

**Free Lunch!**  
**Arbitrage Opportunities in the Foreign Exchange Markets**

Takatoshi Ito, Kenta Yamada, Misako Takayasu, and Hideki Takayasu

**Abstract:**

Using the firm quotes obtained from the EBS (electronic broking system that is a major trading platform for foreign exchanges) data, we found that risk-free arbitrage opportunities—free lunch—do occur in the foreign exchange markets within a few seconds. Arbitrage profit opportunities are in the form of negative spreads in a currency pair and as triangular arbitrage relationship involving three currency pairs. Arbitrage opportunities tend to occur when the markets are active and volatile. Over the 12 year sample period, the frequency of arbitrage opportunities has declined and the probability of disappearance after one second of emergence has increased, mostly due to the introduction of the Primary Customer system and the connection of computers of program traders to the EBS system directly. The probability of its disappearance after 1 second was less than 50% in 1998, but increased to about 90% by 2009. The volume of trade simultaneously on both ask and bid sides increases in one second after the an arbitrage opportunity emerges (controlling for time of the day, and volatilities in preceding seconds), suggesting the free lunch opportunities, when occur, prompt actual trades in an attempt of taking advantage of free lunch. (195 words)