

CAUSAL STRUCTURE OF EXPORT-PRODUCTIVITY NEXUS IN TURKEYAsst. Prof. Muhammed BENLİ* **ABSTRACT**

This paper examines the causal relationship between real exports and economic growth in Turkey for the period 2000Q1-2017Q1 by estimating Directed Acyclic Graphs (DAGs). In doing so, we attempt to shed light on both the direct and indirect causation between the two with respect to other mediating factors. The resulting DAG patterns suggest that economic growth follows real exports expansion in Turkey, while the other variables such as capital formation and foreign output of other industrialized countries are also significant determinants of productivity growth in Turkey.

Key Words: Directed Acyclic Graphs (DAGs), Causality, TETRAD, Real Exports, Productivity.

JEL Classification: C88, F10, F43.

TÜRKİYE'DE İHRACAT-VERİMLİLİK BAĞLANTISININ NEDENSEL YAPISI**ÖZET**

Bu çalışma, Türkiye'de reel ihracat ve ekonomik büyüme arasındaki nedensellik ilişkisini, 2000:Q1-2017:Q1 dönemi için Yönlendirilmiş Döngüsüz Grafikler (DAGs) metodunu kullanarak incelemektedir. Böylelikle bahsi geçen değişkenler arasındaki dolaylı ve dolaysız nedenselliğin, diğer bazı iktisadi faktörlerin de dolaylı ilgisi göz önünde bulundurularak ortaya çıkarılması amaçlanmıştır. Yönlendirilmiş döngüsüz grafik şablonları, ekonomik büyümenin reel ihracattaki büyümeyi takip ettiğini; sermaye teşekkülü ve diğer endüstriyel ülkelerin hasılasının da Türkiye'deki verimlilik artışının anlamlı/önemli belirleyicileri olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Yönlendirilmiş Döngüsüz Grafikler, Nedensellik, TETRAD, Reel İhracat, Verimlilik.

JEL Sınıflandırması: C88, F10, F43.

1. INTRODUCTION

The export-growth nexus has been a hot topic of discussion in the international economics and economic development literature over the past decades. This is mainly due to the role granted to trade

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in promoting economic well-being in the trade literature. Export expansion is expected to be an important factor fostering output growth through raising capital formation by increasing opportunity to finance imports of capital and intermediate goods. Furthermore, export growth causes countries to expose to raising foreign market competition, knowledge transfer and new production technologies. This in turn leads to more efficient allocation of resources, utilization of scale economies and greater capacity exploitation and thus stimulates productivity growth. Exports can also directly affect economic growth by increasing level of employment and income via multiplier effect.

The relationship between export expansion and economic growth has been extensively studied over the past decades, yet the channels and even the direction of causality have remained unresolved in theory and empirics. Broadly speaking, there are two competing hypotheses on the nature of the causality between exports and growth: the export-led growth (ELG) hypothesis suggests a causal flow from exports to productivity, while the growth-led export (GLE) hypothesis asserts that causality runs from productivity growth to exports. The establishment of the direction of causality between the two has important ramifications on countries' trade policies and development strategies.

The empirical literature on export-growth nexus is again equivocal and finds conflicting results. The early studies, as noted by Awokuse (2006), primarily relied on cross country analyses and mostly find evidence in favor of ELG hypothesis (see, e.g. Emery, 1967 and 1968; Severn, 1968; Syron and Walsh, 1968; Kravis, 1970; Michaely, 1977; Balassa, 1978 and 1985; Krueger, 1978; Bhagwati, 1978; Tyler, 1981; Feder, 1983; Kavoussi, 1984; Ram, 1985; Helpman and Krugman, 1985; Heitger, 1987; Rana, 1988; Moschos, 1989; Kohli and Singh, 1989; Otani and Villaneuva, 1990; Fosu, 1990; Esfahani, 1991; Lopez, 1991; Dodaro, 1991; Sheehey, 1992; De Gregoria, 1992, and Edwards, 1993). However, these cross sectional analyses were criticized for their restrictive assumption of causality going from exports to growth, ignoring the possible reverse causal flow and causality running in both directions. Another limitation of this approach was the irrational assumption of similar economic and demographic structures and production technology across different countries (Ram, 1987).

To account for this issue, the subsequent studies switched to individual country studies mostly employing the Granger (1969) non-causality or Sim (1972) causality tests and find inconsistent results (see, e.g. Jung and Marshall, 1985; Chow, 1987; Hsiao, 1987; Sung-Shen et al., 1990; Grabowski et al., 1990; Ahmad and Kwan, 1991; Bahmani-Oskooee et al., 1991; Marin, 1992; Dodaro, 1993; Love, 1994; Paul and Chowdhury, 1995; Riezman and Whiteman, 1996; Jin and Yu, 1996; Yamada, 1998, Richards, 2001; Awokuse, 2003). Nevertheless, this approach has its drawbacks as well. Granger causality/non-causality approach is very sensitive to the omitted variables, so that the results can be spurious or measure wrong feedback relations (Granger, 1980; Lutkepohl, 1982). On the other hand, this approach does not account for indirect causal paths resulting from the correlation of the stochastic disturbances (Awokuse, 2006).

Concerning the studies investigating the ELG hypothesis in the context of Turkey, the findings provide mixed results. These studies mostly rely on the concept of Granger non-causality to test the causal link between exports and growth and employ VAR methodology to model the linear relationship between the two. Some support the ELG hypothesis (see, e.g. Alici and Ucal, 2003; Karagoz and Sen, 2005; Halicioğlu, 2007), while some others suggest reverse causality or report no significant relationship between the two (see, e.g. Cetintas, 2004; Saatcioglu and Karaca, 2004; Cil, 2004; Temiz and Gokmen, 2010).

In light of these contradicting results and reported limitations of the methodologies used in the literature, following Awokuse (2006), we examine the causal structure of export-productivity nexus in Turkey, in conjunction with some other economic factors by employing Directed Acyclic Graphs (DAGs) approach. In doing so, we attempt to illustrate both the direct and indirect causal paths between exports and productivity growth with respect to capital formation, foreign output of OECD nations, and terms of trade.

2. DIRECTED ACYCLIC GRAPHS (DAGs)

DAGs, which are the most widely used graphs in causal modeling, are simply directed graphs (DGs) with no directed cycles. A directed graph (DG) or digraph is a mathematical object consisting of an ordered pair (V, E) . V is a set of vertices (variables) or nodes, whereas A is a set whose elements are called arrows (a set of directed edges). Adjacent variables (vertices) are connected by an edge (line). For example, let $V = \{K, L, M\}$ and $A = \{(L, K), (M, K)\}$. Then $G = (V, E)$ is a directed graph, illustrated in Figure 1 (a). G does not contain any directed cycle because there is no way to start and end at the same vertex, implying that G is a directed acyclic graph (DAG). In contrast, $G' = (V, E')$, where $V = \{K, L, M\}$ and $E' = \{(L, K), (K, M), (M, L)\}$ is not acyclic because a move from A to B ends at A by way of C as seen in Figure 1 (b). In this article, we discuss only acyclic graphs as cyclic graphs are not identifiable (Li et al., 2013).

Figure 1. Examples of Directed Graphs



DAGs are representations of conditional independencies implied by the linear recursive product decompositions (Pearl, 1995):

$$\Pr(v_1, v_2, v_3, \dots, v_n) = \prod_{i=1}^n \Pr(v_i | pa_i) \quad (1)$$

where pa_i represents the realization of some subset of the variables that precede v_i in order $(v_1, v_2, v_3, \dots, v_n)$. Verma and Pearl (1988) showed that the conditional independencies implied by the decomposition (1) can be graphically characterized using d-separation (directional separation)¹.

The PC algorithm is developed by Spirtes et al. (2000) to incorporate the concept of d-separation to build directed graphs. Simply put, the PC algorithm commences with a graph in which all the variables are connected with an undirected edge. Then, these edges are removed recursively by using a stepwise testing approach, based upon Fisher's z test of zero correlation or zero partial (conditional) correlation. The remaining edges are then directed by using the notion of sepset.

Based on Monte Carlo simulations, the PC algorithm may assign the directions of edges incorrectly and may make mistakes of edge exclusion/inclusion, especially for small sample size less than 100 observations (Spirtes, et al. 2000; Demiralp and Hoover 2003; Zhang et al. 2006). Spirtes et al. 2000 suggests using higher significance levels as the sample size drops (e.g., 0.2 at sample size less than 100) and lower significance levels as the sample size increases (e.g., 0.1 at sample size which is between 100 and 300). Given our 69 time series observations (2000q1-2017q1), we choose 20 per cent significance level, which provides an unambiguous directed ordering for most of the variables in this analysis. The PC algorithm and its extensions are available in TETRAD VI which is the software program we use for the estimations in this study².

3. DATA

Fur our purpose in this study, we employ Turkish time series data which covers the period 2000:Q1 to 2017:Q1. The variables included in this study are motivated by the choice of indicators in Awokuse (2006). Real exports variable is defined as nominal exports divided by export unit value. Real GDP per employed person is used as a proxy for productivity. Gross capital formation is a proxy for capital and the variable of real terms of trade is defined as export unit value divided by import unit value. We use industrial production index for OECD countries as a proxy for foreign output shock, and as argued by Awokuse (2006), this variable captures export growth affected by growth in the rest of the world. All the data series are in natural logarithm form.

4. ANALYSIS AND RESULTS

First, as a starting point, we present the preliminary results by examining the correlation matrix in Table 1. The unconditional correlation between each of the variables is summarized in this matrix and processed by TETRAD VI without a priori knowledge of causal relationships among the variables (Zhang et al., 2006).

¹ The definition of d-separation can be found in Pearl (1995).

² The review of some other useful software packages for estimating DAGs from data, including MIM and WinMine as well as LISREL, EQS, and AMOS, can be found in Haughton et al. 2006.

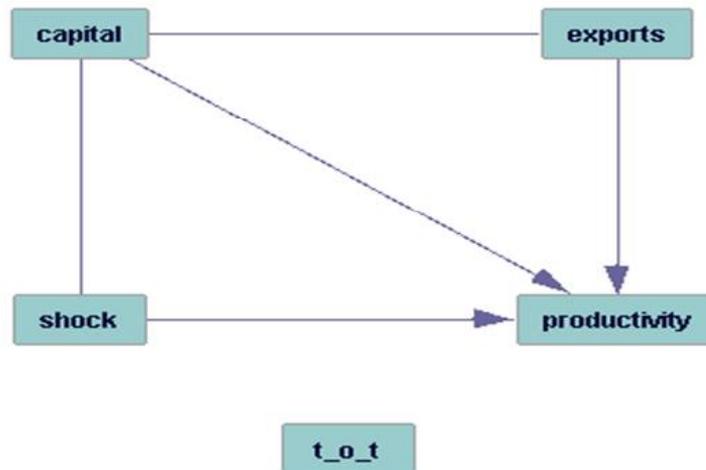
Table 1. The Correlation Matrix for the Variables

	productivity	exports	capital	terms_of_trade	shock
productivity	1				
exports	0.9366	1			
capital	0.9593	0.9627	1		
terms_of_trade	-0.2809	-0.3174	-0.297	1	
shock	0.9088	0.8856	0.9253	-0.2664	1

Table 1 shows that productivity is strongly and positively correlated to exports, capital formation and foreign output shock, with correlation coefficients of 0.94, 0.96 and 0.91, respectively. On the other hand, terms of trade seems to have no correlation with other variables. The correlation matrix also reveals that foreign output shock is highly correlated with exports and capital formation. Furthermore, the matrix indicates a strong and positive correlation between exports and capital formation as the unconditional correlation between them is 0.96. Thus, one can reasonably expect significant direct and indirect causal paths among productivity, exports, capital, and foreign output.

The resulting patterns from the DAG analysis are presented in Figure 2.

Figure 2. Directed Graph at 20% Level (PC Algorithm)



Degrees of freedom: 5; Chi-square: 9.7429; p-value: 0.0829, BIC score: -11.4276

Examining the pattern by the PC algorithm reveals that exports (*export*), capital formation (*capital*), foreign output of other OECD nations (*shock*) have directed and contemporaneous effect on productivity. On the other hand, terms of trade (*t_o_t*) is found to have no relationship with any other

variable in the system, implying that t_o_t is exogenous to the system. On the other hand, the algorithm does not detect any indirect path among the variables in the system. Also we should note the undirected edges between export and capital, and capital and shock, implying causations between these variables. However, the identification of the direction of the associations between them requires higher number of observations and inclusion of some other omitted variables into the system. As an example, with 40% significance level (the results are not presented here), the resulting DAG pattern suggests a causal flow from *export* to *capital*, implying a possible indirect effect of exports on productivity. Overall, it can be argued that the results from DAG support the ELG hypothesis as exports growth directly cause productivity growth.

5. CONCLUSION

In this study, we employ the DAG approach to examine the causal pattern among exports and productivity, and some other economic factors. Using the Turkish quarterly data, time series analysis of export-productivity nexus is examined. Causal patterns, revealed by the PC algorithm, indicate a causal flow from exports, capital and foreign output to productivity. This implies the validity of export-led growth hypothesis for Turkey for the period 2000:Q1 to 2017:Q1. This is line with Alici and Ucal (2003), Karagoz and Sen (2005), Halicioglu (2007) but contradict with the studies of Cetintas (2004), Saatcioglu and Karaca (2004), Cil (2004), Temiz and Gokmen (2010), among others.

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