Investors' Heterogeneity and Exchange Rate Disconnect: Which Heterogeneity Matters the Most?

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Introduction

- Meese and Rogoff (1983): Weak explanatory power of macroeconomic fundamentals and excess volatility of exchange rates (exchange rate disconnect puzzle).

$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^\star) + \varepsilon_t \tag{1}$$

  Low R^2 (around 1%): Random-walk best forecasting performance (Rossi [2013] for a survey).

- Microstructure approach to exchange rates:
  - Investor heterogeneity is a critical driving force behind exchange rate fluctuations.
  - Investors' heterogeneity and Disconnect: i) information heterogeneity (Baccheta and van Wincoop, 2006); ii) strategic behavior (previous paper).

What we do

This paper in a nutshell:

- **Question:**
  - We combine strategic behavior and dispersed information in an monetary model.
    $\hookrightarrow$ How much does each dimension of heterogeneity account for the FX disconnect?

- **Results**:
  - Theoretical: Non linear interaction of the two dimensions of heterogeneity.
  - Quantitative:
    - Investors' heterogeneity increases disconnect by 30%.
      $\hookrightarrow$ Small improvement in predictive power, but still economically relevant (carry trade).
    - Decomposition of excess volatility and disconnect suggests that around 25-30% is due to strategic behavior and 80-70% to dispersed information.

Motivation

- Key features of FX markets:
  - Dispersed Information:
    FX Expectation dispersion from ECB Professional Forecasters, 2002-2020.

	Across all Horizons	Quarter t+1
Average Dispersion (StD)**	4.62	4.01
Median Dispersion (StD)**	4.26	3.63
Average # of Forecasters	47.15	47.39
# of Quarters*	337	76

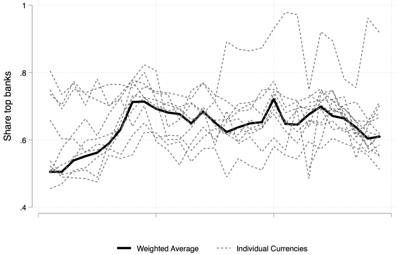
*: From 2002Q1 to 2020Q4.

**: Standard deviation $\times 10^2$.

BvW (2006) show information dispersion leads to magnification of the impact of non-fundamentals trade on the FX (resulting from rational confusion).

Motivation

- Key features of FX markets:
  - Strategic Behavior:
    FX concentration from the NYF FXC Survery, 2005-2020.



EP (2020) show strategic behavior also amplifies noise trading, decreasing price informativeness.

Model

- Standard monetary model of exchange rate determination embedding strategic behavior (as in EP [2020]) and dispersed information (as in Niemark [2018]).

- Two countries: a large (domestic) and a small (foreign) open economy.

- Agents:
  - Continuum of traders of unit mass in domestic country. Heterogeneity in:
    a) Dispersed information about fundamentals.
    b) Competitive vs strategic traders.
  - Noise traders.

- Assets:
  a) Domestic one period bond with nominal return i_t and risk-free technology $\bar{r}$.
  b) Foreign one period bond with nominal return $i_t^{\star}$.
  $\hookrightarrow$ Exogenous Δi_t, AR(1) process.

Investors

- Each investor j lives two periods, born with fixed endowment, ω.

- Conditional on their information set, they maximize Mean-Variance preferences over next period wealth:

$$\max_{b_t^j} E_t[w_{t+1}^j | \Omega_t(j)] - \frac{\rho}{2} Var_t[w_{t+1}^j | \Omega_t(j)]$$

$$\text{s.t. } w_{t+1}^j = (\omega - b_t^j) i_t + b_t^j (i_t^\star + s_{t+1} - s_t)$$

where $(i_t^\star + s_{t+1} - s_t)$ and i_t are the log-linearized real rate of return of foreign and domestic investment.

Demand of foreign assets

- Investors can either act strategically or not, as in EP (2020). In the former case, conditional to their information set, they internalize the effects that their demand has on equilibrium prices.

- FOCs:
  - Foreign asset demand in domestic currency of an atomistic trader is:

$$b_t^j = \frac{E_t[s_{t+1}|\Omega_t(j)] - s_t + i_t^\star - i_t}{\rho\sigma^2}$$

  - Similarly, for a strategic investor:

$$b_t^j = \frac{E_t[s_{t+1}|\Omega_t(j)] - s_t + i_t^\star - i_t}{\rho\sigma^2 + \frac{\partial s_t}{\partial b_t^j}}$$

- Notice we assumed that the conditional variance is the same across investors and time invariant.

Information Structure

- The information set follows Nimark (2018), generalizing Singleton (1987).
- Each investor receives a private signal about fundamentals, $f_t(j)$, which follows the process: $f_t(j) = \Delta i_t + \eta_t(j)$ where $\eta_t(j) \sim N(0, \sigma_\eta^2)$.
- Traders' information set includes also the history of the exchange rate s_t. Formally:

$$\Omega_t(j) = \{f_{t-T}(j), s_{t-T} : T \geqslant 0\}$$

- Traders do not observe perfectly the path of the interest rate and are not able to back out the fundamental component from observing s_t.
- Key difference with BvW (2006): relaxing short-lived private information assumption (innovations to Δi_t are not perfectly and publicly observed after a finite number of periods).

Noise traders and Monetary authorities

- Noise traders investment an exogenous quantity of foreign assets X_t:

$$X_t = (\bar{x} + x_t)\bar{W}$$

where $\bar{W}$ is the aggregate financial wealth in steady state, $\bar{x}$ is a constant and x_t follows is iid $N(0, \sigma_x)$:

- Domestic Central Bank commits to a constant price level ($p_t = 0$) while Foreign monetary policy is stochastic:

$$i_t^\star = -u_t \qquad \text{where } u_t = \rho_u u_{t-1} + \sigma_u \varepsilon_t^u \qquad \text{with } \varepsilon_t^u \sim N(0,1)$$

Thus, the interest rate differential is : $\Delta i_t \equiv i_t - i_t^\star = \bar{r} + u_t$

- Shock to the foreign monetary policy rule is a fundamental shock; shock to X_t is a noise shock to the demand of foreign assets.

Equilibrium and Model Solution

Definition

For an history of shocks $\{\varepsilon_t^x, \varepsilon_t^u\}_{t=0}^{-\infty}$ and signals about fundamentals $\{f_t(j)\}_{t=0}^{-\infty}$, an equilibrium path is a sequence of quantities $\{b_t^j\}_{t=0}^{-\infty}$ and foreign currency (asset) price $\{s_t\}_{t=0}^{-\infty}$ such that investors optimally choose their portfolio and markets clear.

From the market clearing we obtain:

$$s_t = (1-\mu)\left(\frac{\bar{x}}{b} - 1\right) + \mu\left(\int E_t\left[s_{t+1} \mid \Omega_t(j)\right] dj\right) - \mu\left(i_t - i_t^*\right) + (1-\mu)\frac{1}{b}x_t \quad (2)$$

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Full Information. As in EP (2020), using LIE and the law of motion of Δi_t:

$$s_t = -\frac{\mu}{1-\rho_u\mu}\Delta i_t + \frac{1-\mu}{b}x_t \quad (3)$$

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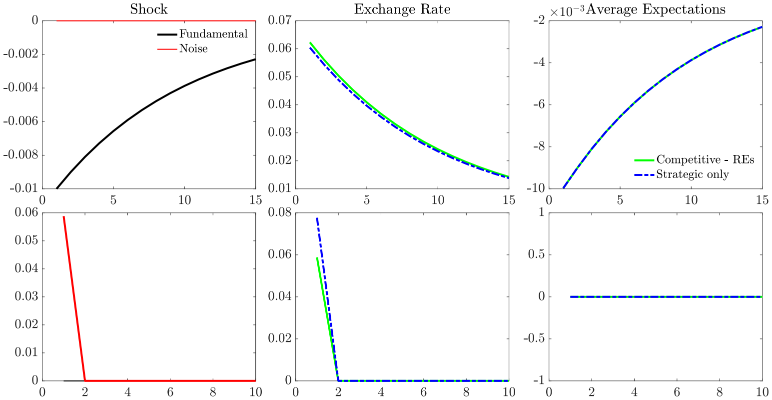
Private Information. s_t depends on the average expectation in period t of fundamentals but also on higher-order expectations (infinite regress):

$$s_t = -\mu \sum_{k=0}^{\infty} \mu^k \Delta i_{t+k|t}^{(k)} + \frac{1-\mu}{b} x_t \quad (3)$$

where $\Delta i_{t+k|t}^{(k)} = \underbrace{\int \mathbb{E}_t \ldots \left[\int \mathbb{E}_{t+k-1}\right.}\left.\Delta i_{t+k} dj\right] \ldots dj$ for any integer k > 0.

Amplification Channel

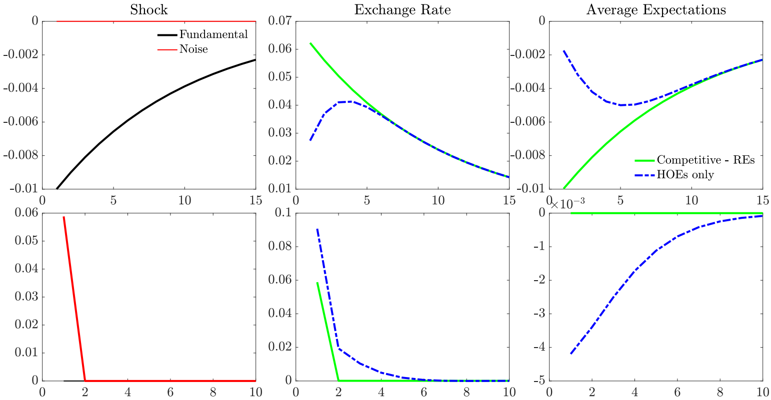
Strategic Behavior



Calibration

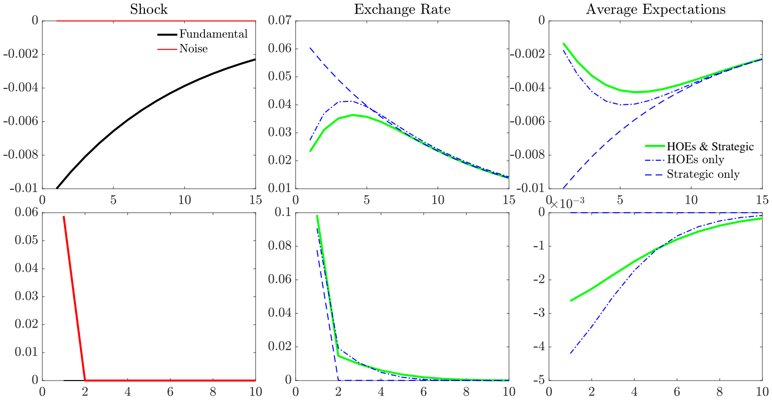
Amplification Channel

Dispersed Information



Amplification Channel

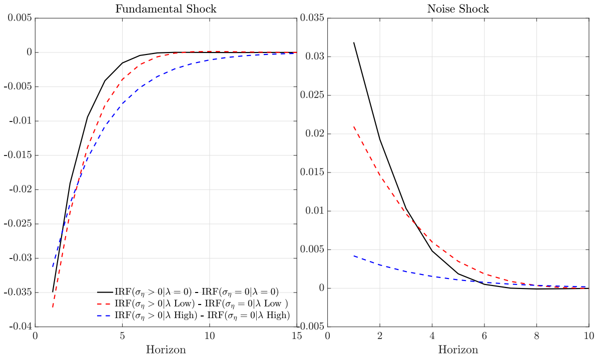
Full Model



Summary theoretical results

- Not surprisingly, qualitative results are still valid: effects of fundamental (noise) innovations are dampened (amplified) by the contemporaneous presence of information heterogeneity and strategic behavior.

Non-linear interaction



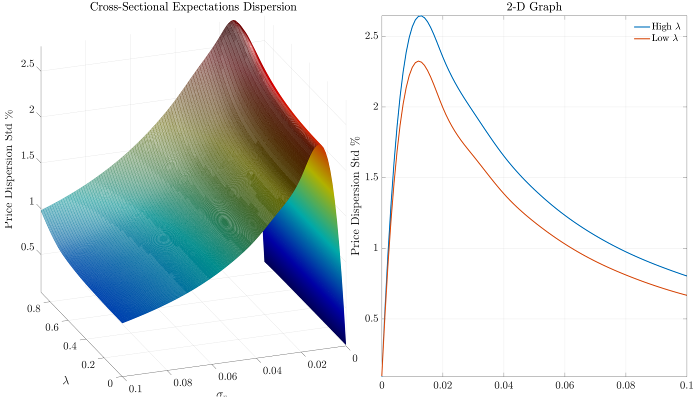
$\lambda \uparrow$: s_t more noisy, lower information content $\rightarrow$ more weight on private signal.

Summary theoretical results (cont'd)

- Not surprisingly, the two amplification channels add up: effects of fundamental (noise) innovations are dampened (amplified).
- Non-linear relationship: amplification (dampening) of noise (fundamental) trading due to information heterogeneity depends negatively (positively) on the level of competitiveness.

Expectation Dispersion

$$\text{Expectation Dispersion} = \underbrace{\text{Dispersion of the signal}}_{+} \times \underbrace{\text{Attached weight} \times \lambda}_{-}$$



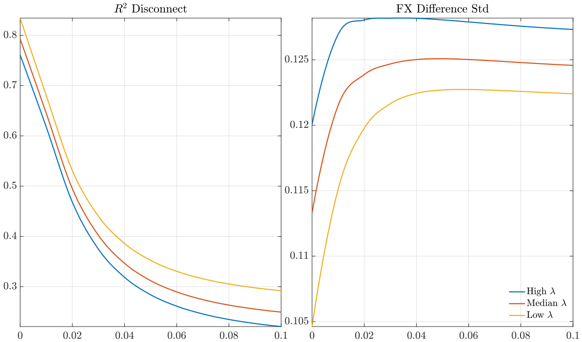
When λ increases, prices become more noisy and traders tend to put more weight on their private signal.

Summary theoretical results (cont'd)

- Not surprisingly, the two amplification channels add up: effects of fundamental (noise) innovations are dampened (amplified).
- Non-linear relationship: amplification/dampening of each channel depends on the other dimension of heterogeneity.
- The presence of strategic behavior amplifies cross-sectional dispersion in price expectations.

Implications for FX Dynamics

The amplification of non-fundamental trading increases the volatility of Δs_t and reduced its connection to fundamentals.



Hump shape dynamics in the volatility of Δs_t as for price dispersion.

Summary theoretical results (cont'd)

- Not surprisingly, the two amplification channels add up: effects of fundamental (noise) innovations are dampened (amplified).
- Non-linear relationship: amplification/dampening of each channel depends on the other dimension of heterogeneity.
- The presence of strategic behavior amplifies cross-sectional dispersion in price expectations.
- Both channels make exchange rate more disconnect and more volatile.

Data and Calibration

- Data for FX from Datastream/Reuters:
  - (Unbalanced) Panel of 12 currencies, both emerging and advanced: EUR, AUD, CAD, GBP, JPY, CHF, MEX, TRY, ARS, CLP, BRL, RUB (all against USD).
  - Monthly frequency, from 1980M1 to 2019M12.
  - 1-month interest rate differentials.
- Data on FX concentration from the NYF FXC Survery, 2005-2020.
- FX Expectation dispersion from ECB Professional Forecasters, 2002-2020.
  $\hookrightarrow$ Future: currency-specific additional data (Consensus Economics).
- SMM to match few moments (see next slides): 150 periods for 100 repetitions.
- We consider persistent noise trading to better match data.

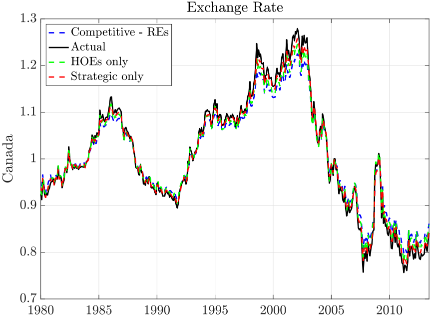
Data and Calibration (cont'd)

	Value	Moment - Target	Data	Model
λ	0.6	Share transactions top dealers (1st quintile) in NYFXC		
N	4	Number of top dealers (1st quintile) in NYFXC		
ρ_u	0.85	Average persistence AR(1) Δi_t		
σ_u	0.0088	Average std innovation AR(1) Δi_t		
$\sigma(\Delta s_t)$	0.04	(Average) Std FX change		
σ_η	0.012	Same Quarter FX Dispersion	0.02	0.017
σ_x	0.0352	$\sigma(\Delta s_t)$	0.04	0.041
ρ_x	0.9	FX RW/Average R^2	0.024 (0.006)	0.0055
ρ	20	UIP deviation level	-1.24	-0.84
b	0.33	Home Bias		
$\bar{k}$	10			

Counterfactual Decomposition

- We calibrate the HOE-Strategic investors model to match real data and filter the underlying states.
- Using the filtered states, we generate counterfactual series for the exchange rate of each currency. We consider:
  - Competitive - REs world (benchmark) ($\lambda = 0$,$\sigma_\eta = 0$);
  - Strategic heterogeneity ($\lambda > 0$,$\sigma_\eta = 0$);
  - Information heterogeneity ($\lambda = 0$,$\sigma_\eta > 0$).
- Comparing counterfactual FXs, we quantify the relevance of each dimension of heterogeneity for i) exchange rate disconnect and ii) excess volatility.

Decomposition Example: CAD



- Left panel: Actual (HOE + Strategic) exchange rate vs counterfactual series.
- Right panel: We normalize the Competitive-REs exchange rate (our benchmark) to one and plot the amplification due to each channel.

Decomposition: Disconnect

For each counterfactual scenario and each currency, we compute the Root Mean Square Error of the ER disconnect regression.

	Full Model (Actual Data)	Competitive - REs Benchmark	Excess Disconnect	Share HOE	Share Strategic Behavior	Non linearity
CAD	0.0190	0.0131	0.4560	0.7478	0.2774	-0.0252
GBP	0.0306	0.0209	0.4599	0.7262	0.2926	-0.0187
EUR	0.0348	0.0239	0.4564	0.7048	0.3096	-0.0144
JPY	0.0384	0.0264	0.4579	0.6633	0.3415	-0.0048
CHF	0.0376	0.0258	0.4586	0.6981	0.3127	-0.0108
AUD	0.0359	0.0247	0.4513	0.7264	0.2913	-0.0178
MEX	0.0375	0.0233	0.6080	0.7069	0.2898	0.0033
CLP	0.0372	0.0247	0.5034	0.7375	0.2826	-0.0202
BRL	0.0707	0.0780	-0.0931	1.9415	-0.5742	-0.3673
RUB	0.0742	0.0454	0.6080	0.6190	0.3348	0.0462
TRY	0.1502	0.3169	-0.5260	1.1573	0.4759	-0.6332
ARS	0.4546	0.2387	0.9048	0.3229	0.2779	0.3992
Median	0.085	0.072	0.40	0.81	0.24	-0.05

Table: Decomposition FX Disconnect - RMSE

- FX is around 40% more disconnect than in a Competitive-REs world.
- 80% (25%) of this excess disconnect is due to the presence of dispersed information among investors.
- Improvements in predictive power in the benchmark world is statistically small but, potentially, economically relevant (carry trade industry based on R^2).

Decomposition: Volatility

We run the counterfactual decomposition for each currency and compute FX difference volatility in each scenario.

	Full Model (Actual Data)	Competitive - REs Benchmark	Excess Volatility	Share HOE	Share Strategic Behavior	Non linearity
CAD	0.0191	0.0131	0.4605	0.7491	0.2752	-0.0243
GBP	0.0309	0.0211	0.4615	0.7252	0.2934	-0.0186
EUR	0.0350	0.0240	0.4578	0.7044	0.3099	-0.0142
JPY	0.0387	0.0265	0.4590	0.6616	0.3427	-0.0043
CHF	0.0379	0.0260	0.4591	0.6961	0.3144	-0.0105
AUD	0.0359	0.0247	0.4542	0.7270	0.2903	-0.0173
MEX	0.0375	0.0233	0.6095	0.7073	0.2891	0.0035
CLP	0.0371	0.0248	0.4978	0.7354	0.2847	-0.0201
BRL	0.0709	0.0928	-0.2364	1.3019	-0.1243	-0.1776
RUB	0.0756	0.0480	0.5729	0.5947	0.3544	0.0508
TRY	0.1500	0.3262	-0.5401	1.1483	0.4553	-0.6036
ARS	0.4607	0.2994	0.5387	0.0843	0.4569	0.4588
Average	0.086	0.079	0.35	0.74	0.29	-0.03

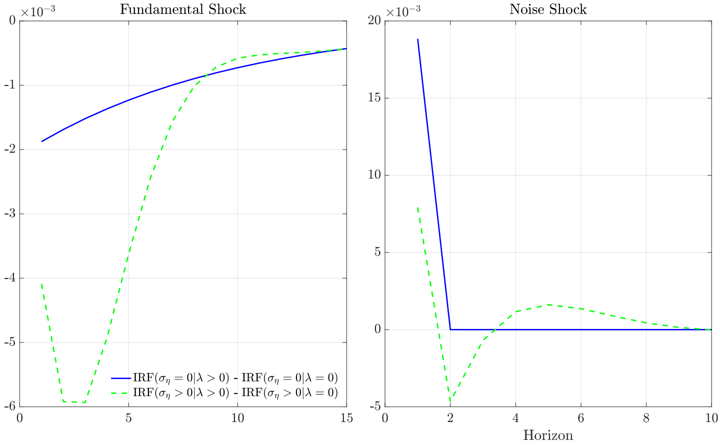
Table: Decomposition FX Volatility

- FX is around 35% more volatile than in a Competitive-REs world.
- 75% (30%) of this excess volatility is due to the presence of information heterogeneity.

Conclusion

- Investors' heterogeneity matters both for ER disconnect and excess volatility. FX is 30-40% more disconnected and more volatile than in a competitive - REs benchmark world.
- Both margins of heterogeneity are quantitatively relevant, with a slightly more relevant role for dispersed information.
- Even though the model provides theoretical predictions for non-linear interaction between the two dimensions of heterogeneity, it seems that they are quantitatively non relevant.
  $\hookrightarrow$ Still need to investigate this aspect better, we are not using currency specific calibration due to lack of data.

Non-linear interaction (cont'd)



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Solution Algorithm

Calibration Qualitative Results

Table: Calibration used for qualitative results.

Parameter	λ	N	σ_x	σ_u	σ_u	ρ_u	$\bar{k}$	ρ	b
Value	0.7	4	1	0.1	0.02	0.9	10	50	0.33

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