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# A topology of world equity markets, 1960-2015

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## Abstract

The aim of this paper is to study the historical dynamics of integration of equity markets, using the literature on topological representations of prices in equity markets. Following the groundbreaking papers of Mantegna (1998), Bonanno et al. (2000) and Tumimnello et al. (2008), this literature studies the characteristics of topological graphs (in particular, the minimal spanning tree, Held and Karp, 1971) obtained starting from the matrix of correlations between all pairs of securities of a given portfolio. These graphs allow to assess the degree of financial integration within the portfolio by quantifying the propagation channels and identifying the directions of causalities. Like the relationships within ecosystems, which are a usual application, the structure of topological graphs changes depending on the economic environment, particularly in cases of multiple equilibria when switching from one equilibrium to another (May et al., 2008; Soromaki et al., 2008). In a context of rapid technical progress, the rise of transactions without human intervention in equity markets reinforces the interest of the representation of equity portfolios in the form of complex systems (Vandewalle et al., 2009; Johnson et al., 2013).

We propose a study of the historical dynamics of integration of world equity markets as represented by the evolution of the topology of their benchmark indices. The contribution is twofold. First, this methodological approach of the dynamics of financial integration of equity markets is entirely new, to the best of our knowledge. The second contribution is to adopt a historical approach over several decades, aimed to characterize the relationships within a sample of national markets, whereas the reference methodology is usually applied over short periods for individual equity securities.

The sample is composed of the benchmark equity markets indices of 32 countries over the period 1960 to 2015, extracted from the FRED database. The evolution of topological representations over five distinct sub-periods is studied on the basis of the characteristics of the minimal spanning trees (including the distribution of values of the corresponding distance matrices) and hierarchical trees. It shows that the dynamics of equity markets prices and financial integration are distinct. The dynamics of financial integration shows a major break only after 2000, two decades after the break in prices dynamics. World equity markets after 2000 are characterized by marked topological specificities: i) the existence of a third specific sub-tree composed of emerging economies, in addition to the USA and continental Europe sub-trees; ii) the convergence of the (relatively low) degree of integration within the USA sub-tree towards the (relatively high) degree of integration within the continental Europe sub-tree; iii) the existence of a cluster of relatively highly integrated emerging economies; iv) the predominance of intermediate distances with symmetrical distribution whereas the other

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sub-periods are characterized by a predominance of high distances.

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