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The price formation of substitute markets

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Introduction

- Price discovery: the process by which private information implicit in investor trading is revealed in subsequent price formation.

- Price formation models:
  - Hasbrouck (1991a,b): Signed trade size
  - Madhavan, Richardson and Roomans (1997): trade direction
  - Dufour and Engle (2000): time between trades
  - Al-Suhaibani and Kryzanowski (2000): order size
  - Chng (2005): trade and net order sizes.

- All of the above are single market models, although some models consider two or more trading parameters.

Literature review

- J. Financial Markets dedicated a special issue [5(3), 2002] to the two commonly used measures of cross market price discovery:
  - Gonzalo & Granger (1995) common factor weights (JBES):
    - Computes the coefficient of error correction terms to infer orthogonal weights on the efficient price contributed by various price sequences.
  - Hasbrouck (1995) information share (JF):
    - Computes contribution to the variance of the efficient price change by various price sequences.
  - Both consider only price parameters of multiple markets.

Main objectives

- Derive a joint trade direction model (JTDM) from the single market MRR (1997) trade direction model.

- Demonstrate the use of the JTDM and test it against the VECM using a comprehensive sample of 20 Chinese twin-board firms (A-B & A-H)
  - Lee and Rui (2000), Sun and Tong (2000), Wang and Jiang (2004) and Yeh, Lee and Pen (2004) use a sample period that is prior to either or both:
    - Feb 2001: Locals with forex accounts can trade B-shares
    - Dec 2002: QFII are allowed to trade A-shares

- This becomes a test of the relevance of price versus non-price parameter in cross market price formation.

The MRR (1997) model

- Highlights the role of lag 1 autocorrelation in trade direction ρX_{t-1} in price formation.
  - X_t assumed to follow a general Markov process
  - The model considers 3 states S: {+1, 0, -1}
  - 3x3 transition matrix
  - Transition of X_t illustrated in Figure 1

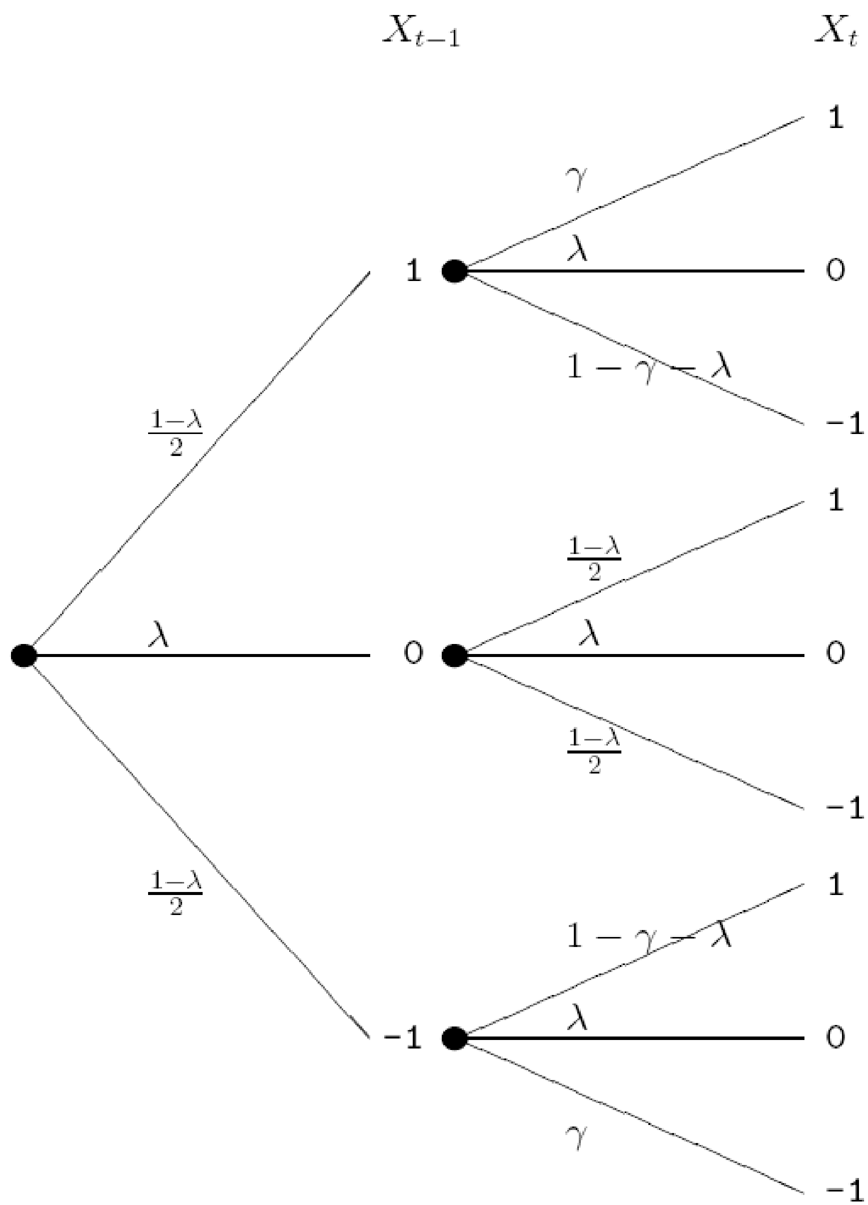

Figure 1: Transition diagram of MRR model

The MRR (1997) model

$$u_t = u_{t-1} + \theta(X_t - E[X_t \mid X_{t-1}]) + \varepsilon_t$$

$$p_t = u_t + \phi X_t + \xi_t$$

$$*E[X_t \mid X_{t-1}] = \rho X_{t-1}, \text{ where } \rho = 2\gamma - (1 - \lambda)$$

$$r_t = \Delta p_t = [\theta(1 - \rho L) + (1 - L)\phi] X_t + \Delta \xi_t + \varepsilon_t$$

Our model

- A bivariate system that highlights the joint trade direction (X_t, Y_t) in price formation.
  - (X_t, Y_t) assumed to follow a general Markov process
  - We consider 4 states S:{(1,1), (1,-1), (-1,1), (-1,-1)}
  - 4x4 transition matrix
  - Transition of (X_t, Y_t) illustrated in Figure 2

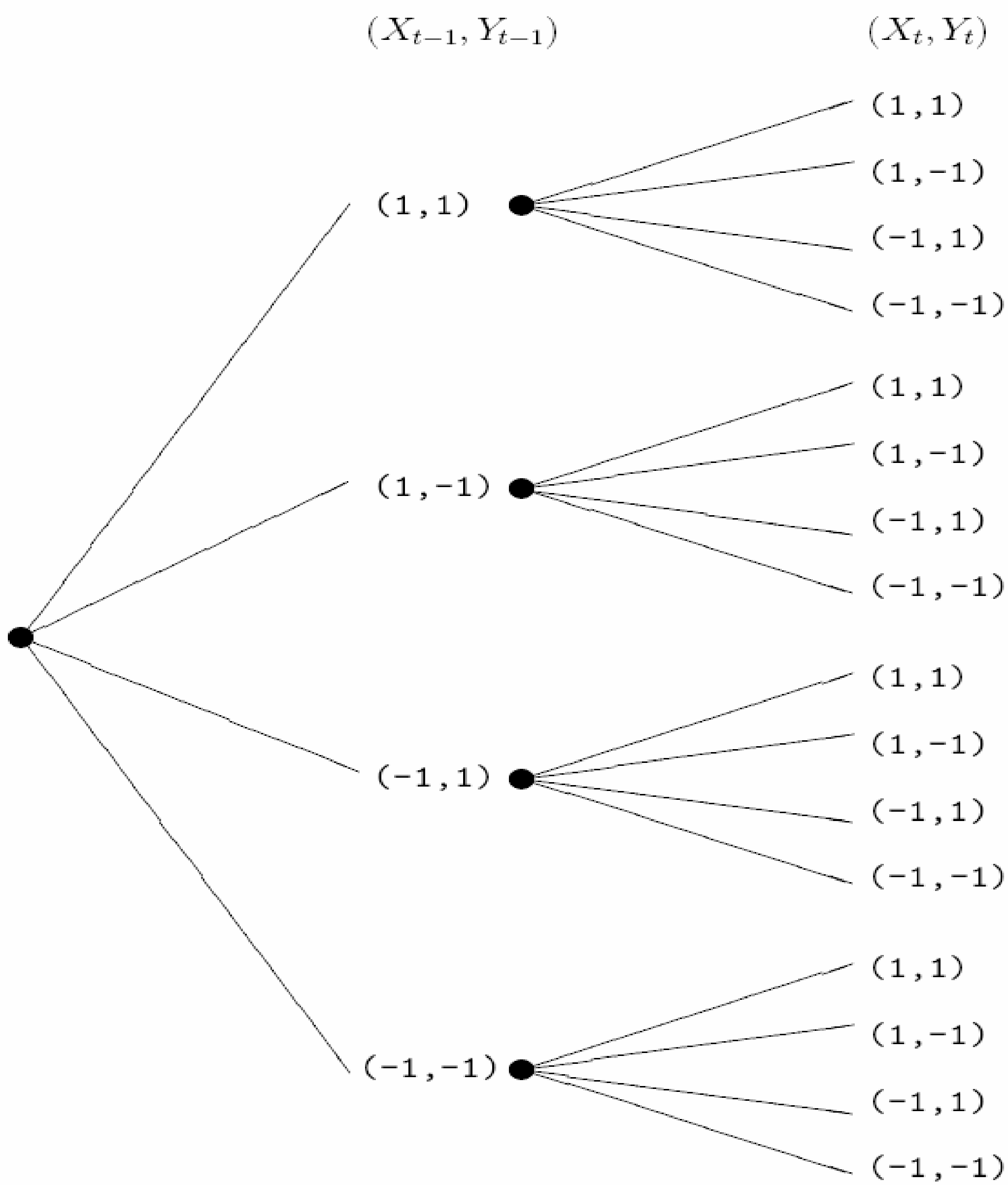

Figure 2: Transition diagram of $\{(X_t, Y_t)\}$

Categorizing the 16 transitions

- Full continuation: Pr $(X_t = X_{t-1}, Y_t = Y_{t-1} | X_{t-1}, Y_{t-1}) = \gamma$
- X-continuation: Pr $(X_t = X_{t-1}, Y_t = -Y_{t-1} | X_{t-1}, Y_{t-1}) = \lambda_X$
- Y-continuation: Pr $(X_t = -X_{t-1}, Y_t = Y_{t-1} | X_{t-1}, Y_{t-1}) = \lambda_Y$
- Full reversal: Pr $(X_t = -X_{t-1}, Y_t = -Y_{t-1} | X_{t-1}, Y_{t-1}) = (1-\gamma-\lambda_X-\lambda_Y)$

The model's focus

- To infer Pr (X-continuation) = λ_X
  Pr (Y-continuation) = λ_Y

- Conditional on opposite trade directions observed at t-1, the JTDM measures which market is more likely to persist in the same direction i.e. continuity.

- This has a natural interpretation as a measure of price leadership/discovery.

Bivariate structural system

$$u_t = u_{t-1} + \theta(X_t + Y_t - E[X_t + Y_t \mid X_{t-1}, Y_{t-1}]) + \varepsilon_t$$

$$p_t^X = u_t + \phi^X X_t + \xi_t^X$$

$$p_t^Y = u_t + \phi^Y Y_t + \xi_t^Y$$

$$*E[X_t + Y_t \mid X_{t-1}, Y_{t-1}]) = \rho X_{t-1} + \delta Y_{t-1},$$

where $\rho = 2(\gamma + \lambda^X) - 1$ and $\delta = 2(\gamma + \lambda^Y) - 1$

$$\rightarrow \rho - \delta = 2(\lambda^X - \lambda^Y)$$

$$r_t^X = (\theta + \phi^X)\Delta X_t + \theta\Delta Y_t + \theta(1-\rho)X_{t-1} + \theta(1-\delta)Y_{t-1} + \omega_t^X$$

$$r_t^Y = (\theta + \phi^Y)\Delta Y_t + \theta\Delta X_t + \theta(1-\rho)X_{t-1} + \theta(1-\delta)Y_{t-1} + \omega_t^Y$$

Twin-share Chinese firms

- Why Chinese market?
  - Chinese financial markets attracting increasing attention
  - Multiple exchanges (SHSE, SZSE HKEx) and multiple listing boards (A, B, H)
  - Similar institutional characteristics
  - Large number of twin-board firms; overlapping trading hours.

- Some institutional details
  - SHSE: A-shares in RMB; B-shares in USD
  - SZSE: A-shares in RMB; B-shares in HKD
  - HKEx: H-shares in HKD
  - A, B, H, A-B or A-H, but not B-H.

- Either the B or H board provides access to a substantial foreign investor clientele, although they are not foreign boards per se.

Sampling methodology

- For all firms that are selected:
  - Tradable share ≥ 30% of issued capital (2005 overall average)
  - Must have ≥ 10% of issued capital allocated to each board.
  - Tradable capital on the smaller board is ≥ 1/5 that which is issued on the larger board.

Overall sample

- A pair of A-B and A-H firms for each of 10 sectors of the Chinese economy.

- Sample period: 4^{th} Jan~30^{th} Sep 05 (≅ 170 days).

- Each day has 100 min-by-min trade observations.
  - All 3 exchanges host a morning and afternoon session
  - Restrict to overlapping trading hours on both sessions
  - 10:05-11:24; 14:35-14:54

Testing methodology

- Apply GMM procedure on the bivariate system to estimate the 5 trading parameters.
  - Specify 6 moment conditions

$$E\begin{bmatrix} X_t X_{t-1} - \rho X_{t-1}^2 \\ Y_t Y_{t-1} - \rho Y_{t-1}^2 \\ \omega_t^X X_{t-1} \\ \omega_t^X Y_{t-1} \\ \omega_t^Y X_{t-1} \\ \omega_t^Y Y_{t-1} \end{bmatrix} = 0$$

Testing methodology

- Apply VECM & JTDM to rank twin boards for each of 20 firms.
- When models give conflicting rankings, apply Wald test and J-test statistics to model selection.
  - Either of both tests favour one model over the other
  - Both test statistics are conflicting or fail to reject both models.

Main results

- VECM and JTDM give consistent ranking in 6 firms; 3 firms (Southern Airline, China Shipping and ZTE Corp) provide strong evidence of H-board performing price discovery.

- Wald and J tests indicate VECM (JTDM) as the preferred model for 3 firms. In all 3, the B/H (A) board is ranked above the A (B/H) board.
  - JTDM ranks A above B/H for the 3 firms with the highest % of no-trade in their B/H samples.

- VECM and JTDM generate conflicting rankings in 8 out of 10 A-B firms. Subsequent Wald and J tests fail to reject both models in 7 of those 8 firms.
  - Unable pick up distinctions in trading since the boards themselves are no longer distinct.