Modeling regional linkage of financial markets

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A R T I C L E   I N F O

A B S T R A C T

With the development of globalization and regional economic integration, regional markets linked with a common currency emerge, in which investors from domestic market are allowed to trade in foreign markets. Empirical studies have evidenced extensively the existence of co-movement of asset prices or cross-correlation in market returns among these markets, especially in global event. However, there is no theoretical model in literature that can provide economically plausible justifications for these stylized facts. This research intends to fill up such a gap with a simplest possible nonlinear dynamic model. Based on the classical market-maker framework of Day and Huang (1990), a two-market HAM model is developed, which does not only prove in theory the existence of price co-movement but also replicate in simulation this typical characteristic, along with other well known stylized facts characterizing individual financial market. Moreover, theoretical analysis suggests meaningful implications for market opening policy. In particular, in terms of financial stability, a relatively small market may not benefit from market linkage and market opening is essentially a double-edged sword.

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1. Introduction

With the development of regional market integration, linkage among markets become stronger and common currency circulating within the region emerges. A typical example is Euro, which serves as the transaction currency for all financial markets within the euro-zone. Examples of regional asset markets include but are not limited to the Shanghai and Shenzhen stock exchange markets in China, and NASDAQ and New York stock exchanges in United States. The common transaction currency eliminates the need of currencies exchange so as to remove the impacts from the foreign exchange market. Along with financial market integration comes markets co-movement or cross-correlation, as it has been widely reported in empirical literature. Kenett et al. (2012b) find that developed Western markets are highly correlated. Egert and Kocenda (2011) find strong correlation among returns of Germany, France and UK, even up to 0.9. In addition, strong co-movement was observed when financial crisis spread to many markets in the past decades. Preis et al. (2012) show that average correlation among DJIA members increases with market stress. Kenett et al. (2012a) report that interdependencies between markets increase at times of global events. Regrettably, there is no theoretical model in literature that can simulate the prices with these stylized facts.

Heterogeneous agents models (HAM) have so far managed to calibrate successfully some of the financial market stylized facts related to individual financial market, among which are large trading volume, cluster volatility, returns distribution with fat tails, and unpredictable asset returns with almost no autocorrelation. For reference, we cite Huang and Day (1993),

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Lux (1995, 1998), Lux and Marchesi (2000), Brock and Lebaron (1996) and Farmer and Joshi (2002). There is a call to build a multi-market model with capability of not only replicating the stylized facts of prices co-movement, but also offering economically plausible explanations. Such model can enhance our understanding of the integrated financial system and further shed light on the study of the propagation mechanism of financial crisis. This research intends to fill up such a gap by building a simplest possible nonlinear dynamic HAM model. For this purpose, a market system composed of two markets linked by a common transaction currency is studied so that the investors are allowed to invest in both markets with no hassle of exchange rate. Such set up is shown to be able to replicate the typical characteristics for multi-markets system in additional to other well known stylized facts characterizing individual financial market.

Day and Huang (1990) introduce a stylized market maker framework in which two agent types, chartist and fundamentalist, invest in an asset market and a market maker updates price in each period. The model is in discrete time and exhibits complicated, chaotic price fluctuations around a fundamental price with random switching between bear and bull market episodes. Instead of the market maker framework, Brock and Hommes (1998) apply the Walrasian equilibrium concept in heterogeneous agents model. In their model, micro-foundation is built on a fitness measure, which is determined by the past realized profit. Every period, agent composition is determined by fitness measures. Agent aims to maximize investment profit and decides her supply and demand according to the chosen strategy. Market clears at the end of each period. This model is capable of explaining some stylized financial behaviors such as irregular switching among phases of price movements. However, LeBaron (2006) argue that the market clearing Walrasian equilibrium in every period has limitations. One of the limitations is that it may not represent the continuous trading of financial market accurately. Nevertheless, the combination of market maker and micro-foundation based on fitness measure develops in later literature such as Westerhoff (2004), He and Westerhoff (2005), Westerhoff and Dieci (2006), He and Li (2008) and Huang et al. (2010).

Majority of the heterogeneous agents models focus on a single market or one risky asset with reference to one riskless asset. Recently, the idea of heterogeneous agents is extended to price dynamics of multi-asset within a market, or even to the interactional dynamics of multi-markets. For example, Bohm and Wenzelburger (2005) investigate the performance of efficient portfolios in a financial market in which heterogeneous investors including rational traders, noise traders, and chartists are active. Brock et al. (2009) introduce additional Arrow securities into the stylized evolutionary equilibrium model of Brock and Hommes (1998) and demonstrate that more hedging instruments may destabilize markets with heterogeneous agents and performance-based reinforcement learning. Westerhoff and Dieci (2006) develop a model in which chartists and fundamentalists invest in two speculative markets. The composition of investors varies according to profit fitness measurement. After stability conditions for the fundamental steady state are derived, the model generates complex price dynamics resembling to actual speculative prices. Dieci and Westerhoff (2010) build up a three-market model in which two stock markets are linked via foreign exchange market. The foreign exchange market is populated with chartists and fundamentalists while the two stock markets have only fundamentalists. It is concluded that upon market interactions, stock markets may be destabilized while the stabilizing effect on the foreign exchange market and the whole market system can be observed.

This paper follows the framework of Day and Huang (1990) and Westerhoff and Dieci (2006). Two types of investors, chartists and fundamentalists, invest in two speculative markets with the same transaction currency. Each investor can invest in either market and choose a chartist or fundamentalist strategy in each market. The difference in this paper is that agents of the same type are inhomogeneous across markets. That is, chartists or fundamentalists from different markets have different demand strengths. In addition, factor of market size/population is included to investigate its role. Theoretical analysis and simulations show that a market that is more stable initially will stabilize the market system while it is subjected to destabilizing effect from the market system. This mutual effect also applies to a market that is more unstable initially. Interpreting from the population size of individual market, a market with a smaller population has lesser influence on the market linkage.

This paper is structured as follows. For the purpose of comparison, we start with in Section 2 a hypothesized case in which two regional markets are isolated with each other in the sense that the investors are not allowed to invest in the foreign market. Section 3 then explores the case when these two isolated markets are linked by allowing the investors from each market to invest in both. Theoretical analysis is carried out so that meaningful policy implications can be drawn. Section 4 provides various numerical simulations and verifies its capability to generate price series matching typical stylized facts documented in the literature, especially the price co-movement and the cross-correlation in volatility. Section 5 concludes with the directions of future research.

2. Market isolation

Following the market maker framework of Day and Huang (1990), we assume that a financial market is composed of three types of agents: chartists, fundamentalists and a market maker. Fundamentalists behave in a way that they sell over-priced asset and purchase under-priced one. In contrast, chartists simply assume the persistence of bullish and bearish market episodes in the short run. Following this expectation, they purchase the over-priced asset and sell the under-valued one.

There exist two regional stock markets, denoted by *A* and *B*. We first assume that these two markets are isolated so that investors are allowed to invest in their domestic market only. The composition of chartists and fundamentalists among the investors depends on market circumstance. Fundamentalists play roles of correcting market price and their composition