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On the integration of financial markets: How strong is the evidence from five international stock markets?

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HIGHLIGHTS

- Price movements between pairwise stock markets are highly nonlinear and complex.
- Multivariate cointegration provides a dynamic way for modeling prices and returns.
- Long-run integration occurs in the system and there is a common market space.
- Evidence on proportionality or full price transmission is limited.
- Nonlinearities move the markets away from homogeneous linear price transmission.

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ABSTRACT

This paper examines the integration of financial markets using data from five international stock markets in the context of globalization. The theoretical basis of this study relies on the price theory and the Law of One Price, which was adjusted to the framework of financial markets. When price levels are nonstationary, cointegration and the error correction model constitute a powerful tool for the empirical examination of market integration. The error correction model provides a fully dynamic framework that allows to separating the long and the short run effects of the integration process. A dataset encompassing the daily stock price series of the PSI 20 (Portugal), IBEX 35 (Spain), FTSE 100 (UK), NIKKEI 225 (Japan) and SP 500 (US) indices from January 4th 1999 to September 19th 2014 is employed.

The results highlight that these five stock markets are linked together by just one long-run relationship, although short-run movements are also present, which causes distinct deviations from the long-run equilibrium relationship. Endogeneity prevails in the system as a whole. While market integration in the sense of the Law of One Price holds, pairwise full price transmission has limited evidence. The results therefore show that stock market price movements are highly nonlinear and complex.

1. Introduction

The contemporary world is dominated by the idea of globalization whose implications affect our lives in many aspects. In some way, it seems clear that the World has become much more interrelated and even more uniform than it was in the past. Of course, important exceptions still remain, but if we look at the Western World we observe that differences between countries and markets are progressively mitigated.

Several studies conducted in the field of Economics have shown that markets are nowadays much more integrated than they were in the past, both at the horizontal and vertical levels [1]. This is true, at least in Western Europe, for some

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commodity markets but it also seems to be the case of financial markets. Then, how can we extend this notion to stock markets? Many authors have studied the process of globalization of international stock markets and they invariably point to the conclusion that markets are highly "globalized" [2–7]. This is intuitively appealing since it is well known that shocks in major markets such as the NYSE have a strong impact on the behavior of worldwide stock markets. However, it is quite surprising that many studies do not in general rely on a concrete definition of market globalization. They basically assess stock market globalization by observing the extent of correlation between markets, however no theory lies behind these empirical tests [8,9].

Bearing these caveats in mind, this paper analyzes the process of stock market globalization on the basis of a theoretical framework derived from the price theory. A precise definition of market globalization based on the Law of One Price leads to a dynamic model specification where the long-run and the short-run effects can be clearly separated. This error correction mechanism uses daily prices and price changes for five stock market indices over a period of 15 years. The model specification is quite flexible and allows for different impacts of price and return movements across markets. For example, a change in the US market, the dominant market, may be transmitted in quite different manners to the remaining markets; if this is the case, it is difficult to conclude that markets tend to uniformity. The process of market globalization is a complex one, and the nonlinear transmission of price movements may obscure the general idea of stock market globalization [10,11].

It is preferable in this context to use stock prices and returns rather than just stock returns since the former retain the long-run information contained in the original data while the latter only capture the short-run information. However, some technical problems arise in this context because the nonstationary nature of price data may lead to spurious relationships. These problems are overcome if the price series are cointegrated when the error correction model provides an appropriate representation of the whole system [12,13]. Additionally, formal tests both of proportionality and weak exogeneity can be performed on the basis of the error correction model. The former leads to tests of full linear price transmission. The latter allows one to test for market leadership.

The remainder of the paper is organized as follows: Section 2 presents the literature review on globalization, market integration and the Law of One Price. Section 3 defines nonstationarity and cointegration. Section 4 describes the data and the main results. Finally, Section 5 concludes.

2. Globalization, market integration and the law of one price

Empirical analyses of market integration often rely on price data to investigate the extent and shape of asset price co-movements over time. The theoretical framework for many of these studies is based upon the price theory as well as precise definitions of market and market integration. A market can be defined as "the area within which the price of an asset tends to uniformity after allowing for different transportation costs" [14] or "differences in quality, marketing, etc." [15]. This definition refers to the price evolution in the long-run, although deviations may occur in the short-run. It is therefore an equilibrium relationship or long-run trend. On the basis of this kind of relationship, it is possible to test for correlation, causality or proportionality in order to verify the extent of market integration [16,17]. Market integration, on the other hand, is one way to analyze the process of globalization, in particular economic globalization, which can be defined as the integration of national economies into the international economy through trade, foreign direct investment, capital flows, migration, and so on.

While it is straightforward to understand and model the definition of market based on the relationship between prices the empirical estimation of such models can be complicated by technical problems, the resolution of which is far from trivial. Such difficulties arise because the vast majority of price series present a property that may result in spurious regressions if not appropriately accounted for—stochastic nonstationarity. As we shall see, this problem is overcome if the price series under analysis are cointegrated; however, if they are not, the results obtained from regressing nonstationary prices suffer from severe biases and the usual test statistics are no longer valid [18]. Of course, in the latter case and if the price variables are integrated of first order, although a regression model based on the first price differences can always be estimated, i.e., the price changes or returns, all the long-run information contained in the original price series is then removed. In this case, regression tests of market integration based on the price theory (and thus economic globalization) cannot be carried out.

The market definition presented above incorporates one element that is crucial in our context, the issue of price uniformity, and it is precisely this issue that leads to the idea of market integration. Indeed, the markets for an asset or group of assets are said to be integrated if the underlying prices move proportionally over time, i.e., if the Law of One Price (LOP) holds. As noted before, differences may occur due to different transportation costs, marketing costs, quality, and so on. This implies that not only must prices be cointegrated (if nonstationary) but they must also be proportional over time. This law, described by Cassel [19] can be regarded as a particular case of the following ADL(p, q) price relationship:

$$x_{1t} = \theta + \sum_{k=1}^{p} \rho_k x_{1,t-k} + \sum_{j=0}^{q} \beta_j x_{2,t-j} + v_t, \tag{1}$$

where x_{it} ($i = 1, 2$) denotes the relative prices (measured in logs) of asset i at time t, ρ_k captures the extent of autocorrelation in x_{1t}, β_j measures the relationship between prices (in levels and lags) and v_t is a white noise perturbation. A generalization of this relationship to more than two price variables is fairly trivial.

In this context, it can be said that x_{2t} causes x_{1t} if the null hypothesis that all parameters β_j are simultaneously zero is rejected; notice that the relationship can be bidirectional. If there is just one unidirectional causal relationship, then one of