The Demand for Money, Adaptive Expectations, and Currency Movements

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Background

- Exchange rate fluctuations have also been notoriously difficult to predict using economic models
  - Meese and Rogoff (1983). A random walk better predicts exchange rates than any economic variable, including those derived from uncovered interest rate parity, purchasing power parity (PPP), and flexible or stickyprice versions of monetary models
  - More recently: purchasing power parity deviations, inflation, output, and productivity (Rossi, 2013), carry (Lustig et al., 2011, 2014), output gap (Colacito et al., 2020; Dahlquist and Hasseltoft, 2020), commodity prices (Chen and Rogoff, 2003; Bakshi and Panayotov, 2013), momentum (Menkhoff et al., 2012; Asness et al., 2013), net foreign investment (Jiang, et al., 2023), and external trade imbalance (Gourinchas and Rey, 2007; Gourinchas, Govillot, and Rey, 2017) showed some success at predicting currency returns
- Trading strategy formed from "relative excess demand" shows it to be a better exchange rate predictor than other constructs in the literature

Paper's Motivating Example

- A surplus of restaurant patrons on a given night or week does not immediately generate a revision in menu prices
  - Menu price changes occur only after weeks of turning away patron requests for reservations that are already taken
  - When remote work became ubiquitous as the 2020 Covid-19 lockdowns were put in place, home prices rose along with the prices of goods to build them like lumber. However, the price increases manifested gradually (weeks and months)
  - What happens in financial (currency) markets when an analogous set of events occurs?

Delayed Reactions

- Currencies with relatively high excess demand supposedly should witness contemporaneous increases in their currency's value
  - Instead, the paper finds much of the price reaction is slow to respond to excess demand, even when estimates of such demand can be computed from information available to traders at the time
  - This delayed price reaction, which lasts as long as twelve months, cannot be explained by known currency risk factors or previously known currency return predictors

Excess Demand

- This paper
  - Each month, rolling sixty-month regressions linearly fit a panel of historical OECD countries' M1 data to three major items reported from each OECD economy: GDP, exports, and imports (along with economy-specific and time fixed effects)
  - The regression's most recent cross-section of residuals represents excess supply
  - Currencies with the most *negative* residuals per unit of M1 have the most *positive* excess money demand and *appreciate* the most in the next few months; those with the most negative excess demand ratios depreciate the most. Thus, currency movements correlate with relative excess demand for M1

Model

- Assume a logarithmic utility reward U from having a given amount of money D for transaction volume C:

$$U = uC\ ln(D - a\ )$$

- u a parameter for money's convenience and a a non-positive shift parameter (u and a are not time-varying?)
- To model such price dynamics empirically, the paper assumes that time t's exchange rate f (domestic currency per unit of foreign currency) follows the process:

$$E[\frac{\Delta f}{f}] = k_t(\frac{e}{M} - \frac{e^*}{fM^*})\Delta t$$

- with k_t is positive, e and e^* are the most recent pair of regression residuals for the domestic and foreign countries

FV and CV Signals

- Two types of signals
  - The contemporary vintage signal "CV" employs information that a foreign exchange trader would have known at month T's end
  - The final vintage signal "FV" employs the most up-to-date information about the state of the economy at T's month-end, even if that information became known after month
- If the best estimate of the actual workings of the economy is relevant for currency movements, the FV signal will be more correlated with currency returns
  - If publicly available knowledge about the economy is more salient, the CV signal will be more correlated with currency movements

Lots of results, including but not limited to:

- Table 2 (Panel Regressions): Panel C shows that Q5 currencies outperform Q1 currencies next month by 30–50 bp per month, depending on the specification

Panel C: Next Month's Excess Returns (t+1) and CV Signal

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Excess Money Demand Quintile Dummies														
Excess Money Demand CV Q5 (t)	0.418	0.417	0.299	0.427	0.449	0.499	0.419	0.422	0.416	0.418	0.466	0.416	0.408	0.375
	[2.22]	[2.22]	[1.45]	[2.25]	[2.38]	[2.58]	[2.19]	[2.28]	[2.19]	[2.23]	[2.34]	[2.23]	[2.17]	[1.88]
Excess Money Demand CV Q4 (t)	0.078	0.077	0.023	0.082	0.083	0.057	0.074	0.081	0.078	0.077	0.090	0.073	0.071	-0.017
	[0.58]	[0.57]	[0.17]	[0.60]	[0.60]	[0.42]	[0.54]	[0.61]	[0.57]	[0.58]	[0.63]	[0.56]	[0.53]	[-0.13]
Excess Money Demand CV Q3 (t)	0.133	0.132	0.119	0.135	0.141	0.146	0.129	0.135	0.131	0.134	0.140	0.135	0.130	0.137
	[1.10]	[1.09]	[0.97]	[1.11]	[1.15]	[1.16]	[1.05]	[1.16]	[1.08]	[1.08]	[1.13]	[1.10]	[1.07]	[1.13]
Excess Money Demand CV Q2 (t)	0.060	0.060	0.056	0.062	0.069	0.057	0.061	0.061	0.059	0.059	0.071	0.057	0.058	0.051
	[0.46]	[0.45]	[0.43]	[0.47]	[0.51]	[0.42]	[0.45]	[0.47]	[0.44]	[0.46]	[0.53]	[0.45]	[0.44]	[0.39]
Growth in M1 (t)		0.391												-0.292
		[0.17]												[-0.16]
Carry Trade (t)			38.40											34.24
			[1.03]											[0.87]
1-Month Momentum (t)				-2.022										0.45
				[-0.55]										[0.10]
3-Months Momentum (t)					-2.479									-1.752
					[-1.06]									[-0.47]
12-Months Momentum (t)						-2.186								-2.255
						[-1.72]								[-1.51]
Filter Rule Combination (t)							-0.229							0.180
							[-1.07]							[0.51]
Dollar Exposures (t)								-0.022						-0.03
								[-0.11]						[-0.15]
Term Spread (t)									1.562					2.814
									[0.34]					[0.56]
Output Gap (t)										0.15				-4.354
										[0.16]				[-1.03]
Currency Value (t)											-0.492			0.155
											[-0.88]			[0.23]
Taylor Rule (t)												0.879		8.946
												[0.47]		[1.06]
Growth in M2 (t)													4.858	4.02
													[1.34]	[1.17]
Month Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

- What is surprising is that the FV signal is much less likely to reach 5% significance level in the various specifications

Panel D: Next Month's Excess Returns (t+1) and FV Signal

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Excess Money Demand Quintile Dummies														
Excess Money Demand FV Q5 (t)	0.220	0.220	0.082	0.225	0.240	0.284	0.214	0.219	0.219	0.220	0.261	0.218	0.209	0.137
	[1.22]	[1.23]	[0.44]	[1.23]	[1.29]	[1.51]	[1.18]	[1.30]	[1.22]	[1.22]	[1.45]	[1.22]	[1.16]	[0.79]
Excess Money Demand FV Q4 (t)	0.005	0.005	-0.110	0.006	0.006	0.009	0.001	0.005	0.007	0.005	0.014	0.002	-0.012	-0.131
	[0.03]	[0.03]	[-0.65]	[0.04]	[0.04]	[0.05]	[0.00]	[0.03]	[0.05]	[0.03]	[0.09]	[0.01]	[-0.07]	[-0.83]
Excess Money Demand FV Q3 (t)	0.069	0.070	0.046	0.072	0.078	0.091	0.066	0.068	0.068	0.070	0.079	0.070	0.063	0.066
	[0.58]	[0.59]	[0.39]	[0.60]	[0.65]	[0.73]	[0.55]	[0.62]	[0.57]	[0.58]	[0.65]	[0.59]	[0.53]	[0.58]
Excess Money Demand FV Q2 (t)	0.130	0.131	0.125	0.134	0.142	0.148	0.135	0.130	0.131	0.130	0.144	0.128	0.124	0.137
	[1.03]	[1.03]	[1.00]	[1.03]	[1.08]	[1.13]	[1.02]	[1.04]	[1.03]	[1.02]	[1.14]	[1.01]	[0.96]	[1.07]
Growth in M1 (t)		0.483												-0.408
		[0.21]												[-0.22]
Carry Trade (t)			54.72											52.87
			[1.53]											[1.37]
1-Month Momentum (t)				-1.769										0.474
				[-0.47]										[0.10]
3-Months Momentum (t)					-2.242									-1.745
					[-0.93]									[-0.46]
12-Months Momentum (t)						-1.887								-2.06
						[-1.43]								[-1.36]
Filter Rule Combination (t)							-0.224							0.161
							[-1.04]							[0.45]
Dollar Exposures (t)								0.007						-0.009
								[0.04]						[-0.04]
Term Spread (t)									1.658					3.2
									[0.37]					[0.65]
Output Gap (t)										0.102				-4.015
										[0.11]				[-0.95]
Currency Value (t)											-0.383			0.174
											[-0.69]			[0.27]
Taylor Rule (t)												0.857		8.256
												[0.46]		[0.98]
Growth in M2 (t)													5.323	4.061
													[1.46]	[1.16]
Month Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This Paper: Focus on Fundamental Information, CV vs FV (Accurate Revised) Fundamentals

- CV signal on fundamentals do correlate with FX returns
  - Contemporaneously
  - And also in future months (An "anomaly" to efficient market)
- FV Signal (future & final revisions)/more accurate fundamental info has little correlation with currency movements

"*Final vintage numbers represent a more accurate portrait of the economy ... The **only** explanation for the greater efficacy of the CV signal is that what currency traders know may be more important for currency movements than more accurate undisclosed information about the economy, which often remains undisclosed for months*"

Other Results

- Regarding Factor Models:
  - Large and significant Q5 – Q1 alpha spreads, both contemporaneously and in the next month, based on the CV signal
  - In contrast, none of the FV signal's alpha spreads is significant at the 5% level
  - Excess money demand subsumes carry, i.e., excess money demand is a cleaner signal of future returns than carry and perhaps accounts for carry's ability to predict currency returns
- Long lasting effect: a long-short strategy in one-month currency forwards, held for a year in the same basket of currencies, earned more than 3.3% per year based on public information
- The economies with the 20% greatest excess demand (predicted to have the highest currency appreciation) tend to have significantly more inflation than the 20% with the lowest excess demand
  - Inflation should make currencies less attractive as investments, generating depreciation in many models, yet the opposite correlation between inflation and contemporaneous currency movements is found

- Empirical paper with a large portion devoted to a model (under-reaction mechanism)
- The comments will be mainly on the theoretical part (without imposing/presupposing that the comment presented here is necessarily the unique/correct theoretical view)
  - The theoretical explanation should be concordant with the empirical findings: gradual/long-lasting/more predicated upon CV than FV (on the currency return predictability aspect)
  - Or more clarification on the current mechanism
- Convinced of the empirical results: some minor empirical comments as well

Under-reaction Mechanism

- The paper posits that the speculators' aggregate demand functions for the domestic and foreign currency forwards are of the form

$$D_s = b_s p(\frac{f}{v} - 1)$$

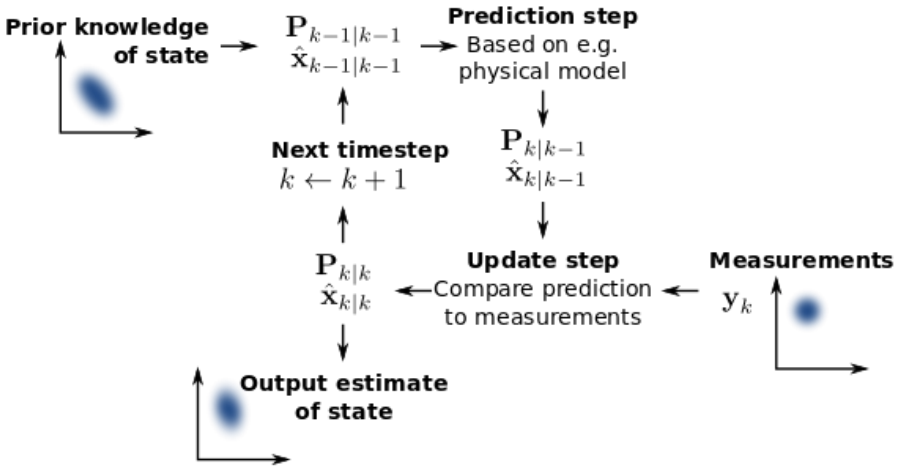
$$D_s^* = -b_s p^*(\frac{f}{v} - 1)$$

- where V is the reference value for the exchange rate, viewed *irrationally* as a fair value
  - Question: If the reference value is building the under-reaction mechanism, at what speed should V be updated to create the results (with very long lasting effects) previously discussed

Going back to the paper's motivating example

- In 2020 Covid-19 lockdowns were put in place, home prices rose along with the prices of goods to build them like lumber. However, the price increases manifested gradually
- How was the information updated? Did we make decisions using information about what we knew about COVID at the time (Contemporary Vintage), or using information that has higher accuracy but is knowledge ex post (Final Vintage)? CV, not FV, and this suggests Bayesian updating

Kalman Filter



- Long-Run Risk (LRR) models can explain the exchange rate dynamics quantitatively (ratio of pricing kernels/relative value of long-run component): Colacito and Croce (JPE 2013)
  - Two types of shocks: idiosyncratic/one-time shocks: $\varepsilon_{c,t}$, and shock-to-fundamental/long-lasting shocks: $\varepsilon_{z,t}$
  - Can add Bayesian learning/Kalman filtering (of z_t) on top of LRR models:

$$\Delta c_t = \mu + z_t + \sigma_{c,h} \cdot \varepsilon_{c,t}$$
$$z_t = \rho \cdot z_{t-1} + \sigma_{z,h} \cdot \varepsilon_{z,t}$$
$$\Delta d_t = \mu_d + \lambda \cdot (\Delta c_t - z_t)$$

Long-Run Risk Model with Bayesian Updates (Kalman Filter)

- Highly auto-correlated state variables z_t, and z_t^*
  - Not directly observable, but the pricing kernel (thus asset pricings/exchange rates) is dependent on the value of z_t (or rather, $\hat{z}_t$ with learning)
  - They determine the long-run prospects of the two economies, higher z_t relatively means appreciating currency
  - Their values have are Bayesian learned from observables such as consumptions

$$I_t^c = \left\{ \{\Delta c_{t-i}\}_{i=0,1,\ldots}, \left\{\Delta c_{t-i}^*\right\}_{i=0,1,\ldots}, \Omega_c \right\}$$

- One positive observation may be attributed to an idiosyncratic shock, repeated positive observations in the same direction increases Bayesian posterior that a fundamental shock had previously occurred
  - Response is gradual, lagged, and predicated upon contemporaneously-available, rather than ex-post (accurate) information (the paper's motivating examples of home/wood prices during lockdown; another example: stock market crash of Singapore in 97)
  - If a fundamental shock is judged likely, it is long-lasting per the LRR setup (high auto-correlation in fundamental z_t)

Filtering/Bayesian Updating

Reusing slide from "Learning in International Markets and a Rational Expectation Approach to the Contagion Puzzle":

- The one-step-ahead state evolution equations for the filtered home and foreign long run persistent components have the following representation:

$$\widehat{z_t} = \underbrace{\rho}_{0.98} \cdot \widehat{z_{t-1}} + \underbrace{K_{11}^c}_{0.041} \cdot \underbrace{(\sigma_{c,h} \cdot \varepsilon_{c,t} + z_t - \widehat{z_t})}_{\textit{innovation in home}} + \underbrace{K_{12}^c}_{0.024} \cdot \underbrace{(\sigma_{c,f} \cdot \varepsilon_{c,t}^* + z_t^* - \widehat{z_t^*})}_{\textit{innovation in foreign}}$$

$$\widehat{z_t^*} = \underbrace{\rho}_{0.98} \cdot \widehat{z_{t-1}^*} + \underbrace{K_{21}^c}_{0.034} \cdot \underbrace{(\sigma_{c,h} \cdot \varepsilon_{c,t} + z_t - \widehat{z_t})}_{\textit{innovation in home}} + \underbrace{K_{22}^c}_{0.041} \cdot \underbrace{(\sigma_{c,f} \cdot \varepsilon_{c,t}^* + z_t^* - \widehat{z_t^*})}_{\textit{innoation in foreign}}$$

- "*if a central bank observes that transactional demand for money is high, it can increase the supply of money. If the central bank does not increase supply, money will become scarce, just like the restaurant seats portrayed in the introduction*"
  - Where does the increase in transactional demand come from?
  - A positive update, by the speculator, on her view of the long-run prospect of an economy, which is learned/Bayesian-updated/Kalman-filtered, i.e., a higher $\hat{z}_t$, this results in higher money demand/appreciating currency, that is gradual/long-lasting/predicated on contemporaneous information (CV)

- Full setup: DSGE model with LRR with learning, central bank with Taylor Rule
- or, as a Shortcut: simply, Kalman filtering of V: the reference value (or fundamental value) of the currency with a long-run component $\leftarrow$ BTW, the can also generate momentum

Minor Comments

- Can have a unified terminology: 'excess demand' or 'relative excess demand'
- More economic and intuitive discussions on the different empirical results of "CV" vs "FV" signals
- Typo on slide: Grinblatt and Han (*1985*)?
- Also, is Prospect Theory needed in the current paper as in Grinblatt and Han (2005), or just the reference value updating component?
- Perhaps the update mechanism for V can be explicitly stated as a numbered formula

Minor Comment: Clustered Errors?

- Mitchell Petersen, Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches (RFS 2009)
- The paper currently uses fixed effects (theoretically motivated) but not clustered errors, in the calculation of residuals:

$$M1_{i,t} = \boldsymbol{a_i} + \boldsymbol{c_t} + \beta_{GDP} GDP_{i,t} + \beta_{EX} X_{i,t} + \beta_{IM} I_{i,t} + \varepsilon_{i,t}$$

- The paper is currently silent on the correlation structure of the observations
  - Should the paper take a stance on why not using clustered errors is justified? The current model yield no correlation structure?
  - There may be correlation if there is a highly auto-correlated long run risk component in the economy

Minor Comments: Linkage with other *potentially-somewhat-related* literature

- Not sure if the relevance is too tangential: Limited Information Processing Capacity of market participants (Van Nieuwerburgh and Veldkamp, 2010), may, as a mechanism, lead to a variety of the hidden-in-plain-sight type of predictability patterns: e.g., Menzly and Ozbas (JF 2010); Addoum and Murfin (RFS 2020); Ho and Lauwers (JFQA 2022)

Great Paper !

- This paper:
  - Lots of interesting results from diverse angles using a new measure
  - New empirical results, predictability in a difficult-to-predict market
  - Bayesian learning (fully rational learning: Kalman Filter with Long Run Risks) may be an alternate (though not necessary) angle to explain the empirical findings
  - More economic explanations on why CV works differently from FV, empirically
  - It's a very nice paper, I have learned a lot, looking forward to its publication