Price Discovery in Currency Market

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INTRODUCTION

- Price discovery is a process by which new information is timely and efficiently incorporated into market prices of the assets.
- When the same asset (or an asset with similar attributes) is traded in multiple markets, the question that arises is: which market incorporates the new information first, or, which market leads the price discovery process?
- Most commonly used techniques are Information Share(IS) proposed by Hasbrouck (1995), and Component Share(CS)
- The approaches are based on the common implicit efficient price that is contained in the observed price of a security and can be estimated using a vector error correction model (VECM) framework
- The technique of interest: Hasbrouck's IS focuses on the variance of the efficient price innovation, and measures what proportion of the efficient price variance can be attributed to the innovations from different markets

DATA DESCRIPTION

- The work cover the spot and futures market for the term of February 2010 to August 2018
- The data for Futures Market is obtained from Metropolitan Stock Exchange of India (formerly MCX-SX)
- The data for spot prices is obtained from CNBC website

FUTURE RESEARCH

- The inherent limitation with the Hasbroucks's measure is the lack of a unique value of Information share as it considers random ordering of market equations which doesn't take into account various observed phenomenons in financial assets.
- The future work would be focussed on method proposed by Grammig and Peter (2013) which provides unique Information share values by incorporating the idea of fat tails and Tail dependence that are prevalently observed in financial markets but lack the theoretical reasoning.
- The other possible addition in future would be finding the evidence of speculation in futures market based on various measures like "T" index of Working (1953)
- The same model can also be contributed to multiple markets, that is combining multiple forex pairs with INR as they have same attributes, for instance, YEN/INR, POUND/INR, EURO/INR

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METHODOLOGY

Model Specification

Let $\mathbf{p}_{i,t} = (p_{1,t}, p_{2,t})'$ denote a vector of (log) prices of a security traded on two distinct markets, 1 and 2, such that

$$\mathbf{p}_{i,t} = (p_{1,t}, p_{2,t}) \sim I(1)$$

Since the prices represent the same security, the two prices are linked by the force of arbitrage and cannot deviate from each other in the long run. The two price series are thus cointegrated and the linear relationship is expressed as

$$p_{1,t} = \beta p_{2,t} + \mu_t$$

where $\mu_t \sim I(0)$, $\beta = (1, -\beta)'$

Note that the analysis is based on cost-to-carry that says that buying in the future at a price agreed today must be equivalent to buying at the current price and storing (carrying) the underlying asset until a future date. Arbitrage should be impossible atleast in long term which gives cointegrating relationship:

$$f_t^T = \theta + \beta s_t + \epsilon_t$$

where f_t^T is the log of future price of asset at time t, with delivery (expiration) date **T**.θ contains the cost to carry and other financing costs.s_t is the log of spot price

VECM representation for k lags: $\Delta \mathbf{p}_t = \alpha\beta' \mathbf{p}_{t-1} + \Gamma_1 \Delta \mathbf{p}_{t-1} + \ldots \Gamma_k \Delta \mathbf{p}_{t-k} + \epsilon_t$

where α represents the coecient associated with the error correction term, ϵ is a 2X1 vector of residuals with $\epsilon_t \sim N(0, \Omega)$. Since the price changes are assumed to be covariance stationary, the vector moving average (VMA) or the Wold representation is given as:

$$\mathbf{p}_t = \mathbf{p}_0 + \Psi(1)\Sigma_{s=0}^{t} \epsilon_s + \Psi^*(L)\epsilon_t$$

where $\Psi(L) = \sum_{s=0}^{\infty} \Psi_s L^s$. The Beveridge-Nelson decomposition can be used to derive the common trends representation in the levels prices:

$$\Delta \mathbf{p}_t = \Psi(L)\epsilon_t$$

where $\Psi(1) = \Sigma_{k=0}^{\infty} \Psi_k$. In the above equation, the matrix $\Psi(1)$ contains the cumulative impact of innovation on all future price movements and thus measures the long run impact of innovations on prices.

Hasbrouck (1995) shows that since both the price series represent an identical security, the long run impact of innovation on each of the price series should be the same. Thus, in principle, the rows of $\Psi(1)$ are identical.

Information Share

$\psi\epsilon_t$ is the incremental change in price that is permanently impounded into the security prices and is presumably due to new information (captured in ϵ_t). Hasbrouck (1995) proposes the use of the structure of the variance of this component to derive the measure of price discovery

$$var(\psi\epsilon_t) = \psi\Omega\psi'$$

If Ω is not diagonal, that is, if the price innovations are correlated, the proposed measure has the problem of attributing the covariance terms to each market. To overcome this problem, Hasbrouck (1995) suggested the use of triangularization/Cholesky decomposition of Ω and measure IS using the orthogonalized innovations.

Let 'F' be a lower triangular matrix such that FF' = Ω. The IS for the jth market is then defined as:

$$IS_j = \frac{([\psi' F]_i)^2}{\Psi\Omega\Psi'}$$

The resulting IS will depend on the ordering of price variables. The upper bound of IS of a particular market can be obtained by placing that market's price rst. Similarly, a lower bound can be obtained by placing that market's price the last. For `n' markets, by doing all the permutations, one can obtain the obtain the upper and lower bound of IS for each market. In our case, there are just 2 markets so we get a pair of upper and lower bound for each market.

RESULTS

On performing the simulation on **R**, using the **'ifrogs'** package, developed by IGIDR Financial Research Group, we obtained the following results:

Information Share for Spot markets lie between : **7.54% (lower bound) - 26.65% (upper bound)**
Information Share for Futures markets lie between : **73.34% (lower bound) - 92.46% (upper bound)**