Implications of the Green and Sustainable Transition in Economic Structure: Analyzing the Evolution of the Complexity of the German Economy

Topic: Input-Output Modelling: Energy Policies - III
Author: Ana Luiza Maria GuimarÃ£es Coelho

This paper quantifies and analyzes the effects of green and sustainable transition as the path of development in the economic structure. We pay special attention to the Germany case. The energy transition is a concept that involves promoting important changes in some strategic economic sectors: energy, transport, and IT. In this context, the economic structure of some countries has been subject to policies that react to national, regional e and international goals. Among the countries that make the most effort to reach these goals are the European countries, particularly Germany. In recent years, german policies promoted important changes in its energy sectors. Those changes affect how those sectors are integrated and their importance for the whole german economy and the regional European economy. In other words, structural changes are happening in the German economic structure due to sustainable transition (Denholm et al., 2010; IRENA (International Renewable Energy Agency), 2017; Schmidt and Sewerin, 2017).

Empirically, measuring structural changes in the input-output framework is a challenge. The input-output table estimations reflect not only structural factors of how the economic sectors are connected but also short-term shocks and fluctuations. The last creates noise in the data, which implies undesirable trends for any measure built directly on such tables. In this case, it becomes tough to analyze the structural information contained in the data (Bullard and Sebald, 1977; Lahr and Dietzenbacher, 2001; Linden and Dietzenbacher, 2000; Miller and Blair, 2009; Sonis et al., 2000; Thakur, 2008). To deal with that, we propose using Markov Chains; in special, we use the steady-state properties. Markov Chains have been applied to input-output literature to analyze world input-output tables. They consist of a method to compute system risk (sensibility), to identify key sectors for the economic system, the level of fragmentation and specialization of the world economy, and also to analyze the conditions of the equilibrium of the system (Kostoska et al., 2020; Moosavi and Isacchini, 2017; Riane and David, 2022).

Differently from those works, we use Markov Chain methods to investigate the evolution of only one economy. We analyze the german economic structure from 1995 to 2018, building stochastic matrixes. To work with Stochastic Absorbing Markov Chains, we modified input-output tables regarding the import and export column; and added value and final demand columns. In this way, we ensured a closed system and continued with the ability to analyze the external impact caused by changes in german structure or the opposite. We assume that the steady state of each matrix represents the equilibrium state after n periods when there was any structural change. Therefore changes in economic structure represent changes in the equilibrium state. Some measures or indicators computed based on the equilibrium transition matrix will show ruptures in its time series or a very characteristic path after a structural change. In the context of this paper, it implies that some of the measures will show a specific behavior over time based on the changes occurring in the german economy's energy sectors. In particular, from it, we can also identify the measures that reflect more structural changes and those that are more affected by short-term fluctuations. We use as a control the time series of some macroeconomic variables.

Besides the use of the traditional indicators proposed in the literature (Aroche-Reyes, 2002; Dietzenbacher, 1992; Miller and Blair, 2009; Morillas and DÃ-az, 2008; Oosterhaven and Stelder, 2002; Sonis et al., 2000) and sectors statistics, we also define a complex index as Hidalgo and Hausmann (2009). The complex index calculates the complexity of each sector's sales and purchase structures, considering the weight of each transaction and the sectorâ€™s connectivity

inside the economy. We use data available from the OCDE and EuroStat between 1995 and 2018 on German input-output tables, and employment, international trade, and technological development statistics (e.g., employees, labor cost, wages, import, export, tax subsidies to innovation, patents, and R&D spending by sector).

Preview results show that among the indicators used, the complex index and indirect multipliers are the most relevant indicators in explaining the evolution of the economic structure. There is no rupture in the evolution of the global complexity index, which is expected for a developed economy. However, the complexity in the energy sector changes and is positively correlated to technological development.