ORDER FLOW AND EXCHANGE RATE DYNAMICS

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MOTIVATION: MICROSTRUCTURE MEETS EXCHANGE RATE ECONOMICS

> Omitted variables is another possible explanation for the lack of explanatory power in asset market models. However, empirical researchers have shown considerable imagination in their specification searches, so it is not easy to think of variables that have escaped consideration in an exchange rate equation.
>
> Richard Meese (1990)

MOTIVATION

Different exchange rate models

- **"...the most critical determinants of exchange rate volatility are not macroeconomic."**

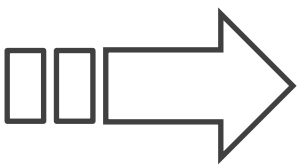
  Flood and Rose (1995)

  - Macro fundamentals like **interest rates, money supplies, trade balances can't explain** monthly exchange rates changes.

- Alternative explanations:
  - Exchange Rate determinants include extraneous varibles
  - Tipycally modeled as rational speculative bubbles (Blanchard 1979, Dornbusch 1982, Meese 1986, Evans 1986, among others);
  - Irrationality
  - Exchange rates may be determined in part from avoidable expactational errors (Dominguez 1986, Frankel & Froot 1987, and Hau 1998 , among others).

- This paper moves in a new direction:

THE MICROECONOMICS OF ASSET PRICING



MOTIVATION

The microeconomics of asset pricing

- Using tools from the field of microstructure finance;
- Focus on new variables that have escaped the consideration of **macroeconomics**...
- ...**the** most important of which is order flow.

Order flow

- Measure of buying / selling pressure
- Net of buyer initiated orders and seller initiated orders
- Proximate determinant of prices in all microstructure models

BID	PRICE	ASK
	102	789
	101	1234
	100	
1111	99	

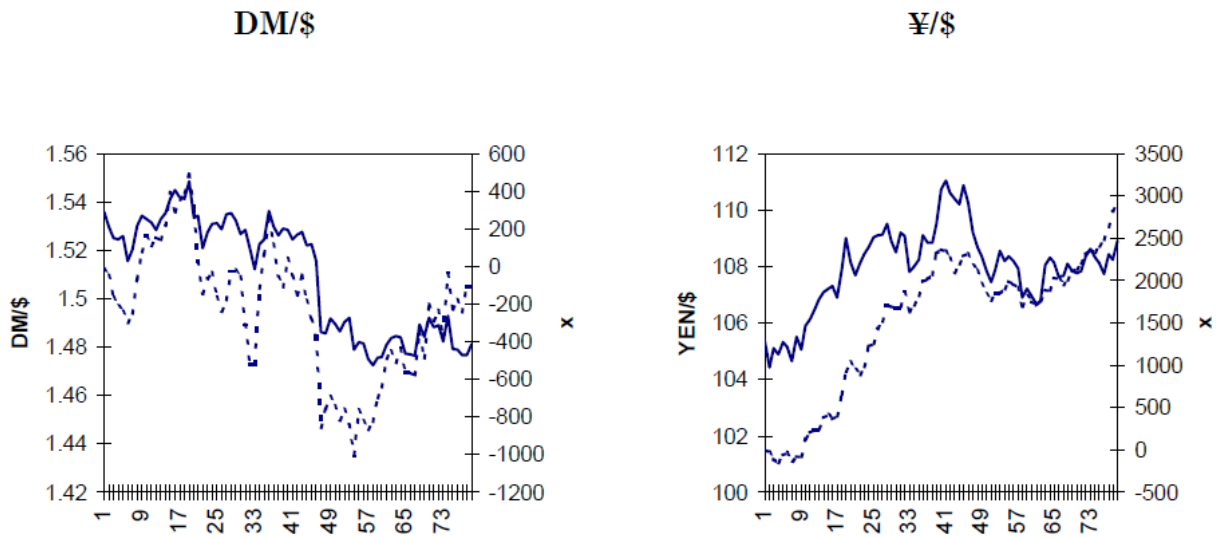
FROM ORDER FLOW TO PRICE

HOW IS IT DETERMINED? IS IT RELEVANT?

MOTIVATION

Hints that order flow matter for exchange rate determination

- Four Months of Exchange Rates (solid) and Order Flow (dashed):
  May 1-August 31, 1996



- The developed model that formalizes this relationship accounts for:
  - 60% of daily changes in the DM/$;
- For comparison, macro models rarely manage to account for 10% of monthly changes.

MOTIVATION

Models of exchange-rate determination: the asset approach

- Models of exchange-rate determination within the asset approach:

$$\Delta P_t = f(i, m, z) + \varepsilon_t$$

- Where,
  ΔP_t= change in the nominal exchange rate over the period
  i= current and past values of home and foreign nominal interest rates
  m= money supplies
  z= other macro determinants (e.g., home and foreign real output

- 2 assumptions of these models

  1. all information relevant for exchange rates is publicly known;
  2. the mapping from that information to prices is also publicly known.

- If either assumption is relaxed, then order flow can convey information that is relevant for prices.

2 MODELS: SPANNING THE MICRO-MACRO DIVIDE

STRUCTURAL MODELS: MACRO APPROACH

$$\Delta p_t = f(\Delta i, \Delta m, \dots) + \varepsilon_t$$

- Where,
  Δp_t= change in the nominal exchange rate over the period
  Δi = current and past values of home and foreign nominal interest rates
  Δm = money supplies
  … = other macro determinants

- Changes in variables (publicly known) drive price;
- No role for order flow – trades have no distinct role in determining the price
- Coherent and appealing models…
- …but not able to account almost none of the monthly exchange rate variation

STRUCTURAL MODELS: MICROSTRUCTURE APPROACH

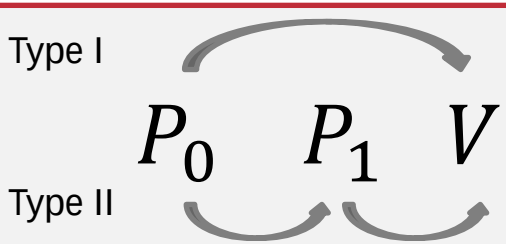
$$\Delta p_t = g(\Delta x, \Delta I, \ldots) + v_t$$

- Where,
  Δp_t= change in the nominal exchange rate over the period
  Δx = order flow
  ΔI= change in net dealer positions (/inventory)
  ... = other micro determinants

- Derived from the optimization problem faced by price setters in the market.
- Trades have a leading role
- Microstructure models predict a positive relation between Δp and Δ x because order flow communicates private information, and once communicated, it is reflected in price.

Two types of Private information

- Type I: Private information about the size of the payoff
- Type II: Information about interim prices



SPANNING THE MICRO-MACRO DIVIDE

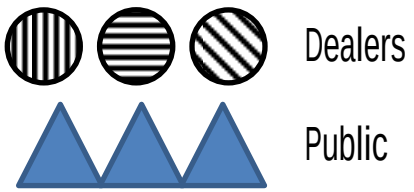
$$\Delta p_t = f(\Delta i, \dots) + g(\Delta x, \dots) + \boldsymbol{\eta}_t$$

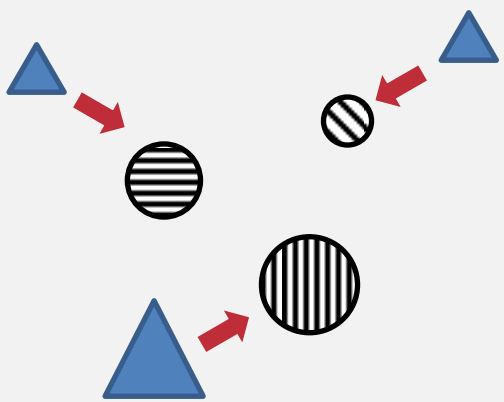
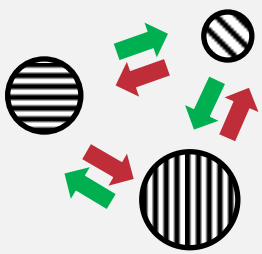
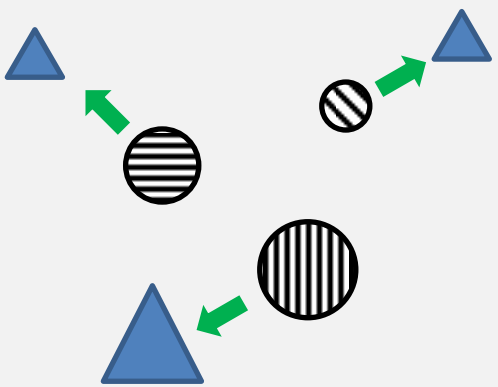
MODEL WITH COMPONENTS FROM BOTH MICRO AND MACRO APPROACHES

3 PORTFOLIO SHIFTS MODEL

PORTFOLIO SHIFTS MODEL: OVERVIEW

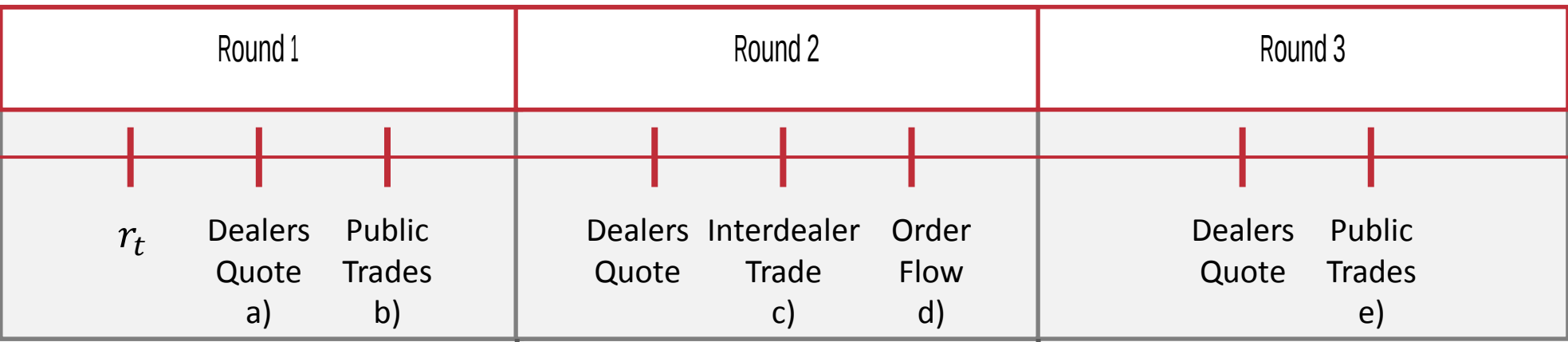
- Portfolio shifts on the part of the public:
  1. Not common knowledge when they occur
  2. Large enough that clearing the market requires adjustment of the exchange rate



I – Beginning of the day	II – During the day	III – End of the day
		
Public Portfolio shifts occur	Inventory risk sharing among dealers	Inventory risk sharing with the public

PORTFOLIO SHIFTS MODEL: IN DETAIL

- Pure exchange economy with T periods and two assets: one risk-free; and, one with a stochastic payoff representing foreign exchange : $F = \sum_{t=1}^{T} r_t$
- The increments r_t are observed before trading in each period and represent the flow of publicly available macroeconomic information



a) Round-one price of Dealer i = P_{i1}

b) Net customer-order realization c_{i1}, executed at price P_{i1}

For example, $c_{i1} < 0$ denotes a net customer sale (dealer i purchase)

c) Interdealer trade initiated by dealer i in round 2 = T_{i2}

d) Order Flow = $\Delta x = \sum_{i=1}^{N} T_{i2}$

e) Public total demand for the risky asset:

$c_3 = \gamma(E[P_{3,t+1}|\mathbf{\Omega}_3] - P_{3,t})$,

Where,

γ captures the aggregate risk-bearing capacity

$\mathbf{\Omega}_3$ is the public information in round 3

EQUILIBRIUM

Equilibrium

- **Dealer's** problem is defined over four choice variables:

$$P_{i1}, P_{i2}, P_{i3} \text{ and } T_{i2}$$

- Intuition: Prices would be equal if they were formed by common information only. But the only common information only happens at the beginning of Round 1 with r_t and order flow is not observed until the end of round 2.
  - P_3 reflects the information in both r_t and Δx ;
  - If Δx influences the price depends on if it communicates any relevant information. Does it? Yes.

- Why?
  - In Round 2, each dealer trades according to the trading rule $T_{i2} = \alpha\, c_{i1}$
  - At the end of Round 2, dealers observe the interdealer order flow, $\Delta x = \sum_i T_{i2}$. They can infer the aggregate portfolio shift (from the public) that happened in Round 1 and also know that they will have to "push" the public to re-absorb this shift in round 3, causing a price adjustment.

FROM ORDER FLOW TO PRICE

HOW IS IT DETERMINED?

THE PRICING RELATION

- The change in price from the end of period t-1 to the end of period t is:

$$\Delta P_t = r_t + \boldsymbol{\lambda}\,\Delta x$$

- $\boldsymbol{\lambda}$ is a positive constant;
- $\boldsymbol{\lambda}\,\Delta x$ = portfolio shift term »»» reflects the price adjustment required to induce re-absorption of the public's portfolio shift from round 1;
- Note: at Round 3, $c_3 + \sum_i c_{i1} = 0$ »»» Dealers end Round 3 without positions.

FROM ORDER FLOW TO PRICE
HOW IS IT DETERMINED?

EMPIRICAL IMPLEMENTATION

$$\Delta P_t = r_t + \boldsymbol{\lambda}\Delta x$$

- To turn into an estimable model, we need to define what the increments r_t are.
  Remember, these are public-information increments .
- The authors decided to focus on nominal interest differential:
  - r_t= Δ(i_t-i_t*), where i_t is the nominal dollar interest rate and i_t* is the nominal non-dollar interest rate.
- The resulting regression model is:

$$\Delta P_t = \beta_1 \Delta(i_t - i_t) + \beta_2 \Delta x + \boldsymbol{\eta}_t$$

4 DATA

DATA

- Data set contains time-stamped, tick-by-tick data on actual transactions for the two largest spot markets—DM/$ and ¥/$—over a four-month period, May 1 to August 31, 1996.
- Data collected from the Reuters Dealing 2000-1 system, which at the time of the paper, accounted for over 90 percent of the world's direct interdealer transactions.
- 3 noteworthy features of the data:
  - Provide information for the whole interbank market over the full trading day;
  - Broader view on market data than the one dealers had at the time they were trading;
  - Long time span (4 months) when compared with other micro data sets.
- The change in interest differential, D(it–it*), is calculated from the daily overnight interest rates for the dollar, the deutschemark, and the yen (annual basis); the source is Datastream.

5 EMPIRICAL RESULTS

EMPIRICAL RESULTS: IN-SAMPLE FIT

In-sample fit of portfolio shifts model

- The following equation is estimated using daily data for the DM/$ and Yen/$:

$$\Delta p_t = \beta_1 \Delta(i_t - i_t^*) + \beta_2 \Delta x_t + \boldsymbol{\eta}_t$$

			Diagnostics		
	$\Delta(i_t - i_t^*)$	Δx_t	R^2	Serial	Hetero
DM	0.52 (0.35)	2.10 (0.20)	0.64	0.78 0.41	0.08 0.02
Yen	2.48 (0.92)	2.90 (0.46)	0.45	0.50 0.37	0.96 0.71

EMPIRICAL RESULTS: ROBUSTNESS

Might the order-flow/price relation be non-linear?

- Adding a squared order-flow term proves to be insignificant in both equations.
- Nonetheless, Yen estimates show signs that buying pressure and selling pressure are not symmetric – to be precise there is a greater sensitivity of price to order flow in the downward direction.

Does the order-flow/price relation depend on the gross level of activity?

- Is order flow state contingent,? (depending on total market activity)
  - For DM and Yen, the data is partitioned in four different groups, according to the quantity of transactions, and then order-flow coefficients are estimated again for each one.
  - In both the DM and Yen equations, all four of the order-flow coefficients are positive.

Does the order-flow/price relation depend on day of the week?

- Similar to the previous state contingency hypothesis but now for each day of the week.
  - In both the DM and Yen equations, all order-flow coefficients are positive.

EMPIRICAL RESULTS: CAUSALITY

Not simply "regressing price on quantity"

- In the model causality runs strictly from order flow to price but there are certainly alternative hypotheses under which causality may be reversed.

Theoretical Overview

Anticipation hypothesis	Pressure hypothesis	Feedback hypothesis
- Order flow can precede price because price adjusts only after the news anticipated by order flow is commonly observed; - Order flow might also precede price because price adjusts only after order flow itself is commonly observed	- Observing order flow provides information about payoffs; - order flow alters equilibrium risk premia.	- Positive-feedback trading involves systematic buying in response to price increases, and selling in response to price decreases. Negative-feedback trading is the reverse.

Empirical Reality

- Anticipation, Pressure, and Feedback may produce a relationship that appears contemporaneous;
- Arguments defense delve around :
  - Intraday positive feedback is an unappealing hypothesis
  - Analysis of bias to understand how extreme the feedback would have to be to be accountable.

EMPIRICAL RESULTS: OUT-OF-SAMPLE FORECASTS

Out-of-sample forecasts errors

- The table below shows that the portfolio shifts model produces better forecasts than the random-walk (RW) model.

		RW	Portfolio Shifts	Difference
	Horizon			
DM	1 day	0.44	0.29	0.15 (0.033)
	1 week	0.98	0.63	0.35 (0.245)
	2 weeks	1.56	0.96	0.60 (0.419)
Yen	1 day	0.40	0.32	0.08 (0.040)
	1 week	0.98	0.64	0.33 (0.239)
	2 weeks	1.34	0.90	0.45 (0.389)

6 DISCUSSION

DISCUSSION

> Perhaps the most important missing generalization in almost all work on asset prices thus far has been uncertainty about the demand curves (via uncertainty about endowments or preferences) of other investors. This injects a form of endogenous uncertainty into the economy that may be on a par with exogenous uncertainty about fundamentals.
>
> Rubinstein (2000)

- There are links that need to be explored. For example, for convenience, portfolio shifts in this model are exogenous but they can be related to macroeconomic variables...
  - ...or maybe outside the traditional set, necessitating a broader definition of what we mean by "fundamentals".
  - ➢ If order flow drives exchange rates, then what drives order flow?

- The Practitioner View versus the Academic View
  - "Walrasian auctioneer" way of thinking from economists vs. "Transition to new prices" view from practicioners (with the role of a dealer)

7 CONCLUSION

CONCLUSION

- New kind of exchange rate determination model, relying on a microstructure determinant – order flow – in addition to a macroeconomic determinant.

- The developed Portfolio Shifts Model is successful in accounting for realized rates:
  - more than 50 percent of daily changes in the DM/$ rate and more than 30 percent of daily changes in the Yen/$ rate;
  - Out of sample, the model produces better short-horizon forecasts than a random walk.

- Existence of benefits of using both macro and microstructure approaches.

QUESTIONS

- What is Order Flow?
- Which assumptions from traditional exchange-rate determination models would have to be relaxed for order flow to exert influence on prices?
- What is the role of public vs. private information in the Portfolio Shifts Model?