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Dynamic European stock market convergence: Evidence from rolling cointegration analysis in the first euro-decade

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ABSTRACT

The introduction of the euro epitomizes European economic integration. This paper assesses the dynamic process of convergence among four major European stock markets in the first euro-decade. Using tests that allow for endogenously determined breaks in cointegrating relationships and rolling cointegration analysis, we show that although some convergence has been taking place over time, it is very much an ongoing process. There is also evidence that the German and French markets appear to be the ones with a higher degree of convergence while the dominant position of Germany within the eurozone seems to be (re)affirmed by tests conducted herein.

1. Introduction

The introduction of the euro in 1999 symbolizes the culmination of efforts to create a single currency zone within the European Union (EU) that started with the creation of the European Monetary System (EMS) three decades ago and then preceded with the Maastricht Treaty criteria and the concomitant obligation by EU member countries to meet them in order to be able to join the single currency union. These criteria included convergence in long term interest rates, inflation rates, as well as, in the fiscal position of prospective eurozone members. As Kim et al. (2005) note, the creation of a currency union without a single financial market presents an interesting case to examine the impact it has on market convergence and integration. Among other things, such convergence depends upon a cohort of macroeconomic variables that characterize and influence the degree of economic integration between the countries involved in the single currency area (Bracker et al., 1999; Kim et al., 2006). In this context, with the advent of the single European currency in 1999, an important issue of consideration has been the extent of European stock markets' convergence. The degree of convergence has significant implications to diversification potential in European stock markets. For example, enhanced European stock market integration implies reduced gains from intra-European portfolio diversification after risk adjustment (Eun and Lee, 2010; Beine et al., 2010). Furthermore, assessing the process of convergence is one interesting and important means of evaluating the extent of the (conceptually broader) financial integration in the EU which has been deemed as a prerequisite for Economic and Monetary Union (EMU) since the early 1990s.[1]

We can broadly divide the recent European stock markets convergence literature into two major strands. The first strand calculates the number of common stochastic trends over pre-specified sample periods using cointegration techniques (Corhay et al., 1993; Engsted and Lund, 1997; Yang et al., 2003). However, these studies treat convergence as a static concept rather than as a gradual and an on-going process. Serletis and King (1997), Rangvid (2001), Pascual (2003) and Gilmore et al. (2008) utilize the same framework of common stochastic trend analysis but focus instead on the dynamic process of convergence using either the Kalman filter, or recursive and rolling cointegration analysis. Serletis and King (1997) and Rangvid (2001) find little evidence of increased convergence, especially in the 1980s and 1990s, whereas Pascual (2003) fails to verify any significant changes in the European stock

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[1] Goddard et al. (2007) and Abad et al. (2009) among others discuss and analyse the impact of EMU on European banks and government bond markets.

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markets long-run co-movements over the same sample period. Similarly, for the 1995–2005 period, Gilmore et al. (2008) find no evidence of a steadily increasing convergence of the Central European (CE) equity markets with those of the UK and Germany.[2]

The second strand, known as the volatility-spillover literature, concentrates on volatility linkages among European stock markets. To address the dynamic process of convergence, researchers employ either variants of GARCH models (Fratzscher, 2002; Kim et al., 2005; Bartram et al., 2007), or regime switching models with time-varying transition probabilities for different regimes (Morana and Beltratti, 2002; Baele, 2005; Hardouvelis et al., 2006). Although these studies uniformly agree that European stock markets integration has generally strengthened in the post-1990 period, their findings differ especially with respect to the timing and degree of convergence. Whilst Hardouvelis et al. (2006) find full integration among the euro-area stock markets by the end of the 1990s, Morana and Beltratti (2002), Fratzscher (2002), Kim et al. (2005) and Bartram et al. (2007) report more modest evidence in favour of integration around the introduction of the single currency. Baele (2005) demonstrates that volatility linkages among European stock markets surged by the early 1990s, thus suggesting that economic integration, boosted by the 1986 Single European Act, and European capital markets liberalization played a more prominent role in stock markets convergence than the introduction of the euro.

This paper is based on, and extends, the first strand of the convergence literature which investigates and compares pre-, as well as, post-euro convergence among European markets. In this paper, we turn our attention exclusively in the post-euro era and examine market integration in the first euro-decade. Essentially, we try to assess how strongly the major markets of the eurozone are integrated and, most importantly, whether the degree of integration has intensified as time progressed after the original introduction of the single European currency in 1999 and, as one would intuitively expect, the process of economic integration deepened. To this effect, we concentrate our investigation on four eurozone stock markets, those of Germany, France, Spain and Italy. As Kim et al. (2006) note, these are the largest and most developed markets in the euro area while the four respective countries represent, in terms of GDP, the largest economies in the currency union and the industrial backbone of the euro-area economy. The dynamic interrelationships among the eurozone stock markets in the post-1999 euro era are analysed using daily data. From the technical perspective of interpreting the results, analysing the extent of European stock market convergence after the adoption of the euro has a significant advantage over examining stock markets denominated in different national currencies prior to the introduction of the single currency. Namely, analysing euro-denominated stock markets enables us to consider stock market convergence without having to impose ad hoc statistical restrictions when confronting the potential serious difficulties of empirical interpretation which arise from the existence of any currency premia.

In this paper, we argue that explicitly accounting for time variation in stock market linkages is important. First, we explore the time-varying behaviour of these linkages using a battery of tests that account for endogenously determined structural breakpoints. Once we establish the instability of the long-run relationships, we make use of the rolling cointegration technique. This technique allows for the emergence of a clearer picture of the possible dynamic linkages among the European stock markets since, although the sample size remains unchanged, the sample period moves ahead by one observation at a time. Therefore, the observed test statistics at every stage reflect the variation in the interrelationship among the stock markets due to new information. Consequently, by rolling analysis, one may assess the gradual convergence over time, i.e. whether the linkages among the EU stock markets have strengthened over the whole period as the process of EMU deepens. In addition, rolling cointegration analysis is very useful in accounting for multiple structural changes in the underlying interrelations among the European stock markets, and hence in assessing the process of convergence in terms of both degree and timing. For example, should we use the full sample period, test statistics after the structural break (or breaks) would stem from data mixed with two (or more) regime shifts and thus may be imprecise or even invalid. Rolling analysis, however, ensures that the effects of such regime shifts are restricted to specific event periods and do not contaminate the overall picture.[3] Given the preceding discussion, the paper is organized as follows. In the section that follows we outline two complementary cointegration-based definitions of stock market convergence. Then, in Section 3 we present and discuss the empirical results of the structural change and rolling cointegration analysis. Section 4 concludes the paper.

2. Defining stock market convergence

Although the importance of stock market convergence as a prerequisite for financial integration has been stressed elsewhere in the literature, it is difficult to find a formal definition of convergence. Consider an X vector of n variables which are determined by a set of m factors (f):

$$X_{it} = \lambda_{ij} f_{jt} (i = 1, \ldots, n; j = 1, \ldots, m; t = 1, \ldots, T; \lambda_{ij} \neq 0 \ \forall i, j) \tag{1}$$

and assume the factors to be orthogonal to each other. The factors can then be ordered according to their explanatory power, i.e. the first factor has the highest explanatory power, the second one has the next highest power and so forth. Under this setting, the notion of ongoing convergence implies that in the limit the first factor would offer a complete explanation of X and all other factors would be zero:

$$\lim_{t \to \infty} (X_{it}) = \lambda_{i1} f_{1t}. \tag{2}$$

Our strategy to assess stock market convergence suggests that it should be done in a system context which models the multilateral dynamic interactions among stock indices. The basic idea is that, even if stock market indices are generally non-stationary, they might cointegrate in the long run if their forcing variables are highly interrelated. In this case, stock markets form cointegrating relationships and share common trends.

Engle and Granger (1987) show that an n-dimensional cointegrated system with r cointegration relations has the following reduced-form error-correction model (ECM) representation:

$$\gamma(L) \Delta X_t = \Pi X_{t-1} + \varepsilon_t, \tag{3}$$

where Π has rank r. According to Granger's Representation Theorem (Engle and Granger, 1987) we know that ΔX_t has a moving average representation:

$$\Delta X_t = C(L) \varepsilon_t. \tag{4}$$

The $C(L)$ polynomial can be decomposed as $C(L) = C(1) + (1-L)C^*(L)$ which implies that ΔX_t has a reduced form common trend representation:

[2] Christiansen and Ranaldo (2009) argue that these markets have actually become more integrated with those in Western Europe after the EU enlargement in May 2004.

[3] Rolling causality analysis is also more appropriate than the alternative recursive analysis with a growing window of data for two reasons. First, by adding observations recursively into the estimation process, one cannot differentiate whether the varying test statistics are due to a change in the extent and/or direction of causality, or to an increase in the power of tests arising from the additional observations. Second, in the presence of structural breaks, recursive analysis suffers from the same drawbacks described in the main text.