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TIME-VARYING NETWORK CONNECTEDNESS BETWEEN THE ORGANIZATIONAL ECOLOGY OF TRANSPORTATION AND STORAGE FIRMS AND MACROECONOMIC VARIABLES

Murathan Tuncer, M.Sc.

Department of Business Administration
Alanya Alaaddin Keykubat University, Turkey
e-mail: murathan.tuncer@alanya.edu.tr
ORCID: 0000-0002-5187-9321

Nesrin Akbulut, M.Sc.

Department of Economics
Alanya Alaaddin Keykubat University, Turkey
e-mail: nesrin.akbulut@alanya.edu.tr
ORCID: 0000-0002-1460-0950

Miraç Savaş Turhan, Ph.D.

Department of Business Administration
Alanya Alaaddin Keykubat University, Turkey
e-mail: mirac.turhan@alanya.edu.tr
ORCID: 0000-0002-9479-1215

Yakup Ari, Ph.D.

Department of Economics
Alanya Alaaddin Keykubat University, Turkey
e-mail: yakup.ari@alanya.edu.tr
ORCID: 0000-0002-5666-5365

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Abstract

Research background: Environmental factors are not adequately addressed in organizational ecology studies. At the same time, it is known that the theory has not received enough attention except for North America, which is the emerging point.
Purpose: We aim to examine macroeconomic connectedness between the organizational ecology of transportation and storage firms and macroeconomic variables such as price and production indexes.

Research methodology: This paper discusses the relation among the following variables within the framework of macroeconomic connectedness via organizational ecology theory. The variables are FOUNDINGS, DISBANDINGS, TRNSP-CPI, PPI IPI and ENERGY. We use the TVP-VAR based Diebold-Yılmaz Connectedness approach in the analysis of the data.
Results: DISBANDING is the net transmitter throughout the entire period. FOUNDING is mainly a net shock receiver during the COVID-19 period and transmitter in other periods. TRANS-CPI and PPI are risk receivers throughout the entire period, and even the shocks they transmit increased in the post-2018 period. ENERGY and IPI are in shock receiver status throughout the entire period. The received shocks of IPI from others have decreased with the effect of the lockdown experienced during the COVID-19 period.
Novelty: The investors can hedge against risk by looking at industry production capacity and the number of firm closures, considering the net bilateral link between the indices, and calculating the appropriate time period for establishing a firm. Connectedness indices vary considerably over the sampling period, which indicates that investors must dynamically adjust their position in the industry.

Keywords: Diebold-Yılmaz Connectedness, Organizational ecology, Organizational foundings and disbandings, Transportation and Storage, TVP-VAR

JEL classification: C11, C22, D22, M10, M20

Introduction

In the literature, transportation and storage activities are gathered under the concept of logistics. Due to its geographical location in the middle of three continents, Turkey has a geopolitical position that can transport commercial products by land, air, sea, and rail transport. In this context, it is possible to say that the transportation sector has an important place in the country's economy. The limited amount of data about the size of the logistics sector in Turkey is included under the H group under the name of "Transportation and Storage" according to the NACE (Nomenclature of Economic Activities) Rev 2 classification based on the Turkish Statistical Institute (TUIK). Activities in the sector are classified as H-49 Road Transport, Rail Transport, Pipeline Transport, H-50 Water Transport, H-51 Air Transport, H-52 Storage and Supporting Activities for Transport, H-53 Post and Courier Activities (Yurdakul, 2020). The transportation and storage sector has great importance due to its interaction with other sectors such as agriculture, trade, tourism and also important due to the potential of creating employment for them. The sector has a constantly developing and renewing dynamic as a result of high competition and intensive use of technology. In this context, the transportation and storage sector plays a major role in the growth and development of countries (Elmas, Özkan, 2021). In addition, the survival of organizations in the sector is also directly effective on the

lives of individuals, especially since they provide labor to large work forces. So, what does the survival of organizations depend on?

The theory of organizational ecology is inspired by the theory of evolution while explaining this subject. According to the theory, environmental conditions are the main determining factor. Just as species increase, decrease or disappear under the influence of environmental conditions, organizations will multiply, decrease or disappear as environmental conditions allow. From this point of view, the theory attaches great importance to the founding-disbanding number of organizations, emphasizes the concepts of structural inertia and density dependence and importance of demographic factors. In organizational ecology theory, besides demographic factors such as size and age and ecological factors such as population density and population dynamics, environmental factors such as technical, legal, and political are employed. However, it is emphasized that the studies on environmental factors have not been sufficiently carried out (Önder, Üsdiken, 2007; Turhan, Arı, 2021).

In this regard, the present paper discusses the relation among the founding rates, disbanding rates, and macro variables within the framework of economic connectedness via organizational ecology theory. For this purpose, we use the TVP-VAR (Time-Varying Parameter Vector Autoregressive) – based Diebold-Yılmaz Connectedness approach in the analysis of the relation between the organizational ecology of transportation and storage firms and macroeconomic variables such as price and production indexes. The data were obtained from the reports submitted by TOBB (The Union of Chambers and Commodity Exchanges of Turkey) on a monthly basis. Considering the importance of the factors (price and production) discussed for all sectors, it is expected that these macroeconomic variables will have an impact on the number of openings and closings of organizations operating in the transportation and storage sector as a result of the research. Although there are various studies in the field which are focused on the reasons of founding and disbanding numbers of organizations (Baum, Amburgey, 2002; Baum, Shipilov, 2006), it is known that organizational ecology theory has not received much attention by researchers, except in North America, which is its starting point (Önder, Üsdiken, 2007). For this reason, it is expected that the research will contribute to the relevant literature in this direction.

The paper consists of five parts. The introduction and literature parts are followed by the materials and method part which includes the data set and the TVP-VAR model, respectively. The fourth section covers the empirical results. Finally, the study ends with the discussion and conclusion part.

1. Literature Review

The organization-environment relationship, which has started to be discussed in management studies as a result of the modern approach on organizational theories, is mostly explained with the themes of the organization being affected by the environment, affecting its own environment, trying to survive in changing conditions and competing with other organizations (Khandwalla,1972). Organizational ecology theory, on the other hand, evaluated the subject with inspiration from the evolutionary perspective in biology (Turhan, 2021; Yeloğlu, 2017). According to the evolutionary point of view, species found in nature; evolve, increase or decrease in number due to various environmental reasons. Some species survive, while others disappear. Based on this, the organizational ecology approach rejected the thesis that organizations adapt to changing conditions, which was stated in previous theories, and stated that the environment is unpredictable and the results of such an effort would only be coincidental (Önder, Üsdiken, 2007; Turhan, 2021). According to the ecological perspective, organizational forms will be found and multiply, which are allowed, and the organizations will gradually decrease and disband, which are not allowed, by the environmental conditions. In other words, the future of organizations will depend on the results of selection. Within the framework of this point of view, organizational ecology theory likened the species found in nature to organizational populations. Organizations that are similar to each other (in terms of structure, activity, environment, etc.), together constitute the organization populations, and organizational populations operating in the same environment constitute the organization communities. With a population ecology perspective, theory tries to understand how environmental conditions and relationships between populations affect organizational diversity (Hannan, Freeman, 1987; Baum, 1999). With this structure, organizational ecology theory, which shifts the focus from organization to organizational populations (Hannan, Freeman, 1977; Carroll, 1984), analyzes organizations at the community level.

The founding (birth) of new organizations and the declining or disbanding (death) of existing organizations are important research topics for organizational ecology theory due to the selection point of view. From an ecological perspective, changing is a challenge for organizations. The theory explains this statement with the concept of structural inertia. Due to various organizational and environmental reasons, organizations will become inert over time, and it will be difficult to adapt to changes promptly and adequately (Hannan, Freeman, 1984).

An important factor in explaining organizational ecology is the theory of density dependence. Theory draws attention to the number of organizations that constitute the

organizational populations. Accordingly, as the number of organizations in a population increases, the population density also increases. When the group first emerges, population density will be low, opportunities will be plentiful, and population participation rate will be high. Over time, the number of members of the population and accordingly the competition will increase, the rate of participation will slow down, and the population will reach the carrying capacity. In this process, the number of disbanding will also increase. In the early stages of populations, their legitimacy will be low, and as the density increases, legitimacy will increase (Baum, 1999). Populations that gain legitimacy will take their place in the ecosystem and will survive as long as ecological conditions allow. Therefore, the relationship between founding and disbanding rates are important for describing the ecosystem in which organizations are located.

Demographic factors are also emphasized in organizational ecology theory. Accordingly, the age and size of the organization are effective in its survival (Wholey, Brittain, 1986). Large organizations are more likely to be successful than small organizations with their well-established structures, large market shares and strong relationships. Small organizations, on the other hand, are more at risk due to lack of experience, finance and reputation (Mata, Portugal, 1994; Michael, Kim, 2005). Besides, as the age of organizations increases, their legitimacy also increases (Turhan, 2021). However, the extended life of the organization may also push the organization into a structure that is closed to changes, as a cause of structural inertia (Hannan, Freeman, 1989).

Looking at recent research, in his mixed method study, Downie (2022) examined the organizational ecology of international organizations in global energy management and reached results that challenged the general acceptance of organizational ecology theory. Olvera and Sutton (2021) examined the organizational ecology of small food businesses in New York City. In his study about governance organizations, Lake (2021) examined the relationship between private governance organizations, intergovernmental organizations and states together via the organizational ecology theory and tried to understand the dynamics between them. In his research, which was carried out on technical assistance providers, Morin (2020) suggests that the first population, which fills the working area at a high level, limits the development of other populations.

2. Materials and method

2.1. Data set

The data set consists of monthly observations of FOUNDINGS (opening numbers of companies operating in the "Transportation and Storage" sector in Turkey), DISBANDINGS (closing numbers of companies operating in the "Transportation and Storage" sector in Turkey), TRNSP-CPI (Transportation Consumer Price Index), PPI (Producer Price Index), IPI (Industry Production Index) and ENERGY (Energy Price Index) variables between January 2010 and February 2022.[1] Since the raw series are not stationary according to the Elliott-Rothenberg-Stock (ERS) unit root test, we used the first log differences, which can be interpreted as monthly percentage changes, in the analysis. Figure 1 shows the time series plots of the variables. Table 1 contains summary statistics for the log difference series. The findings show that the series are not significantly normally distributed according to the Jarque-Bera test and are stationary according to the ERS test. Also, Table 1 shows the unconditional correlation matrix across the log difference series over the sampling period.

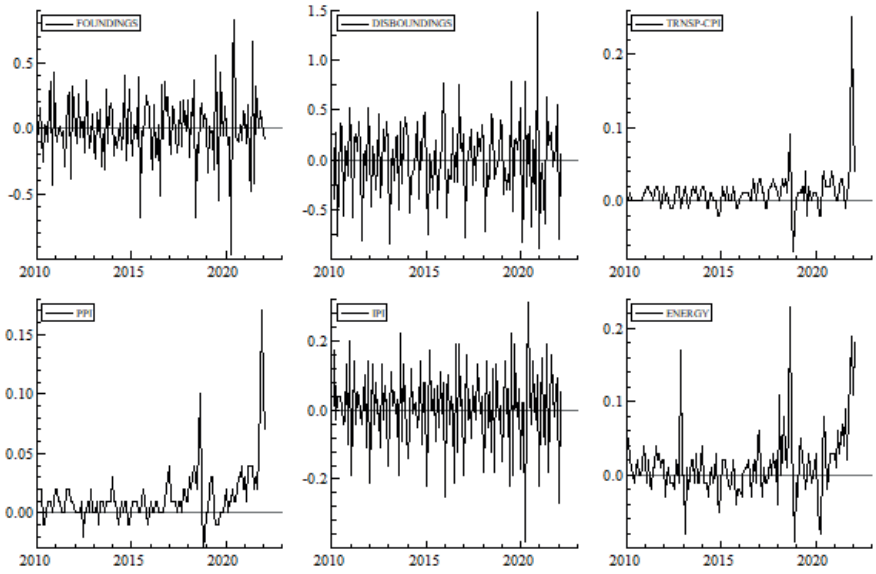

Figure 1. Monthly logarithmic difference series

Source: authors' own elaborations.

[1] FOUNDINGS – DISBANDINGS numbers can be found on the TOBB website https://www.tobb.org.tr under the title "Company Establishment and Liquidation Statistics". The data for other variables can be accessed from the Turkish Statistical Institute website https://www.tuik.gov.tr.

Table 1. Summary Statistics

	FOUNDINGS	DISBANDINGS	TRNSP.CPI	PPI	IPI	ENERGY
Mean	0.00	0.00	0.01	0.01	0.01	0.02
Variance	0.06	0.15	0.00	0.00	0.01	0.00
Skewness	–0.27	0.02	5.00***	3.39***	–0.44**	1.72***
	0.18	*0.91*	*0.00*	*0.00*	*0.03*	*0.00*
Ex. Kurtosis	1.81***	0.83*	40.87***	17.12***	0.35	5.70***
	0.00	*–0.06*	*0.00*	*0.00*	*–0.29*	*0.00*
JB	21.52***	4.17	10,697.99***	2,048.23***	5.34*	267.73***
	0.00	*–0.12*	*0.00*	*0.00*	*0.07*	*0.00*
ERS	–6.95***	–2.76***	–2.53**	–2.10**	–9.18***	–1.95*
	0.00	*0.01*	*0.01*	*0.04*	*0.00*	*0.05*
Q(10)	16.51***	40.15***	39.01***	109.58***	32.27***	38.41***
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$Q^2(10)$	22.78***	7.63	7.10	49.48***	10.15*	19.67***
	0.00	*0.20*	*0.24*	*0.00*	*0.07*	*0.00*
Correlation Matrix						
FOUNDINGS	–					
DISBANDINGS	0.29***	–				
TRNSP-CPI	0.11	0.03	–			
PPI	0.04	–0.04	0.84***	–		
IPI	0.64***	0.25**	0.06	–0.01	–	
ENERGY	0.17*	0.01	0.61***	0.77***	0.15	–

Note: ***, **, * denote significance level at 1%, 5% and 10%;. Italic entries are corresponding probabilities.

Source: authors' own elaborations.

2.2. TVP-VAR based connectedness approach

The connectedness approach proposed by Diebold and Yılmaz (2009, 2012, 2014) for static and dynamic time series network analysis. In this paper, we use a dynamic connectedness approach based on a Time-Varying Parameter Vector Autoregressions (TVP-VAR) by Antonakakis et al. (2018, 2020) to prevent data loss. The TVP-VAR (1) model, determined to be the most appropriate by the Bayes Information Criteria (BIC), is as follows.

$$z_t = \boldsymbol{A_t} z_{t-1} + \epsilon_t \qquad \boldsymbol{\epsilon_t} \sim \boldsymbol{N(0, \sum_t)} \tag{1}$$

$$vec(\boldsymbol{A_t}) = vec(\boldsymbol{A_{t-1}}) + \upsilon_t \qquad \boldsymbol{\upsilon_t} \sim \boldsymbol{N(0, S_t)} \tag{2}$$

where z_t, z_{t-1} and ε_t represent $k \times 1$ dimensional vectors, and A_t and $\sum_t$ are $k \times k$ dimensional matrices, $vec(\boldsymbol{A_t})$ and v_t are $k^2 \times 1$ dimensional vectors. S_t are time-varying variance-covariance matrices of which dimension is $k^2 \times k^2$.

Diebold-Yilmaz's approach is based on the Generalized Forecast Error Variance Decomposition (GFEVD) analysis. The transformation of TVP-VAR into TVP-VMA (Time-Varying Parameter Vector Moving Average) is $y_t = \sum_{h=0}^{\infty} \mathrm{A}_{ht}\, \epsilon_{t-h}$ where $A_0 = I_k$. So, the influence of a shock in variable j on variable i is computed as:

$$\tilde{\phi}_{ij,t}^{g}(H) = \frac{\sum_{h=0}^{H-1}\left(\epsilon_i^T A_{ht}\Sigma_t \epsilon_j\right)^2}{\left(\epsilon_i^T \Sigma_t \epsilon_j\right)\sum_{h=0}^{H-1}\left(\epsilon_i^T A_h \Sigma_t A_{ht}^T \epsilon_i\right)} \tag{3}$$

with $\sum_{j=1}^{m}\tilde{\phi}_{ij,t}^{g}(H) = 1$ and $\sum_{i,j=1}^{m}\tilde{\phi}_{ij,t}^{g}(H) = k$. Thus, the connectedness measures of Diebold-Yilmaz (2012, 2014) via GFEVD are calculated as follows:

Total Directional Connectedness to Others – TO

$$TO_{jt} = \sum_{i=1, i\neq j}^{k}\tilde{\phi}_{ij,t}^{g}(H) \tag{4}$$

Total Directional Connectedness from Others – FROM

$$FROM_{jt} = \sum_{i=1, i\neq j}^{k}\tilde{\phi}_{ji,t}^{g}(H) \tag{5}$$

Net Total Directional Connectedness – NET

$$NET_{jt} = \sum_{i=1, i\neq j}^{k}\tilde{\phi}_{ij,t}^{g}(H) - \sum_{i=1, i\neq j}^{k}\tilde{\phi}_{ji,t}^{g}(H) = TO_{jt} - FROM_{jt} \tag{6}$$

Total Connectedness Index – TCI

$$TCI_t = k^{-1}\sum_{j=1}^{k} TO_{jt} \equiv k^{-1}\sum_{j=1}^{k} FROM_{jt} \tag{7}$$

Net Pairwise Directional Connectedness – NPDC

$$NPDC_{ij,t} = \tilde{\phi}_{ij,t}^{g}(H) - \tilde{\phi}_{ji,t}^{g}(H) \tag{8}$$

3. Empirical Findings

We followed the studies by Koop and Korobilis (2014), Korobilis and Yilmaz (2018), and Antonakakis et al (2020) to figure out the forgetting factors and prior distribution. We set the TVP-VAR forgetting factor as 0.99 and the Exponentially Weighted Moving Average (EWMA) forgetting factor as 0.96. Also, we assume Minnesota Prior for the TVP-VAR model. Our findings follow below.

3.1. Total and Dynamic Connectedness Index

Table 2 figures out the averaged connectedness measures. While the main diagonal of the 6x6 matrix (blue) in Table 2 shows own-variance shares of shocks, and off-diagonal elements reflect the interaction across financial assets. Firstly, there is high connectedness between indices. The TCI value that is included in Table 2 indicates that they constitute 41.75% of the total forecast error variance of the network. In other words, on average, 41.75% of the forecast error variance in one index can be attributed to the innovations in all others. Figure 2 illustrates the dynamic connectedness throughout the whole period. So, one can identify specific episodes that affected connectedness across indices over time.

Table 2. Average connectedness table

	FOUNDINGS	DISBANDINGS	TRNSP-CPI	PPI	IPI	ENERGY	*FROM*
FOUNDINGS	63.88	11.59	1.21	0.69	20.61	2.01	*36.12*
DISBANDINGS	9.35	81.89	0.75	0.36	6.86	0.79	*18.11*
TRNSP-CPI	1.44	0.71	53.00	30.01	1.19	13.66	*47.00*
PPI	2.04	0.36	25.60	48.92	0.59	22.50	*51.08*
IPI	25.53	21.73	1.01	0.44	49.51	1.77	*50.49*
ENERGY	1.89	0.77	15.78	27.64	1.6	52.30	*47.70*
TO	*40.25*	*35.16*	*44.36*	*59.14*	*30.86*	*40.74*	*250.5*
Inc.Own	*104.13*	*117.05*	*97.36*	108.06	80.36	93.04	cTCI/TCI
NET	4.13	17.05	–2.64	8.06	–19.64	–6.96	50.10/41.75
NPT	3	2	2	3	2	3	

Notes: results are based on a TVP-VAR (1) model and a 10-step-ahead GFEVD.

Source: authors' own elaborations.

In the assumptions made about the size of the Turkish logistics sector, it is accepted that its share in GDP is approximately 12% (UTİKAD, 2021). Therefore, this sector and related

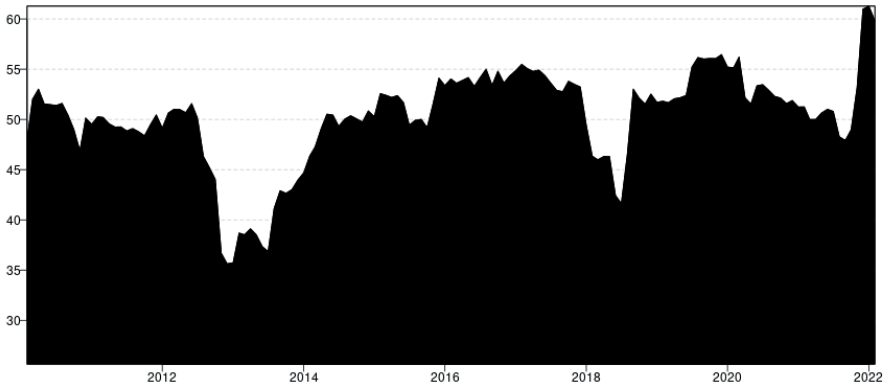

Figure 2. Dynamic Total Connectedness. Results are based on a TVP-VAR (1) model and a 10-step-ahead GFEVD

Source: authors' own elaborations.

ones are open to shocks from domestic and global events. The reasons for high connectedness in the period between 2010 and 2013 are as follows: (i) Turkey's foreign trade has increased continuously in the last 10 years and reached the largest foreign trade volume in 2013. (ii) European debt crisis: risk arising from the debts of many member countries, including Spain, Italy, and Greece, (iii) expectations that the Chinese economy will slow down, (iv) the decrease in energy prices. While the depreciation of the Turkish Lira in August 2018 increased the connectivity level above the average, the extreme fluctuation in the exchange rate in December 2021 and the Russia-Ukraine war increased the connectivity level to the highest level.

3.2. Net Total Connectedness

Figure 3 presents the Net Total Directional Connectedness (NET) of the system. The positive values of the shaded area show the net-transmitting role of the index and negative shades areas show the period when the index is a net receiver of shocks from others.

We see that the DISBANDING is the net transmitter throughout the entire period. FOUNDING is mainly the net shock receiver during the COVID-19 period and transmitter in other periods. We can say that TRANS-CPI and PPI are risk receivers throughout the entire period, and even the shocks they transmit increased in the post-2018 period. ENERGY and IPI are in shock receiver status throughout the entire period. The received shocks of IPI from others have decreased with the effect of the lockdown experienced during the COVID-19 period.

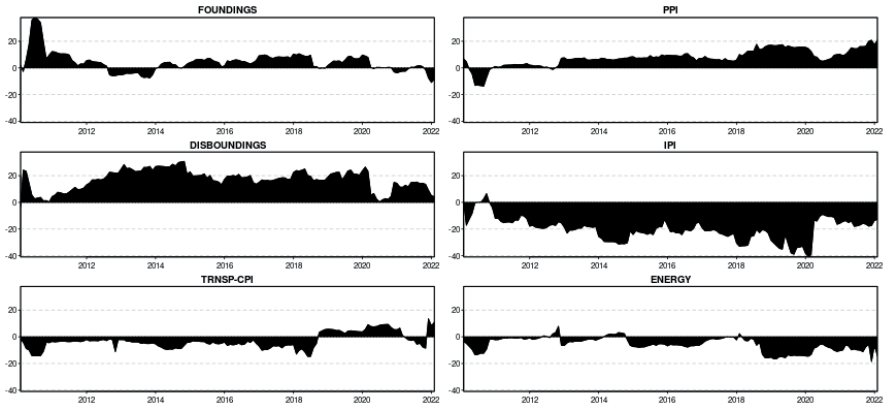

Figure 3. Net Total Directional Connectedness

Source: authors' own elaborations.

3.3. Net Pairwise Directional Connectedness

Figure 4 focuses on the Net Pairwise Directional Connectedness (NPDC) measures of spillovers. In this regard, in this section, we evaluate the outputs only on the variables FOUNDINGS and DISBANDINGS. NPDC illustrates that there are significant spillovers from FOUNDINGS and DISBANDINGS to IPI during the whole period, which means that FOUNDINGS and DISBANDINGS dominate the IPI. In other words, IPI is a net shock receiver from FOUNDINGS and DISBANDINGS. From these results, we understand that there is a high correlation between transportation and storage activities and industry utilization

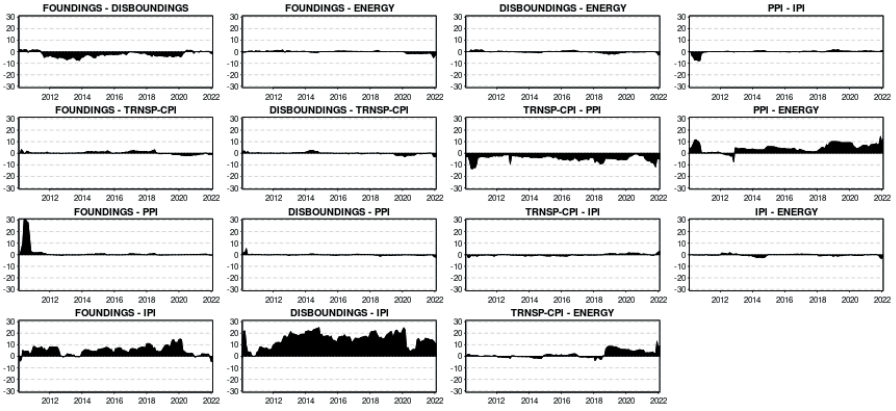

Figure 4. Net Pairwise Directional Connectedness

Source: authors; own elaborations.

capacities. In particular, the "*disbandings"* of companies operating in the field of transportation and storage affects production negatively. Meanwhile, the NPDC between FOUNDINGS and DISBANDINGS shows that the firm closing index for the entire period poses a risk to firm openings. These results are compatible with Ecology Theory.

Discussion and Conclusion

We discussed the relation among the variables (FOUNDINGS, DISBANDINGS, TRNSP-CPI, PPI, and ENERGY) within the framework of macroeconomic connectedness via organizational ecology theory in this paper. We applied the TVP-VAR-based Diebold-Yılmaz Connectedness approach in the analysis of the data. We found that the Total Connectedness Index value is 41.75 which means that on average, 41.75% of the forecast error variance in one index can be attributed to the innovations in all others. We conclude that the DISBANDING is the net transmitter throughout the entire period. FOUNDING is mainly a net shock receiver during the COVID-19 period and transmitter in other periods. Moreover, TRANS-CPI and PPI are risk receivers throughout the entire period, and even the shocks they transmit increased in the post-2018 period. ENERGY and IPI are in shock receiver status throughout the entire period. The received shocks of IPI from others have decreased with the effect of the lockdown experienced during the COVID-19 period. Interestingly, FOUNDINGS and DISBANDINGS dominate the IPI which means that IPI is a net shock receiver from FOUNDINGS and DISBANDINGS. From these results, one can infer that there is a high correlation between transportation and storage activities and industry utilization capacities.

Overall, our results can provide useful information for transport and storage investors and for creating risk management strategies. For example, investors can hedge against risk by looking at industry production capacity and the number of firm closures, taking into account the net bilateral link between the indices, and calculating the appropriate time period for establishing a firm. Also, connectedness indices vary considerably over the sampling period, which indicates that investors must dynamically adjust their position in the industry. In addition, it is thought that this research will contribute to the areas highlighted in the literature. Considering only the transportation and storage sector and not making a distinction according to the types of organizations (such as joint stock company, limited liability company, and limited company) constitute the limitations of this study. Similar studies to be carried out in other sectors and according to the type of organization will contribute to a more general idea about the subject.

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