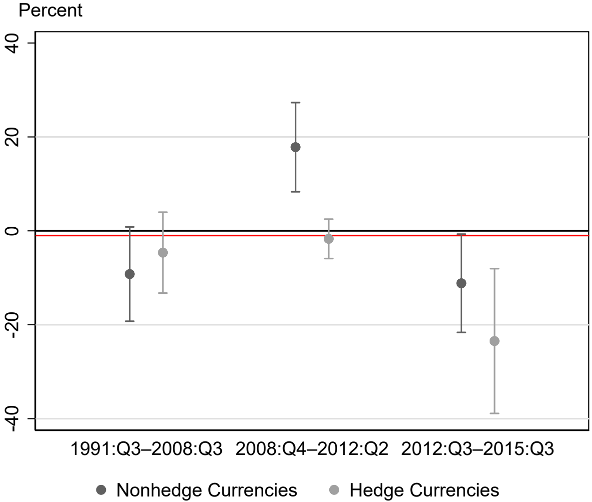


Note: Filled circles denote significance at the 10% level. Covariances calculated using data from 2002Q4 to 2008Q4.

- The dollar appreciated more against currencies that do not serve as good hedges for the US investor (i.e. they depreciate against the USD when the US economy is contracting or the market value of US financial intermediaries falls).

Main Result: Hedge vs Non-Hedge

Figure: Response of Dollar Against Hedge vs Non-Hedge Currencies to US Monetary Policy Surprises



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Decomposing the Exchange Rate Response

- Survey-based decomposition of exchange rate changes [Stavrakeva and Tang (2020)] Details Froot and Ramadorai (2005); Engel and West (2005, 2006, 2010); Engel, Mark and West (2006, 2008); Mark (2009); Engel(2014, 2016); Kim and Wright (2005); Kim and Orphanides (2012); Piazzesi, Salomao, and Schneider (2015); Crump, Eusepi and Moench (2016)

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- Expected excess return from investing in nominal one-period U.S. dollar debt relative to country *i* debt

$$\sigma_t \equiv \underbrace{i_t^{us} - i_t^{foreign}}_{-\tilde{i}_t} + E_t \Delta s_{t+1}.$$

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- Expressing exchange rate in levels and iterating forward...

$$\Delta s_{t+1} = \tilde{\imath}_t - \varphi_{t+1}^{EH} + \sigma_t - \sigma_{t+1}^{F} + s_{t+1,\infty}^{\Delta E}$$

$$\text{where } \varphi_{t+1}^{EH} \equiv \sum_{k=0}^{\infty} \left(E_{t+1} \tilde{\imath}_{t+k+1} - E_t \tilde{\imath}_{t+k+1} \right),$$

$$\sigma_{t+1}^{F} \equiv \sum_{k=0}^{\infty} \left(E_{t+1} \sigma_{t+k+1} - E_t \sigma_{t+k+1} \right),$$

$$\text{and } s_{t+1,\infty}^{\Delta E} \equiv E_{t+1} \lim_{k \to \infty} s_{t+k} - E_t \lim_{k \to \infty} s_{t+k}.$$

If the RER is stationary, $s_{t+1,\infty}^{\Delta E}$ is the revisions in expectations over the relative inflation paths (country i minus the US)

Decomposing the Exchange Rate Response

The estimated response $\beta_n^{\Delta s_{t+1}}$ from:

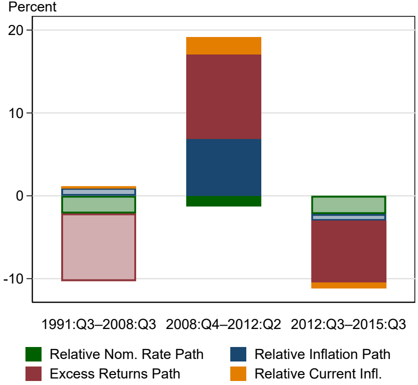
$$\Delta s_{t+1} = \alpha_n^s + \beta_n^{\Delta s_{t+1}} \Delta \tilde{f}_{t+1}^n + error_{t+1}$$

can be decomposed as:

$$\hat{\beta}_n^{\Delta s_{t+1}} = \hat{\beta}_n^{\tilde{\imath}_t - \varphi_{t+1}^{EH}} + \hat{\beta}_n^{\sigma_t - \sigma_{t+1}^F} + \hat{\beta}_n^{s_{t+1,\infty}^{\Delta E}}$$

Decomposing the Exchange Rate Response

Figure: Transmission of US Monetary Policy Through Exchange Rate Change Components



Note: Darker shading indicates significance at 10% level.

- Appreciation of the dollar in response to Fed easings was due to lower expected future excess currency returns from holding the dollar and lower expected future inflation in the US relative to other countries.

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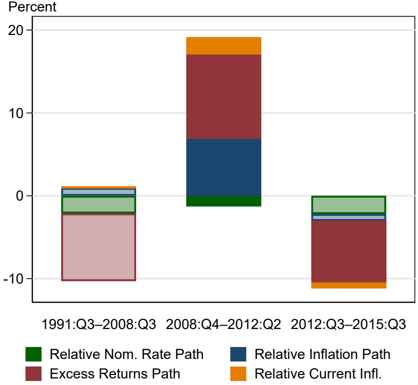

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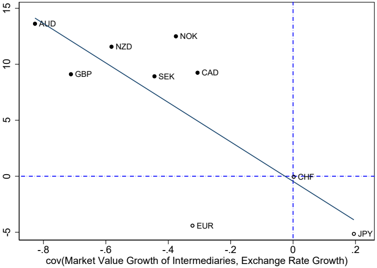
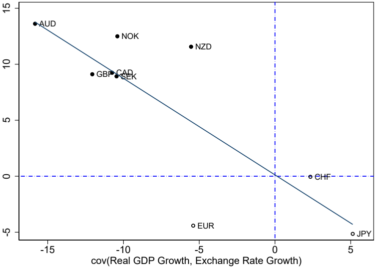
- Appreciation of the dollar in response to Fed easings was due to lower expected future excess currency returns from holding the dollar and lower expected future inflation in the US relative to other countries.
- Transmission through future nominal short rates relatively small and consistent with the conventional wisdom.

Cross-Currency Heterogeneity: Excess Returns Component

Figure: Cross-Currency Heterogeneity in Response to US Monetary Policy Surprises





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Cross-Currency Heterogeneity: Inflation Component

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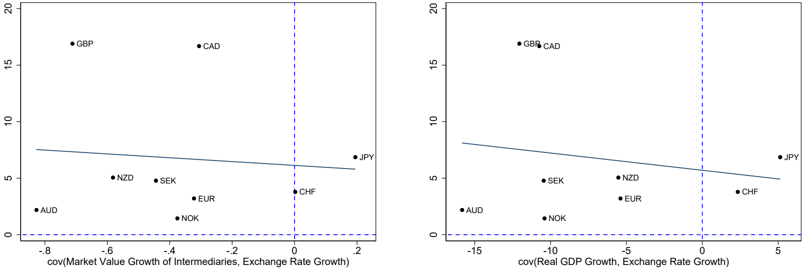

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- Whether the currency is a hedge or not from the perspective of the US investor matters for the response of the expected excess returns component, but not the relative inflation component — consistent with the theory developed next.

Partial equilibrium model of the SDF and monetary policy signalling

- Exogenous data generating processes for real (de-trended) output and inflation

$$\begin{aligned} y_t^{us} &= -\nu \left(i_t^{us} - \pi_t^{us} \right) + \varepsilon_t^{y,us} \\ \pi_t^{us} &= \alpha y_t^{us} \end{aligned}$$

  - Allows expansionary direct effect of a policy easing.
  - Economy with only demand shocks.

- The nominal rate is determined by a Taylor rule

$$i_t^{us} = \phi^y y_t^{us} + \phi^\pi \pi_t^{us} + \varepsilon_t^{mp,us}$$

- $\varepsilon_t^{y,us}, \varepsilon_t^{mp,us}$ are iid, normally distributed, and uncorrelated shocks.

- same data generating processes for country *i*

We can solve for y_t^{us}, π_t^{us} and i_t^{us} in terms of the exogenous shocks:

$$
\begin{aligned}
y_t^{us} &= \frac{\varepsilon_t^{y,us} - \nu \varepsilon_t^{mp,us}}{\eta + \nu\kappa}, \\
\pi_t^{us} &= \alpha \frac{\varepsilon_t^{y,us} - \nu \varepsilon_t^{mp,us}}{\eta + \nu\kappa}, \\
i_t^{us} &= \frac{\kappa \varepsilon_t^{y,us} + \eta \varepsilon_t^{mp,us}}{\eta + \nu\kappa},
\end{aligned}
$$

where $\kappa \equiv \phi^y + \phi^\pi \alpha > 0$ and we assume that $\eta \equiv 1 - \nu\alpha > 0$ – ensuring that a positive interest rate shock increases the equilibrium nominal rate.

Consider the Euler equation of the marginal trader located in the US, who is long one period US bond and short one period bond in currency i:

$$E\left[SDF_{t,t+1}e^{-\pi^{us}_{t+1}}\left(\left(1+i^{us}_t\right)-\frac{S_t}{S_{t+1}}\left(1+i^{i}_t\right)\right)\middle|\mathcal{I}_t\right]=0,$$

- where S_t is the nominal exchange rate defined as units of currency i per one USD,
- $SDF_{t,t+1}=\beta\frac{U_c(t+1)}{U_c(t)}$ is the real SDF of the marginal trader.
- Conditional on assuming normality

$$\sigma_t\equiv E_t\left[\triangle s_{t+1}|\mathcal{I}_t\right]+\left(i^{us}_t-i^{i}_t\right)=\frac{Var_t\left(\Delta s_{t+1}|\mathcal{I}_t\right)}{2}-Cov_t\left(sdf_{t,t+1}-\pi_{t+1},\triangle s_{t+1}|\mathcal{I}_t\right)$$

Consider the following preferences

$$u(C_t) = \frac{C_t^{(1-\rho_{t-1})}}{(1-\rho_{t-1})},$$

- which imply $CRRA = \frac{-C_t U_{cc}(t)}{U_c(t)} = \rho_{t-1}$
- The log SDF can be expressed as:

$$sdf_{t,t+1} = \ln\beta - \rho_t \triangle c_{t+1} - c_t \triangle \rho_t$$

- which implies

$$\sigma_t = \frac{\sigma_s^2}{2} + \rho_t \sigma_{c,s} + \alpha\sigma_{y,s}$$

- where $\sigma_{c,s} = Cov_t\left(\triangle c_{t+1}, \triangle s_{t+1} | \mathcal{I}_t\right)$ and $\sigma_{y,s} = Cov_t\left(\Delta y_{t+1}^{us}, \triangle s_{t+1} | \mathcal{I}_t\right)$ and $\sigma_s^2 = Var_t\left(\Delta s_{t+1} | \mathcal{I}_t\right)$

- We assume that ρ_t has the following data-generating process:

$$\rho_t = a^\rho \rho_{t-1} - \underbrace{\sum_{n=0}^{\infty} \beta_\rho^n \left(E\left(y_{t+n}^{us} | I_t\right) - E\left(y_{t+n}^{us} | I_{t-1}\right)\right)}_{\tilde{\varepsilon}_t^y} + \varepsilon_t^\rho,$$

where ε_t^ρ is a risk aversion shock, orthogonal to the demand and MP shock.

- It implies that the risk aversion will be higher if agents revise their expectations of the path of US real GDP growth downwards.
  - The DGP is consistent with the habit formation literature (see Campbell and Cochrane (1999) and Campbell, Pflueger, and Viceira (2020)) which models risk aversion as increasing if there is negative news on consumption/output
  - It is also consistent with the intermediation based asset pricing literature (see He, Kelly and Manela (2017)) where risk aversion is a function of intermediary leverage (market value) which is higher when the economy is doing poorly

Partial equilibrium model of the SDF and monetary policy signalling

Monetary policy

- Forward guidance: CB sees i^{us}_{t+h} in $t+1$ and announces $a_{t+1} = i^{us}_{t+h}$
- Agents have a common prior over the distribution of shocks and see this announcement (no private signals).
- Linking empirical results to model:
  - Assume that the change of the one-period relative forward rate between $t+h$ and $t+h+1$ due to the announcement a_{t+1} is $-i^{us}_{t+h}$.
  - $\hat{\beta}^{\sigma_t - \sigma^F_{t+1}}_{f,n}$ corresponds to $\frac{\partial \sigma^F_{t+1}}{\partial a_{t+1}}$
  - $\hat{\beta}^{s^{\Delta E}_{t+1,\infty}}_{f,n}$ corresponds to $-\frac{\partial s^{\Delta E}_{t+1,\infty}}{\partial a_{t+1}}$
  - Both derivatives are proportional to the effect of a_{t+1} on expected future real GDP growth.

CB announcement of the future policy rate – a signal both about $\varepsilon_{t+h}^{y,us}$ and $\varepsilon_{t+h}^{mp,us}$

Real GDP growth: $y_{t+h}^{us} \propto \varepsilon_{t+h}^{y,us} - \nu \varepsilon_{t+h}^{mp,us}$

Key statistic: The effect of the announcement on expected future growth.

$$E\left[y_{t+h}^{us} | \mathcal{I}_{t+1}\right] = E\left[y_{t+h}^{us} | \mathcal{I}_{t}\right] + K a_{t+1}$$

$$\text{where } K = \frac{\kappa \frac{Var\left(\varepsilon_{t+h}^{y,us}\right)}{Var\left(\varepsilon_{t+h}^{mp,us}\right)} - \nu\eta}{\kappa^2 \frac{Var\left(\varepsilon_{t+h}^{y,us}\right)}{Var\left(\varepsilon_{t+h}^{mp,us}\right)} + \eta^2}, \quad \eta = 1 - \nu\alpha > 0, \quad \kappa = \phi^y + \phi^\pi \alpha > 0$$

Partial equilibrium model of the SDF and monetary policy signalling

Signaling channel of monetary policy

- *The derivative of the US output revision with respect to UMP is given by K*
- $K > 0$ if
$$\frac{Var\left(\varepsilon_{t+h}^{y,us}\right)}{Var\left(\varepsilon_{t+h}^{mp,us}\right)} > \frac{\nu\eta}{\kappa}.$$
- and the other way round.
- $K < 0$ implies that negative MP surprises lead to higher expected future output
  - If there's no uncertainty over the future demand shock, $\frac{Var\left(\varepsilon_{t+h}^{y,us}\right)}{Var\left(\varepsilon_{t+h}^{mp,us}\right)} = 0$, a_{t+1} is interpreted as only a signal about the interest rate shock so only the direct effect of MP is present and $K = -\frac{\nu}{\eta} < 0$
- $K > 0$ implies that negative MP surprises lead to lower expected future output
  - Higher $\frac{Var\left(\varepsilon_{t+h}^{y,us}\right)}{Var\left(\varepsilon_{t+h}^{mp,us}\right)}$ means a stronger signaling channel of MP

Linking Theory to Empirics

The response of the expected excess return to UMP

$$\hat{\beta}_{f,n}^{\sigma_t - \sigma_{t+1}^F} = \frac{\partial \sigma_{t+1}^F}{\partial a_{t+1}} = \sigma_{c,s} \sum_{k=0}^{\infty} \frac{\partial \left(E\left(\rho_{t+k+1} | \mathcal{I}_{t+1}\right) - E\left(\rho_{t+k+1} | \mathcal{I}_t\right)\right)}{\partial a_{t+1}}$$

$$= -\frac{\sigma_{c,s}}{1 - a^{\rho}} \frac{\beta_{\rho}^{h-1} E\left(y_{t+h}^{us} | \mathcal{I}_{t+1}\right)}{\partial a_{t+1}} = -\frac{\sigma_{c,s}}{1 - a^{\rho}} \beta_{\rho}^{h-1} K$$

- If $K > 0$ the signalling channel is stronger than the direct channel
- If $\sigma_{c,s} < 0$ then the bond denominated in currency *i* is not a hedge for the US investor
- if $K > 0$ and $\sigma_{c,s} < 0$, then $\hat{\beta}_{f,n}^{\sigma_t - \sigma_{t+1}^F} > 0$, as consistent with the estimate over the GFC

Linking Theory to Empirics

The response of the relative inflation path to UMP

$$\hat{\beta}_{f,n}^{s_{t+1,\infty}^{\Delta E}} = -\frac{\partial s_{t+1,\infty}^{\Delta E}}{\partial a_{t+1}} = \frac{\partial}{\partial a_{t+1}} \sum_{k=1}^{\infty} \left(E\left[\pi_{t+k}^{us} | a^{t+1}, \varepsilon^{y,t+1}, \varepsilon^{i,t+1}\right] - E\left[\pi_{t+k}^{us} | a^{t}, \varepsilon^{y,t}, \varepsilon^{i,t}\right]\right)$$
$$= K\alpha$$

- If $K > 0$ the signalling channel is stronger than the direct channel and $\hat{\beta}_{f,n}^{s_{t+1,\infty}^{\Delta E}} > 0$, as consistent with the estimate over the GFC
- Note that the theory is also consistent with the empirical fact that $\hat{\beta}_{f,n}^{s_{t+1,\infty}^{\Delta E}}$ is not a function of the hedging properties of the currency while $\hat{\beta}_{f,n}^{\sigma_t - \sigma_{t+1}^F}$ is

Was the signaling channel stronger during the Global Recession?

GDP forecasts fell with MP easing during Global Recession

Was $K > 0$ over the GFC?

Table: 2SLS Regression of US GDP Forecast Revisions on US Forward Rate Changes

	$E_t[GDP^U_{t+3}S] - E_{t-1}[GDP^U_{t+4}S]$
1991:Q3–2008:Q3	-0.12
	(0.26)
2008:Q4–2012:Q2	0.88^{***}
	(0.15)
2012:Q3–2015:Q3	-0.13^{*}
	(0.08)
# Obs.	96
Pre-ZLB = Early ZLB pval	0.00
Early ZLB = Late ZLB pval	0.00
Pre-ZLB = Late ZLB pval	0.22

Note: Each cell of this table gives the slope coefficient from regressing the revision in the Blue Chip 4-quarter-ahead GDP growth forecast on the change in the 2 to 10 year US forward rate (Δf^{US}_{t+1}). HAC-robust standard errors are in parentheses. Constants are included in the regression, but omitted from this table. Instruments used: Price changes in a 1-hour window around FOMC and QE announcements of federal funds rate futures expiring 3 months hence, eurodollar futures expiring 2, 3, and 4 quarters hence, and 2- and 10-year Treasury bond futures expiring in the current quarter.

Did risk aversion increase with MP easing during the Global Recession?

Table: Response of Various Risk Aversion Measures to US Monetary Policy Surprises (calculated as a residual from an AR(1) process.)

	Leverage	VIX	Risk Aversion
Δf_{t+1}^{US}	-2.94^{***}	-1.07^{***}	-3.72^{***}
	(0.99)	(0.32)	(1.28)
# Obs.	15	15	15

- Risk aversion rose in response to Fed easings during the Global Recession.

Was the increase of risk aversion in response to MP easing due to the signalling channel of MP?

Table: Response of Risk Aversion Movements That are Orthogonal to Revisions in US Growth Expectations to US Monetary Policy Surprises

	Leverage	VIX	Risk Aversion
Δf_{t+1}^{US}	-0.54	0.45	-1.40
	(0.68)	(0.40)	(0.95)
# Obs.	15	15	15

- The component of risk aversion that is uncorrelated with changes in growth expectations did not rise in response to Fed easings during the Global Recession – i.e. the empirical results on risk aversion corroborate the model, where the risk aversion responds to the MP shocks only through it's link to output revisions.

Why was the signaling channel stronger during the Global Recession period?

1. Economic uncertainty especially high in Global Recession period during the immediate aftermath of the financial crisis.

Table: Subsample means of uncertainty measures

	1990:Q3-2008:Q3	2008:Q4-2012:Q2	2012:Q3-2015:Q3
JLN Macro Uncertainty	-0.04	0.80	-0.67
GDP Forecast Dispersion	0.04	0.88	-1.24
BBD Monetary Policy Uncertainty	0.12	-0.06	-0.59

Note: The JLN macro uncertainty measure is the 12-month ahead measure of macroeconomic uncertainty estimated by Jurado et al (2015). GDP forecast dispersion is the 25th-75th percentile range of 4-quarter-ahead US real GDP forecasts from *Blue Chip Economic Indicators*. BBD monetary policy uncertainty is the monetary policy subcomponent of the Baker et al. (2016) policy uncertainty index. All three measures are standardized over the full 1990:Q1–2015:Q3 sample to facilitate interpretation.

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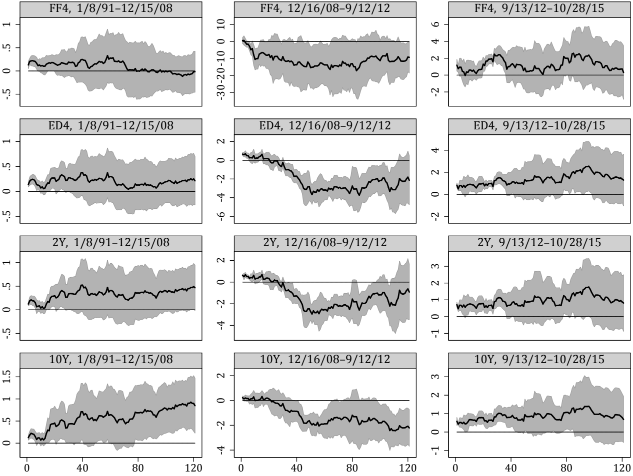
Sep 2012 "the Committee expects that a highly accommodative stance of monetary policy will remain appropriate for a considerable time after the economic recovery strengthens"

Dec 2012 Threshold-based guidance introduced

Higher frequency impulse responses

Further evidence of information effect of calendar-based forward guidance (from another complimentary project)

Figure: Daily Impulse Responses of Exchange Rates to Monetary Policy Surprises on Non-QE Dates

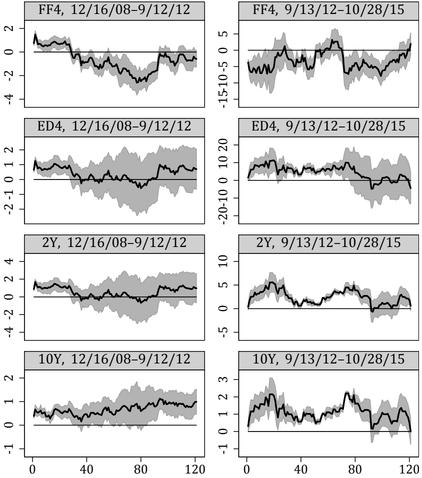


Note: 90 percent confidence intervals based on Driscoll-Kraay standard errors.

Higher frequency impulse responses

Further evidence of information effect of calendar-based forward guidance (from another complimentary project)

Figure: Daily Impulse Responses of Exchange Rates to Monetary Policy Surprises on QE Dates



Note: 90 percent confidence intervals based on Driscoll-Kraay standard errors.

Conclusion

- Over the Global Recession, decreases in US forward rates resulting from US monetary policy shocks ended up appreciating the dollar, contrary to common wisdom.
- This happened for two reasons:
  1. The expected future excess return from being long the dollar fell (stronger safe haven effect).
  2. The long run expected value of the dollar strengthened due to lower US inflation expectations.
- A stronger signaling effect of monetary policy during the Global Recession period can jointly explain the empirical facts.

Extra Slides

Data sources

- *End-of-quarter exchange rates*: Global Financial Data
- *End-of-quarter zero-coupon yields*: Central banks, BIS, Gürkaynak et al. (2007), Wright (2011), Bloomberg
- *High-frequency instruments*: Gürkaynak et al. (2005), Tick Data
- VIX and US net foreign assets: FRED
- Risk aversion estimates: Bekaert, Engstrom, and Xu (2017), He, Kelly and Manela (2017)
- GDP forecasts: *Blue Chip Financial Forecasts*

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Data sample details

Country	Date Range
Australia	1989:Q4 – 2015:Q4
Canada	1992:Q2 – 2015:Q4
Germany	1991:Q2 – 2015:Q4
Japan	1992:Q3 – 2015:Q4
New Zealand	1990:Q1 – 2015:Q1
Norway	1989:Q4 – 2015:Q4
Sweden	1992:Q4 – 2015:Q4
Switzerland	1992:Q1 – 2011:Q2
United Kingdom	1992:Q4 – 2015:Q4
United States	1989:Q4 – 2015:Q1

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Estimating the components

- Need expectations of inflation, short rates, and nominal exchange rate
- We obtain these expectations from a VAR disciplined using survey data.

$$X_{t+1} = \bar{X} + \Gamma X_t + \Xi_{t+1}$$

where X_{t+1} contains 2 lags of $\{q, x^i, z^i, x^{US}, z^{US}\}$.

- $q =$ level of real exchange rate
- x^i, x^{US}: Financial variables including 3-month bill rate and empirical term structure factors

$$slope^j = y^{40,j} - i^j$$
$$curve^j = 2y^{8,j} - \left(y^{40,j} + i^j\right).$$

- z^i, z^{US}: Macro variables including CPI inflation, GDP gap, and CA-to-GDP ratio. US TED spread, VIX, and moving average of US inflation also included.

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Restrictions on Γ:

- Each country's financial variables follow a small VAR (similar to three-factor affine term structure model)
- The US is "large" and is not affected by other countries.
- Conditions in the US spill over into the macroeconomies of other countries.
- Real exchange rate lags enter only its own equation.
- With q in the VAR, stationary estimates imply constant long-run real exchange rate expectations $\Rightarrow E_t \lim_{k\to\infty} s_{t+k}$ depends only on inflation expectations.

Estimating the components

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$$X_{t+1} = \bar{X} + \Gamma X_t + \Xi_{t+1}$$

where X_{t+1} contains 2 lags of $\{q, x^i, z^i, x^{US}, z^{US}\}$.

$$Y_t^S = \bar{Y}^S(\Gamma, \bar{X}) + H(\Gamma, t) X_t + \sum_{l=1}^{P-1} H_l(t) X_{t-l} + \Omega_t$$

where Y_t^S are survey forecasts and the RHS are VAR-implied forecasts.

Estimating the components

- Need expectations of inflation, short rates, and nominal exchange rate
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$$Y_t^S = \bar{Y}^S\left(\Gamma, \bar{X}\right) + H\left(\Gamma, t\right) X_t + \sum_{l=1}^{P-1} H_l\left(t\right) X_{t-l} + \Omega_t$$

where Y_t^S are survey forecasts and the RHS are VAR-implied forecasts.

- Survey forecast data from *Blue Chip* and *Consensus Economics* on 3-month interest rates, inflation rates, and exchange rates.
- Horizons ranging 3 months to $\sim$10 years ahead.
- $\{H, H_l\}$ depend on time deterministically due to nature of forecast data.
- Survey data has been used in a similar manner to estimate term premia.
  Kim and Wright (2005), Kim and Orphanides (2012), Piazzesi, Salomao, and Schneider (2015), Crump, Eusepi and Moench (2016)

Decomposition: Calculating the Components

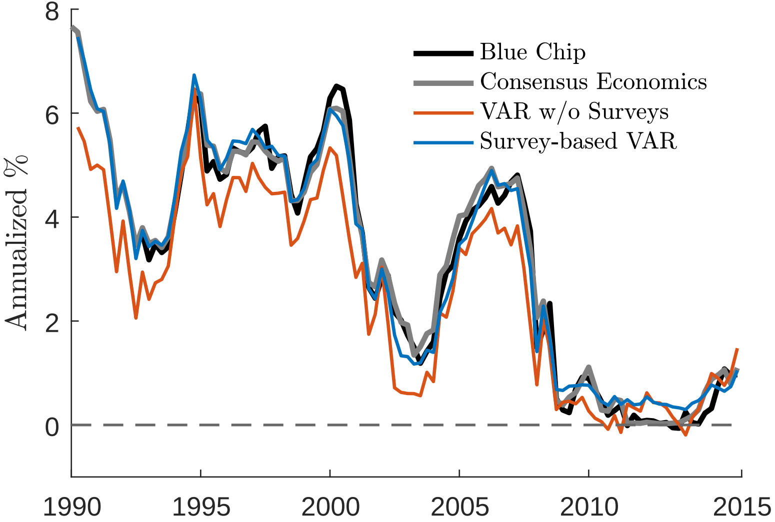
Empirical model: Forecast-augmented VAR

Benefits of this specification:

- Workhorse model in asset pricing for yields
- Can capture policy rate expectations during periods of unconventional policy
- Estimation balances true behavior of variables and market expectations by optimizing one-period-ahead fit of actual data as well as fit of survey forecasts.
- Including survey data has a quantitatively large effect on model-implied forecasts, especially for longer horizons.

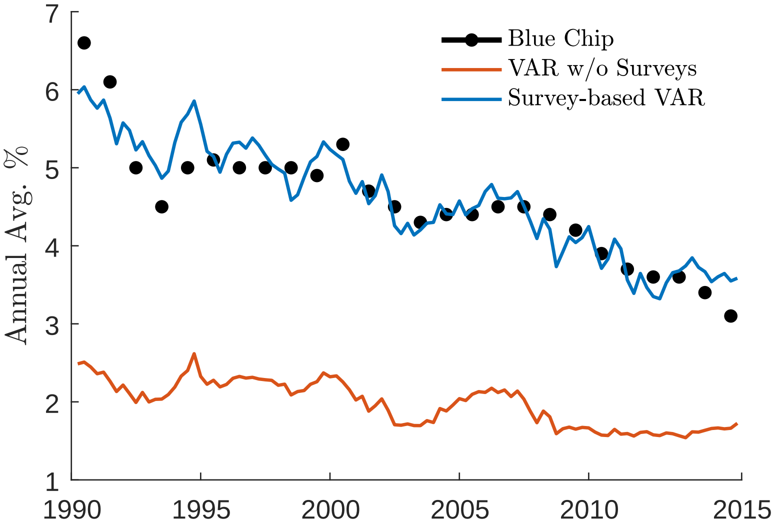
Model-implied Forecasts

Figure: US 3-month Rate: 12 Months Ahead



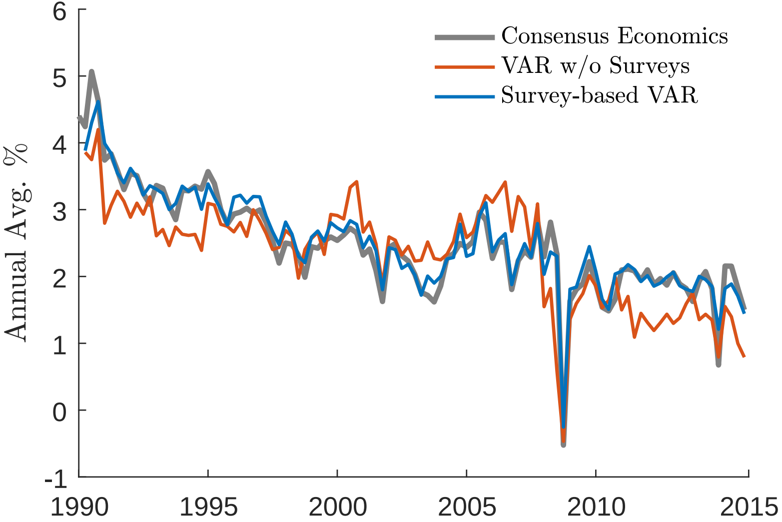
Model-implied Forecasts

Figure: US 3-month Rate: 7-11 Years Ahead



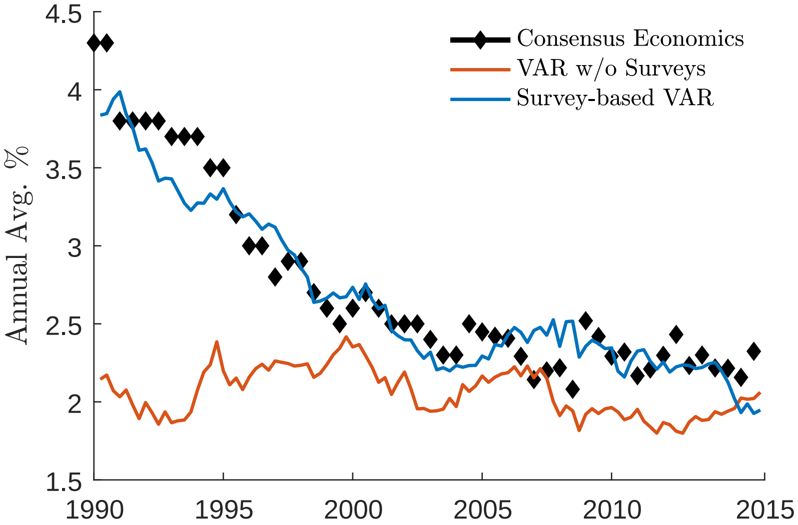
Model-implied Forecasts

Figure: US Inflation: 1 Year Ahead



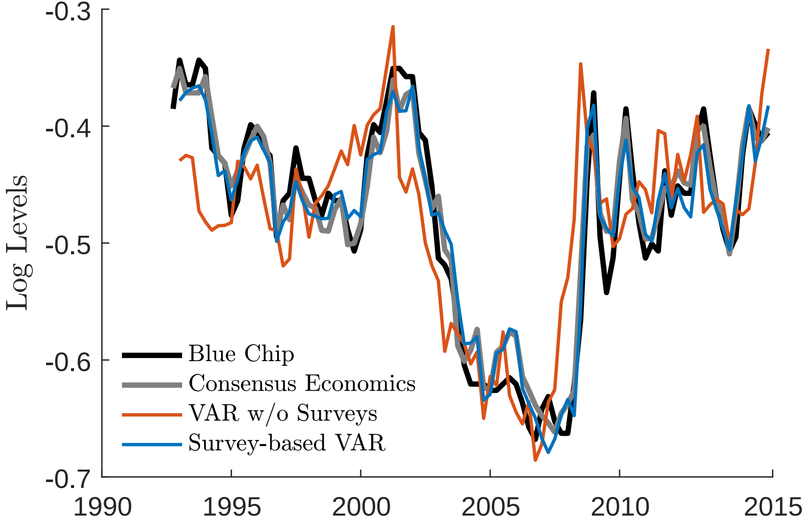
Model-implied Forecasts

Figure: US Inflation: 6-10 Years Ahead



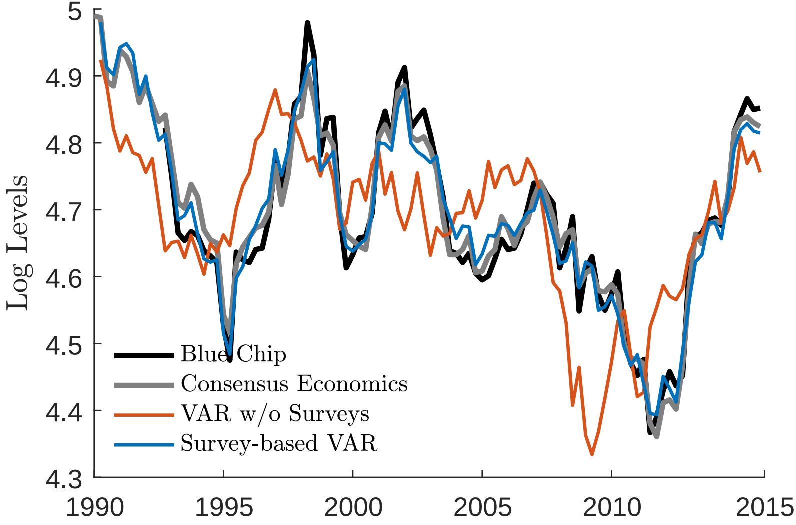
Model-implied Forecasts

Figure: USDGBP Exchange Rate: 12 Months Ahead



Model-implied Forecasts

Figure: USDJPY Exchange Rate: 12 Months Ahead



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