A Fundamental Connection: Exchange Rates and Macroeconomic Expectations

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Motivation

- The current consensus in the profession is that exchange rates and macroeconomic fundamentals are disconnected at business cycle frequency (Meese and Rogoff 1983).
- Recent work has shifted towards attempting to explain exchange rates using financial variables/shocks.
- We revisit the "exchange rate disconnect" debate using a rich data set of macroeconomic surprises/news and by allowing for econometric specifications featuring deviation from FIRE.
- We further trace the connection between macro fundamentals and exchange rates through a novel estimation of a well-known exchange rate decomposition that incorporates survey forecast data.

Results

- We show that high-frequency macroeconomic surprises explain, on average, about 70 percent of the variation in quarterly nominal exchange rate changes.
- Surprisingly, lagged macro surprises are much more important than contemporaneous ones, explaining almost all of the quarterly exchange rate change variation
- Macro surprises are even more important for currencies of major financial centers, and during US recessions and periods of financial turmoil.
- Moreover, excess returns/currency risk premia are also mostly driven by macroeconomic news (over 50 percent of variation).

Related literature

- **Exchange rates and fundamentals at lower frequencies:** Meese and Rogoff (1983), Frankel and Rose (1995), Engel and West (2005), Engel, Mark, and West (2008), Evans (2010), Koijen and Yogo (2020)
- **Exchange rate and macro news at higher frequencies:** Andersen et al. (2003), Faust et al. (2007), Goldberg and Grisse (2013), Altavilla, Giannone, and Modugno (2017)
- **Survey data and exchange rates:** Dominquez (1986), Froot and Frankel (1987; 1989), Ito (1990), Frankel and Chinn (2002;2019), Bussiere et al. (2018), Frankel and Chinn (2019), Stavrakeva and Tang (2020), Kalemli-Ozcan and Varela (2021)
- **Survey forecasts relationship with portfolio choices:** Stavrakeva and Tang (2020), De Marco, Macchiavelli, and Valchev (2020), Greenwood and Shleifer (2014), Giglio et al. (2020)

Outline

- Theoretical link between macroeconomic news and exchange rates
- Macro surprises as drivers of nominal exchange rates
- Exchange rate decomposition using a survey-based VAR
- Macro news and exchange rate sub-components

Theoretical Link between Macroeconomic News and Exchange Rates

Theoretical Link between Macroeconomic News and Exchange Rates

- How are macro news transmitted to exchange rates?
- We answer this with a well-known exchange rate decomposition. Froot and Ramadorai (2005), Engel and West (2005, 2006, 2010), Engel, Mark and West (2006, 2008), Mark (2009), Engel(2014, 2016)

The exchange rate change at any frequency can be expressed as

$$\Delta s_{t+1} = \underbrace{\tilde{\imath}_t + \sigma_t}_{\text{lagged component}} + \underbrace{\sum_{k=0}^{\infty} \left(\tilde{E}_{t+1} - \tilde{E}_t\right)\left(\tilde{\pi}_{t+k+1} - \tilde{\imath}_{t+k+1} - \sigma_{t+k+1}\right)}_{\text{forward looking component } (= s_{t+1} - \tilde{E}_t s_{t+1})}$$

- $\tilde{\imath}_t$ is the difference between foreign and US interest rates
- $\tilde{\pi}_t$ is the difference between foreign and US inflation
- σ_t is the expected excess return from investing in the US and borrowing in foreign risk-free debt
- $\tilde{E}_t$ denotes the expectations of the marginal trader

Theoretical link between Macroeconomic News and Exchange Rates

Consider the decomposition at daily frequency

$$\Delta s_{t+1} = \underbrace{\tilde{\imath}_t + \sigma_t}_{\text{lagged component}} + \underbrace{\sum_{k=0}^{\infty} \left(\tilde{E}_{t+1} - \tilde{E}_t\right) \left(\tilde{\pi}_{t+k+1} - \tilde{\imath}_{t+k+1} - \sigma_{t+k+1}\right)}_{\text{forward looking component}}$$

- The existing literature has focused on the link between contemporaneous macro news and exchange rate changes at daily frequency and has found that on days with macro news releases, macroeconomic surprises (realization minus survey based expectations) are an important driver of exchange rates.
  Andersen et al. (2003), Faust et al. (2007), Goldberg and Grisse (2013)

- Altavilla, Giannone, and Modugno (2017) have translated this approach to lower frequencies by regressing daily exchange rate changes on contemporaneous news and constructing a monthly macro news index as a sum of the fitted values. They show that contemporaneous reactions to macro news do not explain much of the monthly exchange rate change variation and argue the disconnect at low frequency remains.

Theoretical link between Macroeconomic News and Exchange Rates

What is missing?

$$\Delta s_{t+1} = \underbrace{\tilde{\imath}_t + \sigma_t}_{\text{lagged component}} + \underbrace{\sum_{k=0}^{\infty} (E_{t+1} - E_t)(\tilde{\pi}_{t+k+1} - \tilde{\imath}_{t+k+1} - \sigma_{t+k+1})}_{\text{forward looking component FIRE}}$$

- Assuming FIRE, and assuming that the "lagged component" of exchange rate changes (which is the daily expected exchange rate change), is second order, then only contemporaneous macro news should matter.
- However, a growing literature documents deviations from FIRE in survey-based expectations, which implies that lagged macro news should also matter.

Theoretical link between Macroeconomic News and Exchange Rates

$$\Delta s_{t+1} = \underbrace{\tilde{\imath}_t + \sigma_t}_{\text{lagged component}} + \underbrace{\sum_{k=0}^{\infty} \left(E_{t+1} - E_t\right)\left(\tilde{\pi}_{t+k+1} - \tilde{\imath}_{t+k+1} - \sigma_{t+k+1}\right)}_{\text{forward looking component FIRE}}$$

- Theories that explain survey-based expectations and feature deviation from FIRE in aggregate data are often isomorphic to:
  - Models with dispersed/imperfect information with respect to the state variables and learning
  - Models where agents do not know the true parameters of the DGP
  - For a recent exhaustive literature review see Angeletos, Huo and Sastry (2020); for an exchange rate theory with deviations from FIRE see Stavrakeva and Tang (2020)
- These models imply a theoretical link between lagged macro surprises and the subjective forward looking component of exchange rate changes.

Macro Surprises as Drivers of Nominal Exchange Rates

Mapping High-Freq Macro News to Quarterly Exchange Rate Changes

Two step procedure building on Altavilla, Giannone, and Modugno (2017)

1. Construct daily news index from daily responses of exchange rates to surprises:

$$\Delta s_{t_d} = \alpha + \sum_{k=1}^{K} \left(\sum_{j=0}^{126} \beta_j^k Surp_{t_d-j}^k \right) + error_{t_d},$$

   where k indexes the surprises and in order to estimate fewer coefficients we impose the following constraints: $\beta_j^k = \delta_1^k$ for $21 >= j >= 4$, $\beta_j^k = \delta_2^k$ for $42 >= j >= 22$ ... $\beta_j^k = \delta_6^k$ for $126 >= j >= 106$.

   - Dynamic (step-wise) response of exchange rates to each macro surprise summarized by 10 coefs

2. Exchange rate regressed on quarterly sums of daily index:

$$\Delta s_t = \alpha + \beta \widehat{\Delta s_t}^{macro} + error_t$$

   where Δs_t is a quarterly exchange rate change and $\widehat{\Delta s_t}^{macro}$ is a quarterly sum of the fitted values from the first step.

High-Frequency Macro Surprise Data

- Surprises in macroeconomic data releases on activity, inflation, trade, the labor market, and monetary policy
- Actual value minus forecast from Bloomberg and Informa Global Markets recorded at most a week before the data release
- Sample: 2001:Q4–2015:Q3

Importance of Macro News for Exchange Rate Changes at High and Low Frequencies

R^2s from Daily Regressions of the Exchange Rate Change on Macro News

		AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	USD
	# of Surprises	10	11	7	21	10	9	8	8	11	13
Exchange Rate	# of Obs.	3716	3716	2541	3717	3716	3716	3717	3716	3717	
	R^2	0.08	0.08	0.11	0.12	0.08	0.09	0.07	0.08	0.10	

Macro surprises do matter for daily changes in exchange rates, but they explain only up to 12 percent of the daily exchange rate change variation.

Importance of Macro News for Exchange Rate Changes at High and Low Frequencies

Quarterly Regressions of the Exch Rate Change on Macro News Index

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
Exch Rate News Index	0.93***	0.91***	1.01***	1.08***	1.05***	0.99***	1.07***	1.07***	1.03***	1.02***
	(0.11)	(0.13)	(0.11)	(0.06)	(0.08)	(0.06)	(0.07)	(0.09)	(0.09)	(0.02)
Constant	-0.05	-0.02	0.03	0.02	-0.00	0.00	0.00	0.06	0.01	0.01
	(0.56)	(0.43)	(0.50)	(0.25)	(0.33)	(0.36)	(0.39)	(0.53)	(0.48)	(0.01)
# of Obs.	57	57	39	57	57	57	57	57	57	495
Adjusted R^2	0.62	0.51	0.67	0.87	0.74	0.75	0.79	0.62	0.64	0.69

At a lower quarterly frequency, macro news instead explain a large majority of variation, indicating that much of the daily variation that's unrelated to macro news averages out at lower frequencies.

Greater Importance During Recessions to Times of High Financial Volatility

Adjusted R^2s From Quarterly Regressions of the Exch Rate Change on Macro News Index, US Recessions and High Financial Volatility Periods

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
US Recessions	0.84	0.64	0.98	0.94	0.90	0.92	0.86	0.97	0.96	0.89
Not US Recessions	0.52	0.45	0.60	0.86	0.57	0.66	0.75	0.53	0.56	0.62
VIX High	0.71	0.63	0.73	0.86	0.77	0.75	0.86	0.70	0.77	0.77
VIX Low	0.43	0.27	0.52	0.86	0.67	0.65	0.54	0.47	0.37	0.53

Importance of Different Types of Macro News

Partial R^2s From Quarterly Regressions of Exch Rate Change on Macro News Subindices

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
All concept subindices	0.60	0.49	0.65	0.86	0.73	0.75	0.78	0.61	0.63	0.69
Inflation contribution	0.24	0.11	0.33	0.69	0.39	0.19	0.51	0.11	0.37	0.36
Activity contribution	0.47	0.42	0.49	0.76	0.42	0.54	0.49	0.36	0.44	0.53
External contribution	0.24	0.12	0.05	0.49	0.01	0.12	0.05	0.20	0.08	0.18
Monetary contribution	0.07	0.14	0.16	0.46	0.54	-0.00	0.25	0.13	0.11	0.22
All country subindices	0.62	0.51	0.66	0.87	0.74	0.74	0.78	0.61	0.64	0.69
US contribution	0.30	0.31	0.68	0.88	0.51	0.59	0.60	0.45	0.41	0.57
Foreign contribution	0.59	0.44	0.16	0.71	0.52	0.43	0.54	0.39	0.60	0.54

- Activity indicators are most important followed by inflation news.
- US and foreign surprises are similarly important.

Importance of Lagged News

Partial R^2s From Quarterly Regressions of Exch Rate Change on Macro News Subindices

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
All timing-based subindices	0.60	0.50	0.62	0.86	0.75	0.72	0.76	0.60	0.62	0.69
Contemporaneous contribution	0.04	0.03	0.04	0.08	-0.00	0.06	0.04	0.01	0.03	0.04
Lag 1M contribution	0.27	0.10	0.11	0.30	0.49	0.10	0.13	0.15	0.16	0.22
Lag 2M contribution	0.09	0.10	0.35	0.27	0.20	0.14	0.34	0.18	0.17	0.21
Lag 3M contribution	0.11	0.29	0.11	0.41	0.13	0.22	0.24	0.25	0.13	0.23
Lag 4M contribution	0.18	0.11	0.20	0.43	0.13	0.12	0.14	0.16	0.14	0.21
Lag 5M contribution	0.10	0.18	0.16	0.23	0.07	0.15	0.17	0.09	0.05	0.16
Lag 6M contribution	0.20	0.17	0.24	0.30	0.20	0.11	0.24	0.24	0.10	0.21

- There is some correlation across surprises.
- Longer-lasting dynamics in exchange rate responses to macro news are a crucial element of their explanatory power.

Importance of Lagged News

Partial R^2s From Quarterly Regressions of Survey-Based
Exch Rate Surprise $(s_{t+1} - \tilde{E}_t^S s_{t+1})$ on Macro News Subindices

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
All timing-based subindices	0.53	0.42	0.53	0.79	0.73	0.65	0.74	0.48	0.51	0.61
Contemporaneous contribution	0.00	0.03	0.03	0.05	-0.00	0.04	0.03	-0.00	0.03	0.03
Lag 1M contribution	0.17	0.07	0.10	0.29	0.42	0.05	0.09	0.04	0.11	0.14
Lag 2M contribution	0.08	0.11	0.25	0.21	0.24	0.15	0.33	0.18	0.13	0.20
Lag 3M contribution	0.21	0.27	0.15	0.36	0.09	0.26	0.24	0.25	0.14	0.24
Lag 4M contribution	0.10	0.08	0.21	0.34	0.15	0.11	0.13	0.07	0.11	0.15
Lag 5M contribution	0.10	0.17	0.11	0.21	0.04	0.13	0.19	0.16	0.01	0.15
Lag 6M contribution	0.19	0.16	0.23	0.33	0.22	0.04	0.27	0.23	0.10	0.20

- The importance of longer-lasting dynamics extends to survey-based measures of just the forward-looking component of quarterly exchange rate changes.
- Lags beyond the current quarter matter, evidence of a deviation from FIRE.

Why are lags so important?

- To gain intuition, we estimate impulse responses using the local projection approach of Jordà (2005)

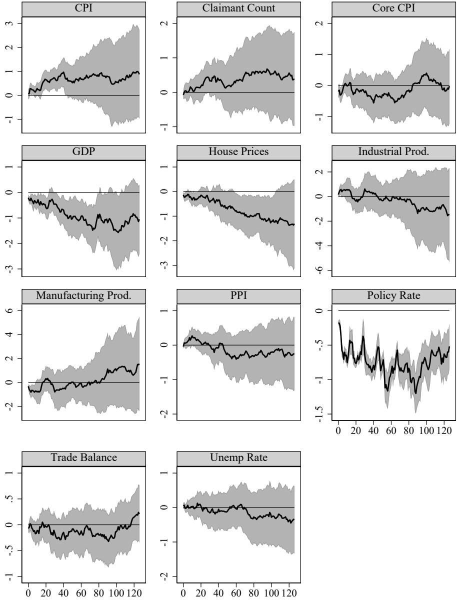
$$s_{t_d+h} - s_{t_d-1} = \alpha_h^{IR} + \sum_{k=1}^{K} \beta_h^{IR,k} Surp_{t_d}^k + error_{t_d+h}^{IR,h}$$

- Assume that the surprises are iid over time. Then, the β_j^k coefficients from our stage 1 daily regressions are related to these local projections as follows:

$$\beta_h^{IR,k} = \sum_{j=0}^{h} \beta_j^k$$

- *If only the contemporaneous response to macro surprises matter, the impulse response h periods ahead should be very similar to the one on the day of the announcement.*

Impulse Responses of GBP per USD to UK surprises



Why are lags so important?

The importance of lagged news on exchange rates is consistent with the literature on post announcement drift in:

- bond markets (post monetary policy announcement drift) – Indriawan, Jiao and Tse (2020), Brooks, Katz, Lustig (2020)
- equity markets (post-earnings announcement drift) – De Bondt and Thaler (1985); Cutler, Poterba, and Summers (1991); Lakonishok, Shleifer, and Vishny (1994)

Robustness checks

- Bayesian estimation of the first stage
  - Allows for unrestricted first stage coefficients, where we use standard priors (related to Ridge regressions)
  - Exchange rate change regressions: the first stage unadj R^2 increases to about 40% while the second stage R^2 is 55%
- Jordà (2005) projection method estimation of the first stage and assuming no auto-correlation of the macro surprises
  - Allows for fewer estimated coefficients in the first stage per regression
  - Allows us to include first stage interactions with the GFC and the VIX
  - Exchange rate change regressions: the second stage R^2 is 47% without any interactions; 57% with a high/low VIX interaction; 42% with a GFC interaction

Exchange Rate Decomposition Using a Survey-Based VAR

Theory: Exchange Rate Decomposition

How is macro news transmitted to exchange rates? We answer this with our exchange rate decomposition.

- Strategy: Present-value decomposition based on an accounting identity
- Expected excess return from being long nominal one-period U.S. dollar debt and short the foreign country

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

- Expressing exchange rate in levels and iterating forward (and assuming LIE) gives

$$s_t = -\tilde{E}_t \sum_{k=0}^{\infty} \left[\tilde{i}_{t+k} + \sigma_{t+k}\right] + \tilde{E}_t \lim_{k \to \infty} s_{t+k}.$$

Exchange Rate Decomposition

Taking a first difference gives

$$\Delta s_{t+1} = \tilde{\imath}_t + \sigma_t - \varphi^{EH}_{t+1} - \sigma^F_{t+1} + s^{\Delta E}_{t+1,\infty}$$

$$\begin{aligned}
\text{where } \sigma_t &\equiv \tilde{E}_t \Delta s_{t+1} - \tilde{\imath}_t, \\
\varphi^{EH}_{t+1} &\equiv \sum_{k=0}^{\infty} (\tilde{E}_{t+1} - \tilde{E}_t)\tilde{\imath}_{t+k+1}, \\
\sigma^F_{t+1} &\equiv \sum_{k=0}^{\infty} (\tilde{E}_{t+1} - \tilde{E}_t)\sigma_{t+k+1}, \\
\text{and } s^{\Delta E}_{t+1,\infty} &\equiv (\tilde{E}_{t+1} - \tilde{E}_t) \lim_{k\to\infty} s_{t+k}, \\
&= \sum_{k=0}^{\infty} (\tilde{E}_{t+1} - \tilde{E}_t)\tilde{\pi}_{t+k+1} \text{ if RER is trend-stationary.}
\end{aligned}$$

Estimating the Exchange Rate Change Components

- To estimate exchange rate change components, we need expectations of entire future path of inflation, short rates and the nominal exchange rate. FX Forecasts
- Existing papers use expectations implied by VARs; embedding some FIRE-consistent behavior into the estimated components
- Standard VARs produce unrealistic expectations (e.g., small-sample bias, etc)
- Our solution: Borrowing from the term structure literature, we estimate the VAR coefficients with an additional goal of matching survey data. Kim and Wright (2005), Wright (2011), Kim and Orphanides (2012), Piazzesi, Salamao, and Schneider (2015), and Crump, Eusepi, and Moench (2016)
  - In other work, we find evidence that survey exchange rate forecasts are strongly related to asset positions in currency derivatives markets.
  - Corroborates other evidence of survey forecasts correlating with financial market actions. Stavrakeva and Tang (2020), De Marco et al. (2020), Greenwood and Shleifer (2014), Giglio et al. (2020)
- Another interpretation: a structured way to interpolate/extrapolate survey data to other horizons.

Data

- Quarterly data on 10 advanced economies: Australia, Canada, Switzerland, Germany, Japan, Norway, New Zealand, Sweden, UK, US
- Sample period: 1990:Q1–2015:Q4 (differs slightly across countries)
- Variables in VAR: Real exchange rate, CPI inflation, GDP gap, CA-to-GDP ratio, 3-month bill rate, yield curve slope and curvature, and US VIX and TED spread.
- Survey forecast data from *Blue Chip* and *Consensus Economics* on 3-month interest rates, 10-year yields, inflation, and exchange rates for horizons from 3 months to 10 years ahead.

Details

Survey-Based VAR

VAR with 2 lags:

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

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.

Survey-Based VAR

VAR with 2 lags:

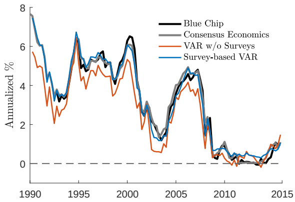
$$X_{t+1} = \bar{X} + \Gamma X_t + \Xi_{t+1}$$

$$Y_t^S = H_t(\bar{X}, \Gamma) X_t + Z_t + \Xi_{h,t}^S$$

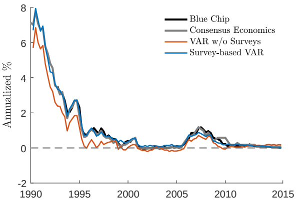
- Additional set of equations maps VAR forecasts to survey forecasts (Y_t^S).
  - Mapping matrix H depends on time deterministically due to nature of forecast data. Z_t is a set of pre-determined variables.
- We are *not* adding survey forecast data to the VAR.
- $\{\bar{X}, \Gamma\}$ are estimated to minimize both one-quarter-ahead standard VAR errors and the errors in fitting survey data.

Model-Implied vs Survey Forecasts

3-month Rate: 12 Months Ahead

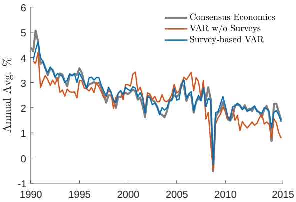


(a) U.S.

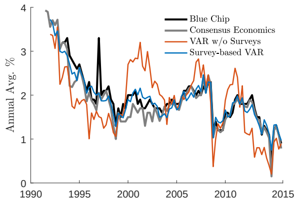


(b) Japan

CPI Inflation: 1 Year Ahead



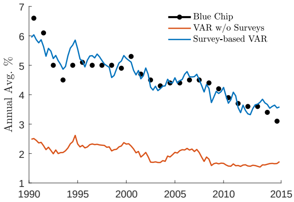
(c) U.S.



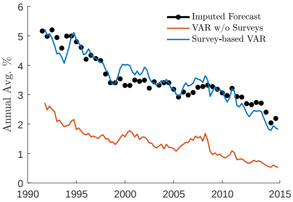
(d) Germany/Eurozone

Model-Implied vs Survey Forecasts

3-month Rate: Long Horizon

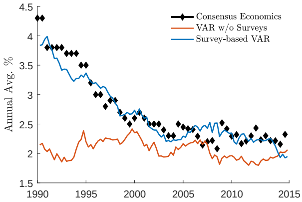


(e) U.S.

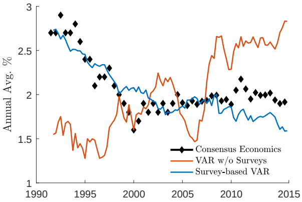


(f) Germany/Eurozone

CPI Inflation: Long Horizon



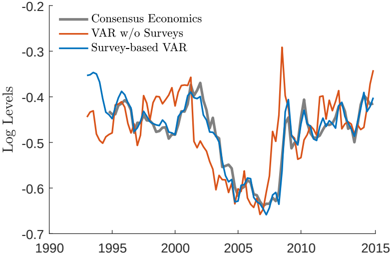
(g) U.S.



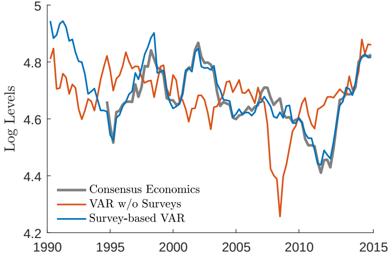
(h) Germany/Eurozone

Model-Implied vs Survey Forecasts

Exchange Rates: 24 Months Ahead



(i) USDGBP



(j) USDJPY

More Details on Fit

Decomposing Exchange Rate Variation

$$
\begin{aligned}
Var\left(\Delta s_{t+1}\right) \quad = \quad & Var\left(\tilde{i}_t - \varphi^{EH}_{t+1}\right) + Var\left(s^{\Delta E}_{t+1,\infty}\right) + Var\left(\sigma_t - \sigma^F_{t+1}\right) \\
& + 2Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, s^{\Delta E}_{t+1,\infty}) + 2Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, \sigma_t - \sigma^F_{t+1}) + 2Cov(s^{\Delta E}_{t+1,\infty}, \sigma_t - \sigma^F_{t+1})
\end{aligned}
$$

Component Var and Cov
(avg across pairs)

	USD Base
$Var(\Delta s_{t+1})$	30.52
$Var(-\varphi^{EH}_{t+1} - \sigma^F_{t+1} + s^{\Delta E}_{t+1,\infty})$	28.37
$Var(\tilde{i}_t - \varphi^{EH}_{t+1})$	14.80
$Var(s^{\Delta E}_{t+1,\infty})$	4.22
$Var(\sigma_t - \sigma^F_{t+1})$	28.29

Other Bases

- Forward looking terms drive most of the exchange rate change variation
- High volatility of excess returns component has been used as evidence of exchange rate being primarily driven by financial factors.
- But these components are endogenous and macro fundamentals may still matter for excess returns.

Macro News and Exchange Rate Sub-components

Importance of Macro News for Quarterly Exchange Rate Changes

- We now add news indices constructed in the same way using daily changes in short rate, yield curve slope and curvature.
- Additional news indices are important for subcomponents, particularly components reflecting interest rate and inflation expectations.

Constructing News Indices

R^2s from Daily Regressions of Exch Rates and Yield Curve Factors on Macro News Indices

		AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	USD
	# of Surprises	10	11	7	21	10	9	8	8	11	13
Exchange Rate	# of Obs.	3716	3716	2541	3717	3716	3716	3717	3716	3717	
	R^2	0.08	0.08	0.11	0.12	0.08	0.09	0.07	0.08	0.10	
3-Month Bill Rate	# of Obs.	3597	3566	2368	3680	3686	3587	3583	3569	3588	3566
	R^2	0.18	0.16	0.13	0.20	0.08	0.07	0.14	0.15	0.40	0.03
Yield Curve Slope	# of Obs.	3587	3542	2359	3636	3685	3586	3561	3567	3575	3566
	R^2	0.09	0.10	0.12	0.11	0.06	0.06	0.09	0.08	0.14	0.06
Yield Curve Curvature	# of Obs.	3587	3542	2359	3636	3685	3586	3561	3567	3575	3566
	R^2	0.12	0.14	0.09	0.11	0.07	0.05	0.06	0.08	0.13	0.07

Similarly to daily changes in exchange rates, we are not overfitting the daily yield curve changes.

Importance of Macro News for Exchange Rate Subcomponents

Adjusted R^2s from Quarterly Regressions of the Exch Rate Change and its Components on Macro News Indices (USD base)

	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	Panel
Δs_{t+1}	0.60	0.50	0.66	0.87	0.76	0.72	0.78	0.61	0.63	0.70
σ^F_{t+1}	0.45	0.26	0.51	0.73	0.49	0.53	0.73	0.35	0.47	0.52
φ^{EH}_{t+1}	0.54	0.47	0.68	0.33	0.46	0.48	0.46	0.55	0.31	0.43
$s^{\Delta E}_{t+1,\infty}$	0.33	0.32	0.22	0.25	0.61	0.31	0.44	0.48	0.29	0.33

- Macro news explains a large amount of variation even in the expected excess returns component, commonly thought to be driven by financial factors.
- Macro surprises from the previous quarter are very important for explaining the forward looking components of the exchange rate change, implying that the correct model of exchange rates must feature deviation from FIRE
- Theories must include a channel that connects macro information to exchange rates through expected excess returns

Importance of Lagged Macro News for Forward-Looking Components

Partial R^2s from Quarterly Regressions of the Exch Rate Change and its Components on Macro News Subindices (Panel)

	Δs_{t+1}	$s_{t+1} - \tilde{E}_t s_{t+1}$	σ^F_{t+1}	φ^{EH}_{t+1}	$s^{\Delta E}_{t+1,\infty}$
All timing-based subindices	0.71	0.65	0.53	0.48	0.46
Contemporaneous contribution	0.04	0.03	0.04	0.04	0.15
Lag 1M contribution	0.19	0.17	0.13	0.03	0.01
Lag 2M contribution	0.15	0.13	0.13	0.09	0.03
Lag 3M contribution	0.15	0.16	0.14	0.03	0.04
Lag 4M contribution	0.18	0.16	0.09	0.05	0.01
Lag 5M contribution	0.12	0.13	0.10	0.05	0.03
Lag 6M contribution	0.17	0.15	0.12	0.07	0.02

- Lagged news continue to be important even for purely forward-looking components.
- This is particularly true for the risk premia component.

Importance of Macro News for Exchange Rate Subcomponents

Adjusted R^2s From Quarterly Panel Regressions of the Exch Rate Change and its Components on Macro News Indices, Recessions and High Financial Volatility Periods

	Δs_{t+1}	σ^F_{t+1}	φ^{EH}_{t+1}	$s^{\Delta E}_{t+1,\infty}$
US Recessions	0.91	0.78	0.66	0.66
Not US Recessions	0.63	0.46	0.38	0.17
VIX High	0.79	0.59	0.51	0.47
VIX Low	0.53	0.42	0.25	0.14

- Greater importance in times of economic or financial turmoil extends to all subcomponents.

Conclusion

We use high-frequency macro surprises along with a novel survey-based exchange rate decomposition to document that:

- Macro news drive a large majority of quarterly exchange rate change variation: up to 87% bilaterally and 70% for a panel of AEs against the USD.
  - Longer-lasting dynamics in the response to macro news is a crucial element
- Excess returns are still the most volatile component of exchange rates, but they too are largely driven by macro news: up to 73% bilaterally and 52% for a panel of AEs against the USD.

These new facts support theories that link macro variables to exchange rates through excess returns and allow for deviation from FIRE.

Extra Slides

Data Sources

- *End-of-quarter exchange rates*: Global Financial Data
- *Short-term interest rates*: Central banks, Reuters, Bloomberg
- *End-of-quarter zero-coupon yields (maturities greater than 3 months)*: Central banks, BIS, Gürkaynak et al. (2007), Wright (2011), Bloomberg
- *CPI inflation, output gap, current account to GDP ratio*: OECD
- *High-frequency instruments*: Gürkaynak et al. (2005), Tick Data
- *Forecast data*: Blue Chip, Consensus Economics

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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:Q4
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:Q4

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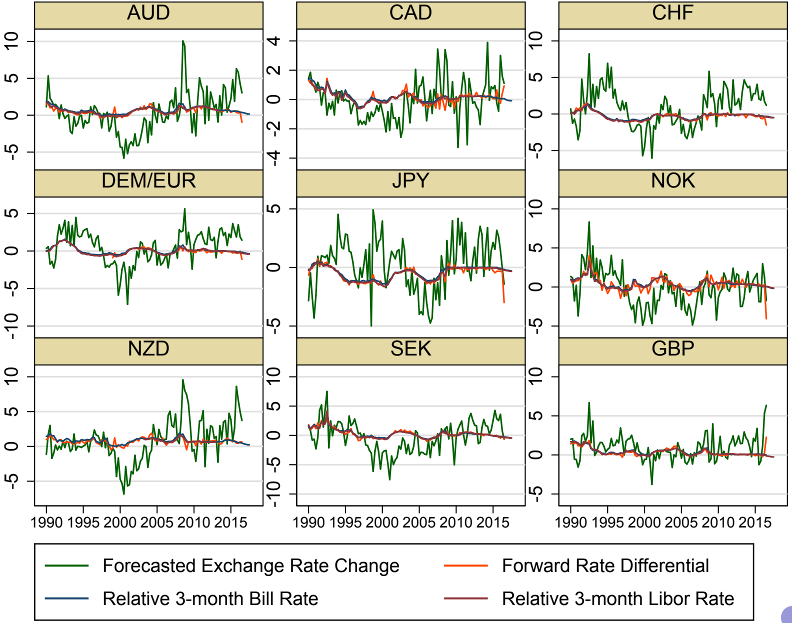
Exchange Rate Change Survey Forecasts



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In-Sample Fit of Survey Data

- 3-month interest rate forecasts: Details
  - Correlations with surveys are at least 95% for horizons up to two years, 42–97% for long-horizon forecasts.
  - RMSDs reduced by up to a factor of 10 compared to standard VAR without surveys.
  - 10-year yield fits are similar.
- Inflation forecasts: Details
  - Most correlations are 80% or better.
  - RMSDs reduced by up to a factor of 7.
- Exchange rate forecasts: Details
  - Correlations of at least 93% across all horizons (up to two years).
  - RMSDs reduced by up to a factor of 10.
- One-quarter currency premia: Correlations of 41–77%.

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In-Sample Survey Data Fit: Details

Correlations Between Survey and Model-Implied Forecasts: 3-month Interest Rates

Panel A: With Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
3M	BC	0.990	0.990	0.972	0.992	0.991				0.994	0.991
3M	CF	0.996	0.992	0.990	0.995	0.997	0.991	0.994	0.995	0.996	0.998
6M	BC	0.987	0.990	0.963	0.993	0.990				0.995	0.993
12M	BC	0.981	0.984	0.966	0.989	0.987				0.995	0.988
12M	CF	0.992	0.978	0.989	0.993	0.996	0.970	0.975	0.989	0.993	0.991
0Y	BC	0.985	0.987		0.994	0.980				0.997	
1Y	BC	0.963	0.979		0.982	0.960				0.992	
2Y	BC	0.972	0.977		0.971	0.945				0.987	
LR	BC/Imp.	0.956	0.928	0.586	0.939	0.948	0.835	0.525	0.969	0.423	0.926

Panel B: Without Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
3M	BC	0.974	0.983	0.955	0.984	0.990				0.988	0.989
3M	CF	0.994	0.991	0.989	0.993	0.998	0.988	0.991	0.986	0.994	0.997
6M	BC	0.948	0.982	0.940	0.982	0.983				0.988	0.985
12M	BC	0.901	0.975	0.918	0.974	0.952				0.987	0.969
12M	CF	0.952	0.973	0.975	0.985	0.990	0.958	0.933	0.978	0.990	0.974
0Y	BC	0.934	0.973		0.981	0.945				0.988	
1Y	BC	0.819	0.961		0.955	0.808				0.980	
2Y	BC	0.899	0.976		0.955	0.628				0.987	
LR	BC/Imp.	0.946	0.924	-0.031	0.903	0.326	0.802	0.323	0.945	-0.101	0.851

Note: The horizons 0Y-2Y in this table represent current year up to two years ahead. The "LR" horizon represents the average over years 7 to 11 ahead for the U.S. For other countries, this horizon represents imputed forecasts for the average of years 6 to 10 ahead.

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In-Sample Survey Data Fit: Details

RMSD Between Survey and Model-Implied Forecasts: 3-month Interest Rates

Panel A: With Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
3M	BC	0.054	0.068	0.085	0.061	0.026				0.067	0.074
3M	CF	0.048	0.062	0.086	0.053	0.035	0.068	0.065	0.091	0.052	0.039
6M	BC	0.064	0.066	0.094	0.053	0.027				0.058	0.066
12M	BC	0.076	0.078	0.083	0.062	0.033				0.060	0.081
12M	CF	0.077	0.094	0.081	0.059	0.038	0.114	0.103	0.114	0.065	0.070
0Y	BC	0.064	0.075		0.047	0.035				0.048	
1Y	BC	0.094	0.086		0.077	0.058				0.069	
2Y	BC	0.089	0.082		0.105	0.070				0.086	
LR	BC/Imp.	0.075	0.064	0.062	0.069	0.088	0.071	0.071	0.054	0.072	0.072

Panel B: Without Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
3M	BC	0.087	0.124	0.133	0.102	0.049				0.134	0.150
3M	CF	0.078	0.073	0.136	0.090	0.063	0.132	0.081	0.169	0.114	0.077
6M	BC	0.130	0.152	0.164	0.113	0.070				0.143	0.177
12M	BC	0.194	0.224	0.216	0.162	0.128				0.187	0.249
12M	CF	0.288	0.196	0.255	0.173	0.152	0.232	0.181	0.260	0.194	0.230
0Y	BC	0.129	0.155		0.120	0.087				0.134	
1Y	BC	0.212	0.275		0.240	0.192				0.231	
2Y	BC	0.229	0.360		0.327	0.250				0.310	
LR	BC/Imp.	0.290	0.569	0.456	0.614	0.654	0.477	0.236	0.562	0.678	0.663

Note: The horizons 0Y-2Y in this table represent current year up to two years ahead. The "LR" horizon represents the average over years 7 to 11 ahead for the U.S. For other countries, this horizon represents imputed forecasts for the average of years 6 to 10 ahead.

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In-Sample Survey Data Fit: Details

Correlations Between Survey and Model-Implied Forecasts: Nominal Exchange Rate

Panel A: With Forecast Data

Horizon	Source	AUD	CAD	CHF	DEM	JPY	NOK	NZD	SEK	GBP
3M	BC	0.993	0.994	0.988	0.988	0.985				0.982
3M	CF	0.993	0.998	0.993	0.993	0.992	0.988	0.993	0.989	0.991
6M	BC	0.985	0.993	0.986	0.985	0.985				0.983
12M	BC	0.982	0.985	0.984	0.977	0.973				0.971
12M	CF	0.987	0.996	0.986	0.989	0.984	0.974	0.985	0.974	0.986
24M	CF	0.977	0.995	0.981	0.981	0.963	0.969	0.980	0.966	0.977
0Y	BC	0.966	0.978		0.973	0.980				0.974
1Y	BC	0.962	0.977		0.958	0.960				0.957
2Y	BC	0.967	0.982		0.928	0.956				0.964
3M CP	BC	0.770	0.410	0.746	0.722	0.539				0.505
3M CP	CF	0.636	0.648	0.748	0.741	0.597	0.478	0.670	0.595	0.561

Panel B: Without Forecast Data

Horizon	Source	AUD	CAD	CHF	DEM	JPY	NOK	NZD	SEK	GBP
3M	BC	0.956	0.970	0.950	0.936	0.928				0.904
3M	CF	0.968	0.982	0.949	0.950	0.950	0.950	0.973	0.938	0.936
6M	BC	0.884	0.935	0.901	0.857	0.841				0.820
12M	BC	0.808	0.851	0.804	0.706	0.577				0.764
12M	CF	0.841	0.884	0.811	0.706	0.648	0.707	0.845	0.656	0.775
24M	CF	0.670	0.707	0.838	0.466	0.242	0.585	0.581	0.465	0.637
0Y	BC	0.913	0.928		0.869	0.836				0.820
1Y	BC	0.804	0.768		0.605	0.513				0.720
2Y	BC	0.611	0.691		0.383	0.327				0.718
3M CP	BC	-0.010	-0.133	0.095	-0.056	0.005				-0.163
3M CP	CF	0.204	0.293	0.027	0.035	0.155	-0.003	0.148	0.072	0.187

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In-Sample Survey Data Fit: Details

RMSD Between Survey and Model-Implied Forecasts: Nominal Exchange Rate

Panel A: With Forecast Data

Horizon	Source	AUD	CAD	CHF	DEM	JPY	NOK	NZD	SEK	GBP
3M	BC	0.023	0.017	0.025	0.022	0.024				0.019
3M	CF	0.021	0.010	0.018	0.015	0.018	0.021	0.021	0.020	0.012
6M	BC	0.030	0.018	0.027	0.023	0.024				0.020
12M	BC	0.033	0.024	0.029	0.026	0.031				0.023
12M	CF	0.024	0.013	0.023	0.017	0.024	0.028	0.026	0.025	0.014
24M	CF	0.030	0.013	0.023	0.019	0.028	0.028	0.025	0.023	0.016
0Y	BC	0.048	0.032		0.030	0.026				0.021
1Y	BC	0.048	0.030		0.033	0.032				0.024
2Y	BC	0.049	0.025		0.040	0.035				0.023
3M CP	BC	2.258	1.720	2.453	2.161	2.417				1.915
3M CP	CF	2.095	1.021	1.780	1.483	1.791	2.059	2.134	2.029	1.224

Panel B: Without Forecast Data

Horizon	Source	AUD	CAD	CHF	DEM	JPY	NOK	NZD	SEK	GBP
3M	BC	0.055	0.037	0.054	0.048	0.052				0.041
3M	CF	0.044	0.028	0.051	0.041	0.046	0.043	0.044	0.050	0.032
6M	BC	0.087	0.054	0.077	0.069	0.075				0.055
12M	BC	0.110	0.087	0.117	0.092	0.113				0.060
12M	CF	0.093	0.078	0.111	0.088	0.107	0.103	0.101	0.116	0.055
24M	CF	0.133	0.157	0.125	0.115	0.131	0.144	0.178	0.162	0.067
0Y	BC	0.079	0.057		0.067	0.075				0.052
1Y	BC	0.110	0.115		0.104	0.111				0.060
2Y	BC	0.150	0.176		0.127	0.126				0.063
3M CP	BC	5.495	3.665	5.404	4.836	5.186				4.085
3M CP	CF	4.420	2.827	5.133	4.137	4.584	4.283	4.381	4.973	3.170

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In-Sample Survey Data Fit: Details

Correlations Between Survey and Model-Implied Forecasts: Inflation

Panel A: With Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
0Y	BC	0.908	0.905		0.965	0.962				0.972	
0Y	CF	0.940	0.973	0.991	0.971	0.985	0.973	0.909	0.992	0.993	0.990
1Y	BC	0.795	0.788		0.917	0.921				0.893	
1Y	CF	0.896	0.738	0.979	0.950	0.949	0.921	0.779	0.979	0.927	0.971
2Y	BC	0.905	0.807		0.918	0.821				0.613	
2Y	CF	0.907	0.655	0.975	0.959	0.916	0.902	0.851	0.978	0.618	0.965
LR	CF	0.895	0.577	0.214	0.794	0.773	-0.226	0.728	0.689	0.877	0.942

Panel B: Without Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
0Y	BC	0.862	0.841		0.933	0.935				0.925	
0Y	CF	0.865	0.947	0.974	0.949	0.977	0.944	0.863	0.983	0.966	0.978
1Y	BC	0.177	0.233		0.505	0.712				0.510	
1Y	CF	0.203	0.294	0.728	0.624	0.868	0.537	0.457	0.879	0.578	0.772
2Y	BC	-0.506	-0.103		0.294	0.357				0.008	
2Y	CF	-0.523	0.063	0.284	0.392	0.640	0.283	0.246	0.737	-0.141	0.650
LR	CF	-0.708	0.505	0.112	-0.375	0.158	0.464	0.506	0.051	0.028	0.137

Note: The horizons 0Y, 1Y, and 2Y in this table represent current year, next year, and two years ahead. Inflation forecasts are on an annual-average over annual-average basis. The "LR" horizon represents the average over years 6 to 10 ahead.

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In-Sample Survey Data Fit: Details

RMSD Between Survey and Model-Implied Forecasts: Inflation

Panel A: With Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
0Y	BC	0.399	0.286		0.222	0.232				0.231	
0Y	CF	0.358	0.156	0.182	0.223	0.196	0.205	0.450	0.287	0.120	0.148
1Y	BC	0.280	0.184		0.210	0.304				0.181	
1Y	CF	0.414	0.209	0.194	0.212	0.322	0.301	0.487	0.304	0.189	0.190
2Y	BC	0.169	0.190		0.196	0.426				0.144	
2Y	CF	0.313	0.133	0.214	0.162	0.400	0.306	0.255	0.265	0.158	0.157
LR	CF	0.280	0.193	0.190	0.194	0.351	0.336	0.211	0.229	0.167	0.199

Panel B: Without Forecast Data

Horizon	Source	AU	CA	CH	DE	JP	NO	NZ	SE	UK	US
0Y	BC	0.530	0.400		0.329	0.320				0.410	
0Y	CF	0.575	0.228	0.339	0.306	0.236	0.316	0.591	0.449	0.282	0.226
1Y	BC	0.798	0.587		0.619	0.653				0.750	
1Y	CF	1.264	0.528	1.050	0.595	0.512	0.749	0.902	1.020	0.732	0.536
2Y	BC	0.941	0.688		0.703	0.969				0.755	
2Y	CF	1.409	0.590	1.685	0.679	0.840	0.816	0.832	1.352	0.791	0.597
LR	CF	1.140	0.498	6.927	0.636	1.179	0.579	0.380	0.873	0.381	0.872

Note: The horizons 0Y, 1Y, and 2Y in this table represent current year, next year, and two years ahead. Inflation forecasts are on an annual-average over annual-average basis. The "LR" horizon represents the average over years 6 to 10 ahead.

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Decomposing Exchange Rate Variation

$$Var\left(\Delta s_{t+1}\right) = Var\left(\tilde{i}_t - \varphi^{EH}_{t+1}\right) + Var\left(s^{\Delta E}_{t+1,\infty}\right) + Var\left(\sigma_t - \sigma^F_{t+1}\right)$$
$$+2Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, s^{\Delta E}_{t+1,\infty}) + 2Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, \sigma_t - \sigma^F_{t+1}) + 2Cov(s^{\Delta E}_{t+1,\infty}, \sigma_t - \sigma^F_{t+1})$$

Component Variances and Covariances

Bases (avg across pairs)	AUD	CAD	CHF	DEM/EUR	GBP	JPY	NOK	NZD	SEK	USD
$Var(\Delta s_{t+1})$	35.54	27.28	31.40	24.28	24.80	48.25	27.46	33.64	28.42	30.52
$Var(\tilde{i}_t - \varphi^{EH}_{t+1})$	13.94	8.88	12.05	9.56	7.87	14.27	16.50	10.48	16.15	14.80
$Var(s^{\Delta E}_{t+1,\infty})$	3.25	2.64	2.69	2.21	4.18	4.95	2.98	3.86	4.26	4.22
$Var(\sigma_t - \sigma^F_{t+1})$	32.73	28.32	32.09	26.90	25.37	48.39	35.53	30.83	28.32	28.29
$Var(-\varphi^{EH}_{t+1} - \sigma^F_{t+1} + s^{\Delta E}_{t+1,\infty})$	34.99	25.46	29.04	23.92	24.42	41.79	24.88	31.21	24.67	28.37
$Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, s^{\Delta E}_{t+1,\infty})$	−4.71	−2.06	−2.49	−2.60	−1.33	−5.53	−1.66	−3.44	−5.70	−4.43
$Cov(\tilde{i}_t - \varphi^{EH}_{t+1}, \sigma_t - \sigma^F_{t+1})$	−2.34	−4.32	−5.74	−5.41	−3.65	−3.53	−10.65	−2.82	−6.26	−4.40
$Cov(s^{\Delta E}_{t+1,\infty}, \sigma_t - \sigma^F_{t+1})$	−0.14	0.10	0.51	0.82	−1.33	−0.62	−1.47	0.49	1.80	0.44
$Var(\tilde{r}_t - \varphi^{r,EH}_{t+1})$	7.92	7.51	10.01	6.60	9.27	8.24	16.54	7.48	9.22	9.76
$Cov(\tilde{r}_t - \varphi^{r,EH}_{t+1}, \sigma_t - \sigma^F_{t+1})$	−2.64	−4.07	−5.21	−4.58	−4.93	−3.61	−12.44	−2.08	−4.65	−3.92

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