European Countries' Competitiveness and Productive Performance Evolution: Unraveling the complexity[1]

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Improving European countries' competitiveness has been an everlasting policy goal. In this line, National and European efforts have been directed in implementing policies aiming at a two-level end result; on one hand supporting at the national level sectoral competitiveness and at a second level achieving a catching-up rate for all European economies. However, empirical evidence suggests that technology gaps between European countries still remain (Syverson, 2011; Pianta, 2014). The persistence of technology gaps among European countries may be attributed to three main sources; (i) the path-dependence process of technological evolution (David, 1985; Antonelli, 2013), (ii) the rather persistent underlying technological heterogeneity (Dosi and Lechevalier, 2010) and (iii) the complexity surrounding the processes with which firms, industries and eventually countries achieve their competitiveness (Arthur, 2013).

Exploiting a unique dataset of 17 European Countries and 13 industries belonging to the Manufacturing and Transport sectors for the period 2000-2006, we investigate the evolution of European countries' sectoral productive performance employing a two-step novel methodology. At the first step, we estimate European sector's technology gaps arising in a metafrontier context, following closely (Kounetas et al. 2009).The introduction of metafrontier analysis as an approach that allows the investigation of the interrelationships between different technologies (Battese et al., 2004) and can be used in order to explain differences in production opportunities that can be attributed to available resource endowments, economic infrastructure, and other characteristics of the physical, social and economic environment in which production takes (O'Donnell et al. 2008).

At a second step, we estimate the evolution of such technology gaps, taking into consideration all three sources of persistence of technology gaps, that is, path dependence, technological heterogeneity and complexity, employing and *autoregressive latent trajectory* (ALT) model (Bollen and Curran, 2004). In addition, the growth evolution of the technology gaps is associated with a competitiveness index at the end of the observation period in order to determine whether technology gaps influence at the long run a country's competitiveness. The ALT model

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incorporates features of both the autoregressive model and the latent growth curve model in a single framework. With respect to the second part of the ALT model, the latent growth curve model, it is a methodological framework employed in the social sciences and aims at studying the growth process of a key indicator. The growth process is assumed to be composed of two main sources and specifically, the initial state upon which the indicator under investigation is firstly observed and the corresponding growth rate. Another level of sophistication is added when it is assumed that the sample under investigation is derived from a heterogeneous population with different distributions. This particular type of heterogeneity may be investigated employing a mixture modeling approach.

The estimated model allows us to incorporate complexity by simultaneously estimating the latent growth factors that is the initial conditions and growth rate, the interrelation (covariance) between them, along with the effect of the path dependency. Empirical results reveal that all three sources of persistence indeed play a significant, although distinctive, role in determining the growth evolution of technological gaps in European countries and industries. Therefore the convergence – divergence issue, within the unified European economy, becomes a multifaceted phenomenon. More specifically, two groups of European industries are identified sharing commonalities in the growth evolution pattern of technology gaps, thus allowing us to minimize the heterogeneity of the growth evolution patterns. Moreover, path dependence is a statistically significant determinant of the growth process and also sectoral differentials seem to be important determinants of the growth evolution but not in all cases. Last but not least, both identified groups of European industries evolution patterns influence positively their corresponding country competitiveness at the end of the observation period. Catching up or falling behind phenomena are further investigated.

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