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Araştırma Makalesi

Testing Kaldor's Growth Laws for Turkey: New Evidence from Symmetric and Asymmetric Causality Methods[1]

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Abstract
Nicholas Kaldor's main contribution to economic theory was his work on the industry-based growth model. Kaldor's laws examine the relationship between the industrial sector, economic growth, and labor productivity. This paper aims to test the validity of Kaldor's first and second (Kaldor-Verdoorn's) law for Turkey covering the period of 1980-2014 by using symmetric and asymmetric causality methods. According to the results of the symmetric causality tests, Kaldor's first and second laws are valid for Turkey. In this regard, industry value-added has a positive effect on growth and labor productivity in the industrial sector. The asymmetric causality test results indicate that Kaldor's first law holds in Turkey; however, Kaldor-Verdoorn's law is invalid. In other words, while the industry sector supports economic growth, it does not contribute to labor productivity. As a result, the findings indicate that the validity of Kaldor's laws may vary depending on the method used.
Keywords: Asymmetric Causality Test, Industrialization, Kaldor's Laws, Productivity
Jel Classification Codes: C22, L60, O14

Kaldor Yasalarının Türkiye için Testi: Simetrik ve Asimetrik Nedensellik Yöntemleri ile Yeni Bulgular

Öz
Nikolas Kaldor'un iktisat teorisine temel katkısı sanayiye dayalı büyüme modelidir. Kaldor yasaları sanayi sektörü, ekonomik büyüme ve işgücü verimliliği arasındaki ilişkileri incelemektedir. Bu çalışma Türkiye için 1980-2014 döneminde Kaldor'un birinci ve ikinci (Kaldor-Verdoorn) yasasının geçerliliğini, simetrik ve asimetrik nedensellik yöntemleri kullanarak test etmeyi amaçlamaktadır. Simetrik nedensellik testlerinin sonuçlarına göre Kaldor'un birinci ve ikinci yasası Türkiye için geçerlidir. Bu bağlamda sanayi sektöründe yaratılan katma değer hem ekonomik büyüme hem de sanayi sektöründeki işgücü verimliliği üzerinde pozitif bir etkiye sahiptir. Asimetrik nedensellik testinin bulguları ise Kaldor'un ilk yasasının geçerli olduğunu ancak ikinci yasasının geçerli olmadığını belirtmektedir. Diğer bir ifadeyle sanayi sektörü ekonomik büyümeyi desteklerken işgücü verimliliğine katkı sağlamamaktadır. Sonuç olarak, bulgular Kaldor kanunlarının geçerliliğinin kullanılan yönteme göre değişebildiğini göstermektedir.
Anahtar Kelimeler: Asimetrik Nedensellik Testi, Sanayileşme, Kaldor Yasaları, Verimlilik
Jel Sınıflandırma Kodları: C22, L60, O14

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1. Introduction

The industrial sector involves the whole process of manufacturing high-value-added products from raw materials and intermediate inputs using information and high technology. Technological advancement and new inventions often play an important role in economic development. The invention of the steam engine in the United Kingdom and improvement in the textile industry led to the Industrial Revolution, which then spread worldwide and paved the way for important economic reforms in many countries. The rapidly developing industrial sector gradually eclipsed the agricultural sector in economic importance by contributing to the development of other sectors such as transportation, service, and construction.

The Industrial Revolution, which began in England toward the end of the 18th century, resulted in different economic growth rates that divided the world into rich and poor areas (Kaldor, 1977). Before the Industrial Revolution, economic growth in most countries was quite slow, and the differences in living standards in different areas were comparatively small. With the Industrial Revolution, large-scale enterprises operating in the manufacturing industry achieved rapidly increasing growth rates. Countries that came to serve as large industrial centers became richly endowed with capital, machinery, increased education levels, and a qualified workforce.

Identifying industry disruption as the reason for post-WWII economic stagnation in the United Kingdom, Kaldor (1966) referred to the industrial sector as an engine of growth. Contrary to endogenous growth theories, Kaldor emphasized the importance of demand and external factors that affect demand by arguing that the industrial sector offers increasing returns to scale. In particular, the notion of increasing returns to scale is not valid in the agricultural sector, and the industrial sector provides capital, machinery, and high-tech products the agricultural sector requires.

Kaldor (1957) indicated that economic growth could be achieved by increased technical progress function, a concept he introduced to economics research. The establishment of industrial plants increases the rate of technical progress, which in turn led to the production of new intermediate and capital goods, improved production techniques, and increased labor productivity. Moreover, the plants provide transformation to a labor-saving production process that resulted in the continuous manufacture of new and better products. A country's industrial sector revives both domestic and external demand, thus, contributes to economic growth and development. Like Keynesian economists, Kaldor argued that effective demand is an important determinant of economic growth.

This study investigates the validity of Kaldor laws in Turkey is composed of six sections. Following the introduction, Section 2 refers to the development of the industrial sector in Turkey. Section 3 presents the relevant literature review; Section 4 includes the data set; Section 5 describes the methodology and empirical results. Finally, Section 6 presents the study's conclusions.

2. The Development of the Industrial Sector in Turkey

Turkey's industrialization process can be examined in terms of three stages (Tekeli, 2010). The primary goal of the first period, from 1929 to 1950, was to reduce dependency on imports by producing basic consumer goods through state economic enterprises. The primary goal of the second period, from 1950 to 1960, was to promote private investments in the industrial sector and produce investment goods in addition to basic consumer needs. The primary goal of the third period, from 1963 to 1976, was to improve the industrial sector directly by implementing growth and development plans. The government first aimed to develop the industrial sector through government grants during the implementation of the first 5-year development plan. With the state economic enterprises (SEEs), the production of raw materials and investment goods was achieved even at a loss. Industrialism was encouraged by providing low-interest loans and raw materials to the private sector. Newly established small enterprises were protected against the foreign competition through the means of import prohibitions. During the same period, the private sector played an important role in the development of industry in Europe. In Turkey, government grants were provided for a while, and then in the next stage, the intention was to help private sector entrepreneurs gain importance in the industrial sector by developing the necessary infrastructure. Such policies, based on the import substitution industrialization strategy, restricted foreign trade, thus leading to a foreign exchange bottleneck.

Moreover, the state did not achieve economic efficiency because of the lack of foreign companies with which local firms could compete. To solve this problem, the government replaced the fixed exchange rate system with the flexible exchange rate system due to the decisions made on January 24, 1980. With the liberalization of imports and exports, competition arose between local and foreign companies, and thus efficiency and effectiveness were achieved in production.

The industrial sector is an important employment area for individuals. In 2013, 25.524 million people were employed in Turkey, of whom 105,000 were employed in the industrial sector, mining, and quarrying; 4.632 million were employed in the manufacturing sector; and 218,000 were employed by utilities — electricity, gas and steam, and sewer (Turkstat, 2014). The total number of people working in the manufacturing industry was 2.06 million in 1980. As of today, this figure has increased by more than 50%. Table 1 shows the shares of the three sectors in Turkey's GDP over 30 years. The agricultural sector's share in the GDP decreased to a considerable extent during the liberalization period. On the other hand, the shares of the industrial and tertiary sectors increased. Between 2010 and

2014, the three sectors were balanced, and no significant change was observed in their shares in the GDP. During this period, the GDP shares of the industrial and service sectors increased, whereas those of the agricultural sector decreased globally.

Table 1: Proportions of Economic Sectors in Turkey's GDP (%)

Sector	1980	1990	2000	2010	2011	2012	2013	2014	(%)
Agriculture	26.5	18.00	11.31	9.45	9.00	8.84	8.33	8.00	-69
Industry	23.8	32.15	31.33	26.39	27.47	26.66	26.60	27.10	14
Service	49.68	49.75	57.34	64.15	63.52	64.48	65.05	64.89	31

Source: World Development Indicators at http://data.worldbank.org/country/turkey

In the industrial sector, technological intensity and exports are of high importance. Table 2 shows the production rates calculated based on the prices of 2010, excluding exports and gold. According to these rates, a transformation has occurred in the Turkish industrial sector in recent years regarding medium-high-technology.

Table 2: Production and Export Structure of Industry in Turkey

Technological density	Production			Export		
	2007	2012	2013	2007	2012	2013
High	3.4	3.5	3.4	4.5	3.7	3.5
Medium-high	23.2	24.1	24.7	32.8	31.4	32.3
Medium-low	34.8	33.3	32.9	29.7	31.5	29.0
Low	38.7	39.1	39.0	33.0	33.5	35.3

Source: Republic of Turkey Ministry of Development, 2014.

The reason for the increase in high-technology production and export was the improvements in the automotive industry financed by foreign funds. The technological intensity of the exports shows production rates decreased, but export rates increased from 2007 to 2013 only for low-tech products. Although the production of goods requiring medium-high-technology intensity increased, their export did not. Medium-low- and low-technology products make up 64.3% of Turkish industrial exports. Almost all of Turkey's exported goods are industrial goods. The industrial sector is of crucial importance both for Turkey and other countries worldwide for its contribution to the national economy through domestic and foreign demand. Thus, the relationship between economic growth and the industrial sector has become a research subject.

3. Literature Review

Kaldor's first growth law, which states manufacturing is the engine of economic growth, and Kaldor's second law, which states increasing manufacturing output also increases sector productivity (Kaldor-Verdoorn's law) were tested by Kaldor

(1966) for 12 countries. He found that the industrial sector positively affects economic growth and labor productivity. According to Rowthorn (1975), the results of Cripps and Tarling (1973), which supported Kaldor's work for the same period and same country group, were inappropriate because they included Japan in the 12 countries studied. Rowthorn excluded Japan from the cross-sectional group and conducted the analysis by regressing productivity concerning employment and production increase in the industrial sector. He found no significant relationship between the industrial sector and productivity in this sector and argued that Kaldor's model is inappropriate.

The studies conducted using the ordinary least squares (OLS) method by Stoneman (1979) in the United Kingdom, by McCombine and De Ridder (1983) in the United States, by Drakopoulos and Theodossiou (1991) in Greece, by Atesoglu (1993) in the United States, by Wells and Thirlwall (2003) in 45 African countries, and by Millin and Nichola (2005) in South Africa confirmed the validity of Kaldor's first law. Five studies, except for Stoneman's (1979), validated Kaldor-Verdoorn's law. Relatively new studies such as Keho (2018) used the ARDL bounds testing approach for 11 Economic Community of West African States countries, and Opoku and Yan (2019) performed GMM on 34 African countries. Both confirmed the validity of Kaldor's first law. McCausland and Theodossiou (2012) and Almosabbeh and Almoree (2018) also verified the validity of Kaldor's first and second laws.

For Turkey, Bairam (1991), using OLS, also verified the validity of Kaldor's law. Necmi (1999) utilized cross-section data for 45 countries, including Turkey, and confirmed the validity of both Kaldor's laws. Terzi and Oltulular (2004) used Hsiao's Granger-causality and the Engle-Granger cointegration tests and found bidirectional causality between the index of industrial production and economic growth. Cetin (2009) used OLS on 14 EU member states and Turkey and found that the increase in industrial production index had a positive impact on the GDP in Turkey and 10 EU member states (except for Romania, Ireland, and France). Doruk et al. (2013) conducted a study in Turkey using OLS and concluded that growth in the manufacturing sector increased economic growth more than growth in the agricultural sector. Marconi et al. (2016) conducted tests using dynamic panel data analysis for 63 middle- and high-income countries, including Turkey and confirmed the validity of both Kaldor's laws.

Six studies in the literature review were conducted for Turkey or a sample of countries, including Turkey. Terzi and Oltulular's (2004) study on Turkey and Cetin's (2009) study on several other countries reported bidirectional causality between the industrial sector and GDP. Both studies used the industrial production index as an indicator for the industrial sector. Among these studies, only Stoneman's (1979) research does not support Kaldor-Verdoorn's law. No study in the literature separates positive shocks from negative ones.

Our study contributes to the existing literature in two ways. First, to the best of our knowledge, there is no study that tests the Kaldor's laws with asymmetric causality test. Second, this is the first study using industrial value-added growth rate minus the total growth rate of the agricultural and service sectors as an indicator of the industry as proposed by Thirlwall (1983) for Turkey.

4. Data and Model

We obtained the data from the World Bank Development Indicators (WDI) and the Turkish Statistical Institute database. Since the decisions of January 24, 1980, in which Turkey abandoned the import substitution strategy and adopted an export-oriented industrial strategy, the country's industrial sector has experienced significant structural changes. Therefore, this study takes the period of 1980–2014.

Kaldor's first law states that GDP increases through the industrial sector. In Equation 1, GDP indicates the gross domestic product (constant 2010 US Dollars), IND indicates the production in the industrial sector (constant 2010 US Dollars), and u_t indicates the error term. The equation can also be expressed as the growth rate of the variables. In Equation 2, GDPR indicates the gross domestic product growth rate, and INDR indicates the industrial production or value-added growth rate.

$$GDP=\beta_0+\beta_1 IND+u_t \quad (1)$$

$$GDPR=\alpha_0+\alpha_1 INDR+e_t \quad (2)$$

Kaldor (1966) indicated that a positive correlation might exist between the two variables because the manufacturing sector has a share of 25% to 40% in the GDP. According to Thirlwall (1983), a spurious regression problem may arise because GDPR included the growth of manufacturing and non-manufacturing sectors in the second equation. Thus, estimators may not be effective and reliable. Revising Kaldor's first law, as in Equation 3 solves this problem.

$$GDPR=\delta_0+\delta_1 INDRE+\varepsilon_t \quad (3)$$

In Equation 3, INDRE indicates the industrial value-added growth rate minus the total growth rate of the agricultural and service sectors. The first two equations were not used in the study due to the mentioned problems. Equations 3 and 4 were analyzed for testing Kaldor's first and second laws.

$$PRD=\mu_0+\mu_1 INDR+z_t \quad (4)$$

Kaldor’s second law, known as Kaldor-Verdoorn’s law, states that technical progress, division of labor, and specialization in the industrial sector bring increasing returns; thus, labor productivity increases with industrial production. Equation 4 is the representation of Kaldor’s second law, where PRD indicates the labor productivity calculated by subtracting the growth rate of industrial labor from the industrial value-added growth rate (INDR – INDEMP). According to Kaldor’s second law (1975), labor productivity and industrial employment are endogenous, whereas the exogenous growth of Keynesian demand determines industrial output growth.

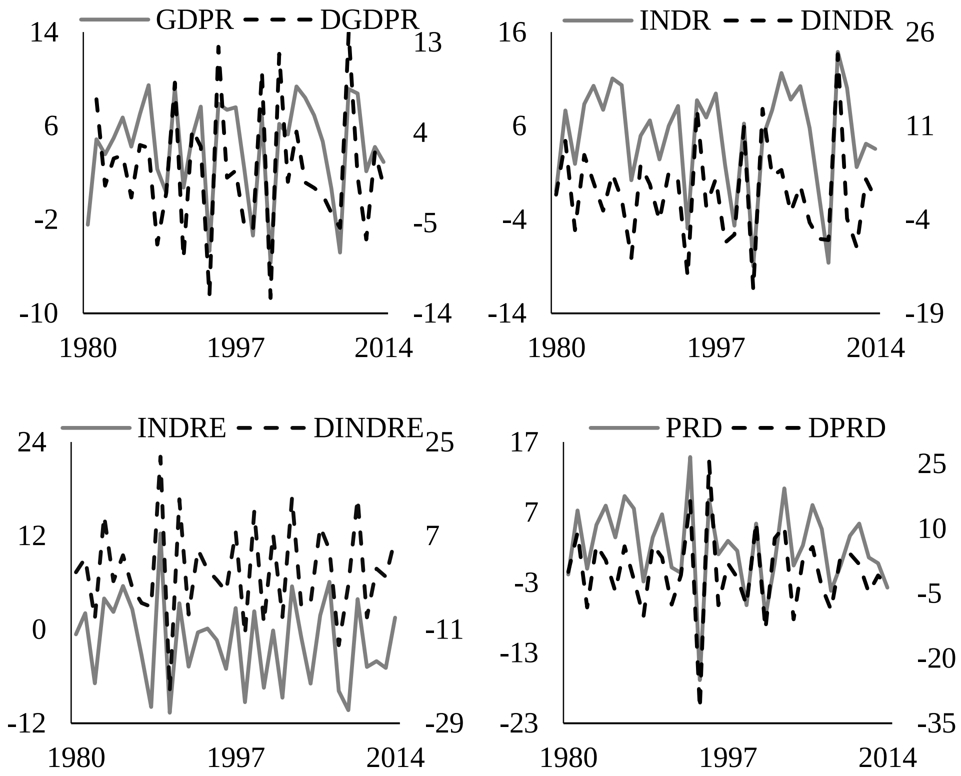

Figure 1. Level and First Differenced Variables

In Figure 1, it is seen that the series do not have an increase or decrease trend in both level values and first differences. In addition, some descriptive statistics of the variables are shown in Table 3.

Table 3: Descriptive Statistics

Variables	GDPR	INDR	INDRE	PRD
Mean	4.16	4.89	-1.49	2.06
Median	4.97	6.23	-0.61	2.31
Maximum	9.48	13.87	12.28	14.88
Minimum	-5.69	-8.98	-10.64	-16.84
Std. Dev	4.33	5.63	5.60	5.99
Observation	35	35	35	35

5. Methodology and Empirical Results

5.1. Unit Root Tests

During the analysis of the developing countries, the tests that do not include structural breaks in the models may give misleading results. Equations 5, 6, and 7 show the three models built for the Zivot-Andrews (ZA) unit root test, which allows for one endogenous structural break (Zivot and Andrews, 1992). The null hypothesis (H_0: $\alpha = 0$) states that the series have a unit root, whereas the alternative hypothesis ($H_{alternative}$: $\alpha \neq 0$) states that the series are stationary with structural breaks.

$$\Delta x_t=\delta+\beta t+ \alpha x_{t-1}+\mu_1 DU(\lambda)_t+\sum_{i=1}^{m} n_i\Delta x_{t-i}+\varepsilon_t \quad \text{Model A} \quad (5)$$

$$\Delta x_t=\delta+\beta t+ \alpha x_{t-1}+\mu_2 DT(\lambda)_t+\sum_{i=1}^{m} n_i\Delta x_{t-i}+\varepsilon_t \quad \text{Model B} \quad (6)$$

$$\Delta x_t=\delta+ \beta t+\alpha x_{t-1}+\mu_1 DU(\lambda)_t+\mu_2 DT(\lambda)_t+\sum_{i=1}^{m} n_i\Delta x_{t-i}+\varepsilon_t \quad \text{Model C} \quad (7)$$

Lumsdaine and Papell (1997) (LP) introduced another unit root test that allows for two structural breaks by improving the ZA (1992) unit root test. Equations 8, and 9 indicate the two models built for the LP unit root test.

$$\Delta x_t=\delta+\beta t+ \alpha x_{t-1}+\mu_1 DU1_t+\mu_2 DT1_t+\sum_{i=1}^{m} n_i\Delta x_{t-i}+\varepsilon_t \quad \text{Model AA} \ (8)$$

$$\Delta x_t=\delta+ \beta t+\alpha x_{t-1}+\mu_1 DU1_t+\mu_2 DT1_t+\mu_2 DU2_t+\mu_2 DT2_t+\sum_{i=1}^{m} n_i\Delta x_{t-i}+\varepsilon_t \quad \text{Model CC} \ (9)$$

In these equations, Δ is the difference operator, ε_t represents the normally distributed white noise error terms, and Δx_{t-i} shows the lagged values of the variable. $DU1_t$, $DU2_t$, $DT1_t$, and $DT2_t$ are the dummy variables that give the first and second break dates of the series in the intercept and trend. In Model AA and Model CC, when T_{b1} is the first break date, T_{b2} is the second break date, if $t > T_{b1(b2)}$, the dummy variables $DU1_t$ ($DU2_t$) take the value 1; otherwise, 0. If t >

$T_{b1(b2)}$, the dummy variables $DT1_t$ ($DT2_t$) take the value t – $T_{b1(b2)}$; otherwise, 0. In the LP unit root test, the null hypothesis (H_0: $\alpha = 0$) means the series have a unit root without any structural break, whereas the alternative hypothesis ($H_{alternative}$: $\alpha \neq 0$) means the series are stationary with two structural breaks. The results of the LP and ZA unit root tests are given in Table 4.

Table 4: ZA and LP Unit Root Test Results

k=9	ZA		LP	
Variables	Model A	Model C	Model AA	Model CC
INDR	-6.43 (0)*** [2003]	-6.34 (0)*** [2003]	-6.61 (0)** [1998;2002]	-7.11 (0)*** [2002;2009]
PRD	-7.23 (1)*** [2003]	-6.97 (1)*** [2003]	-10.45 (0)*** [1984;2002]	-10.85 (0)*** [1987;2002]
GDPR	-7.01 (0)*** [2003]	-6.96 (0)*** [2003]	-5.65 (0) [2003;2007]	-6.79 (3)** [2000;2007]
INDRE	-7.01 (2)*** [2003]	-6.96 (2)*** [2003]	-10.34 (0)*** [1986;2007]	-10.77 (0)*** [1986;2008]
ΔINDR	–	–	–	–
ΔPRD	–	–	–	–
ΔGDPR	–	–	–	–
ΔINDRE	–	–	–	–

Notes: *** and ** denote significant at 1% and 5% level, respectively. ( ) are the optimal lag lengths determined by AIC for both unit root tests by allowing for a maximum of nine lags.

According to Table 3, the INDR, PRD, GDPR, and INDRE series were found to be stationary at level I(0) with one and two structural breaks, respectively. Therefore, d_{max} was not used in models 3 and 4

5.2. Symmetric Causality Tests

The TY causality test (1995) incorporates variables into the analysis at their level irrespective of the order of integration properties, thus solving the problem of the long-term information loss in the Granger (1969) causality test. Because some of the variables included in a VAR model are nonstationary, the Wald test statistic applied to test linear restrictions on the parameters does not follow its usual asymptotic χ^2 distribution under the null hypothesis. Therefore, Toda and Yamamoto (1995) stated that the Wald test statistic applied to a VAR model by adding lags to the lag length p to the extent of the maximum order of integration of the variables (d_{max}) would follow the χ^2 distribution. If all series included in the TY Granger causality analysis are found to be stationary at level, no additional lag length is added because dmax = 0 and the results obtained are similar to those obtained from the unrestricted VAR analysis.

$$Y_t=\delta_{10}+\sum_{i=1}^{p}\beta_{1i}\,Y_{t-i}+\sum_{i=p+1}^{p+d_{max}}\emptyset_{1i}\,Y_{t-i}+\sum_{i=1}^{p}\vartheta_{1i}\,X_{t-i}+\sum_{i=p+1}^{p+d_{max}}\partial_{1i}\,X_{t-i}+u_{1t} \quad (10)$$

$$X_t=\delta_{20}+\sum_{i=1}^{p}\alpha_{2i}X_{t-i}+\sum_{i=p+1}^{p+d_{max}}\theta_{2i}X_{t-i}+\sum_{i=1}^{p}\mu_{2i}Y_{t-i}+\sum_{i=p+1}^{p+d_{max}}\omega_{2i}Y_{t-i}+u_{2t} \quad (11)$$

Equations 10 and 11 applied the Wald test to the sum of the lag length p to test two null hypotheses (i.e., H_0: $\vartheta_{1i} = 0$ and H_0: $\mu_{2i} = 0$). If both coefficients are different from zero, a bidirectional causality exists between two variables.

Table 5: VAR Granger Causality Results

Models	Causality [Coefficient]	SUR-Wald Test (p)		$p+d_{max}$
GDPR=f(INDRE)	INDRE→GDPR[+0.31]	χ^2=6.95 (0.01)***		1+0=1
INDRE=f(GDPR)	-			
PRD= f(INDR)	INDR→PRD[+0.57]	χ^2=6.33 (0.01)***		1+0=1
INDR= f(PRD)	-			
Diagnostic Tests	AR Roots max; min	LM stat.	Normality	White χ^2
Model 3	0.50; 0.06	>2.66 (0.62)	2.14 (0.71)	7.22 (0.84)
Model 4	0.58; 0.04	>5.11 (0.28)	3.81 (0.43)	15.69(0.21)

Notes: [ ] is the total value of both lags for Model 1 and 2. ( ) are the probability values. *** and ** denote significant at 1% and 5% level, respectively.

Table 5 shows the findings obtained from the TY-VAR analysis conducted to examine the relationship between the industrial sector and economic growth and productivity. Because we found both variables added to Model 3 and 4 to be stationary at their levels, we performed unrestricted VAR analysis. At the end of the VAR causality analysis conducted using the SUR procedure, we confirmed the validity of Kaldor's first and second laws for the Turkish economy. The industrial sector increases both economic growth and labor productivity. The diagnostic tests, White χ^2 values, and LM statistics for the estimated four VAR models do not indicate the presence of heteroscedasticity autocorrelation and problems. Normality test results indicate that the error terms of the models are normally distributed.

The CUSUM and CUSUMSQ tests developed by Brown et al. (1975) and applied to consecutive error terms and squares of consecutive error terms help determine whether the estimated coefficients are stable. These tests statistics in Table 6 show that the coefficients in the VAR models are stable.

Table 6: CUSUM and CUSUMSQ Test Results

Models	CUSUM Statistics	P-values	CUSUMSQ Statistics	P-values
GDPR=f(INDRE)	0.23	0.99	0.23	0.20
PRD= f(INDR)	0.65	0.33	0.11	0.99

The Hacker-Hatemi-J (2006) (HH) causality test obtains appropriate table critical values using the bootstrap simulation approach introduced by Efron (1979). If the estimated TY-VAR ($p + d_{max}$) is expressed $X = \widehat{D}Z + \hat{\delta}$, the expressions are $X = (x_1, x_2, x_3 \ldots, x_T)(nxT)$ matrix, $\widehat{D} = (\hat{\alpha}, \widehat{A}_1, \widehat{A}_2, \widehat{A}_p, \ldots\ldots, \widehat{A}_{p+dmax})(nx(1 + n(p + d_{max}))$ matrix;

$$Z_t=\begin{bmatrix} 1 \\ x_t \\ x_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ x_{t-p-d_{max}+1} \end{bmatrix}\big((1+n(p+d_{max}))x1\big)\text{matrix, } t=1,\ldots,T,$$

$Z = (Z_0, Z_1, Z_2 \ldots, Z_{T-1})((1 + n(p + dmax)xT)$ matrix, and $\delta = (\hat{u}_1, \hat{u}_2, \hat{u}_3 \ldots, \hat{u}_T)$ (nxT) matrix. Equation 12 shows the modified Wald (Mwald) test.

$$MWald=\left(C\hat{\beta}\right)'\left[C\left(\left(Z'Z\right)^{-1}\otimes S_u\right)C'\right]^{-1}(C\hat{\beta}) \quad (12)$$

In the HH causality test, the main hypothesis indicating that no causality exists is tested as H_0: $C\beta = 0$. In addition, Hatemi-J (2003) recommended the Hatemi-J information criterion (HJC) involving Schwarz's information criterion (SIC) and Hannan-Quinn information criterion (HQ) in equation 13.

$$HJC=\ln(\left|\widehat{\Omega}\right|+j(\frac{n^2\ln T+2n^2\ln(\ln T)}{2T}), \qquad j=0\ldots\ldots,k., \quad (13)$$

According to Table 7, which presents the results of the HH causality analysis, the test statistics found to be greater than the bootstrap table critical values confirm the validity of Kaldor's first and second laws.

Table 7: Hacker-Hatemi-J Bootstrap Causality Results

Null Hypothesis (H0)	Test Statistics	1%	5%	10%	Optimal Lag
INDR≠>GDPR	7.32**	8.75	5.14	3.59	1
GDPR≠>INDR	4.08*	7.47	4.09	2.79	1
INDRE≠>GDPR	6.34**	7.37	4.06	2.76	1
GDPR≠>INDRE	0.10	7.58	4.05	2.84	1
INDR≠>PRD	5.77**	7.11	4.14	2.82	1
PRD≠>INDR	1.62	7.00	3.83	2.63	1

Notes: Optimal lag length is selected by HJC. Number of bootstrap replications is 10000. ** and * means significant at 5% and 10% level, respectively.

5.3. Asymmetric Causality Test

Hatemi-J (2012) made improvements on Granger and Yoon's (2002) hidden cointegration approach for the TY causality test. This method takes account of the effects of positive and negative shocks separately.

$$INDR_t=INDR_{t-1}+\varepsilon_{1t}=INDR_{1,0}+\sum_{i=1}^{t}\varepsilon_{1i}$$

$$GDPR_t=GDPR_{t-1}+\varepsilon_{2t}=GDPR_{2,0}+\sum_{i=1}^{t}\varepsilon_{2i} \quad (14)$$

In Equation 14, $INDR_{1,0}$, and $GDPR_{2,0}$ are initial values (constant terms); ε_{1i} and ε_{2i} are stationary error terms. $\varepsilon_{1i}^{+}=\max(\varepsilon_{1i},0)$, and $\varepsilon_{2i}^{+}=\max(\varepsilon_{2i},0)$; and $\varepsilon_{1i}^{-}=\min(\varepsilon_{1i},0)$ $\varepsilon_{2i}^{-}=\min(\varepsilon_{2i},0)$ are positive and negative shocks. They are described $\varepsilon_{1i}=\varepsilon_{1i}^{+}+\varepsilon_{1i}^{-}$ and $\varepsilon_{2i}=\varepsilon_{2i}^{+}+\varepsilon_{2i}^{-}$ as a whole. The case as indicated in Equations 15 and 16 following the decomposition.

$$INDR_t=INDR_{t-1}+\varepsilon_{1t}=INDR_{1,0}+\sum_{i=1}^{t}\varepsilon_{1i}^{+}+\sum_{i=1}^{t}\varepsilon_{1i}^{-} \quad (15)$$

$$GDPR_t=GDPR_{t-1}+\varepsilon_{2t}=GDPR_{2,0}+\sum_{i=1}^{t}\varepsilon_{2i}^{+}\sum_{i=1}^{t}\varepsilon_{2i}^{-} \quad (16)$$

Equation 17 estimates the causality test for the VAR model with k lag length, which has positive shocks. For negative shocks, the same operations are repeated by turning plus (+) into minus (–):

$$X_t^{+}=\alpha+A_1X^{+}_{t-1}+\ldots+A_kX^{+}_{t-1}+u_t^{+} \quad (17)$$

where X_t^{+} is a variable vector of 2x1 size, and A is a parameter matrix $\begin{bmatrix} b_{11}^{1} & b_{12}^{1} \\ b_{21}^{1} & b_{22}^{1} \end{bmatrix}$ of 2x2 size. r (r = 1,…..,k) is the lag length for the A_r matrix. After the appropriate lag length is determined using the HJC criteria, the VAR model for the analysis of the null hypothesis is defined as X = DZ+δ. The expressions in the equation are as follows, respectively:

$$Z_t=\begin{bmatrix} 1 \\ x_t^{+} \\ x_{t-1}^{+} \\ \cdot \\ \cdot \\ \cdot \\ x_{t-k+1}^{+} \end{bmatrix}\big((1+nk)x1\big)\text{matrix}, t=1,\ldots,T,\ Z=(Z_0, Z_1, Z_2\ldots.., Z_{T-1})((1+nkxT)$$

matrix, and

$\delta = (u_1^+, u_2^+, u_3^+ ..., u_T^+)$(nxT) matrix. In this case, the null hypothesis $H_0 = C\beta = 0$ indicates, using Equation 19, that no causality is tested:

$$\text{Wald}=(C\beta)' \left[C\left((Z'Z)^{-1} \otimes S_u\right) C'\right]^{-1} (C\beta) \qquad (19)$$

Following this estimation, we estimate the equation $X^* = \widehat{D}Z + \delta^*$. Bootstrap error terms (δ^*) are adjusted such that each one is bootstrapped (i.e., with error terms having zero mean). If the Wald test value, performed at the last stage, is larger than the bootstrap table critical value, the null hypothesis of no causality is rejected.

Table 8 shows the results of the Hatemi-J asymmetric causality test conducted by the positive and negative shocks of six variables included in four models tested by the TY-VAR and HH bootstrap causality tests. We included d_{max} lag length, added to the optimum lag length by means of the TY-VAR procedure, in the models based on the degrees of integration obtained by applying unit root tests. We found positive and negative shocks of GDPR and INDRE stationary at their levels, and we found the other variables stationary at the first difference. The findings showed causality from the positive (negative) shocks of the industrial value-added growth rate minus the growth rate of other sectors to the positive (negative) shocks of the GDPR.

Table 8: Asymmetric Causality Test Results

Null Hypothesis (H_0)	Test Statistics	1%	5%	10%	Optimal Lag
$INDR^- \not\Rightarrow GDPR^-$	0.53	8.24	4.18	2.93	2
$INDR^+ \not\Rightarrow GDPR^+$	0.08	9.79	4.44	2.89	2
$GDPR^- \not\Rightarrow INDR^-$	1.37	11.20	5.14	3.38	2
$GDPR^+ \not\Rightarrow INDR^+$	0.10	10.52	4.95	3.02	2
$INDRE^- \not\Rightarrow GDPR^-$	12.32***	9.01	4.42	2.95	2
$INDRE^+ \not\Rightarrow GDPR^+$	13.73***	10.10	5.72	3.94	1
$GDPR^- \not\Rightarrow INDRE^-$	0.21	7.98	4.30	2.90	2
$GDPR^+ \not\Rightarrow INDRE^+$	4.30*	8.71	4.65	3.23	1
$INDR^- \not\Rightarrow PRD^-$	0.22	9.17	4.25	2.85	2
$INDR^+ \not\Rightarrow PRD^+$	0.06	9.91	4.30	2.85	2
$PRD^- \not\Rightarrow INDR^-$	0.17	9.26	4.80	3.00	2
$PRD^+ \not\Rightarrow INDR^+$	0.01	12.28	5.40	3.31	2

Notes: Optimal lag length is selected by HJC. Number of bootstrap replications is 10000. ***, ** and * means significant at 1%, 5% and 10% level, respectively.

6. Conclusion

In Turkey, the decisions made on January 24, 1980, achieved considerable progress in economic growth and development. Since then, export-oriented policies have replaced the import-substitution industrialization strategy. The decisions of 1980 reshaped both the foreign trade and industrial sectors, and the government-initiated production activities oriented to both foreign and domestic markets. This study used annual data for the liberalization period from 1980 to 2014 to examine whether Kaldor's two laws are valid for the Turkish economy. The findings obtained from the VAR causality test using model 3 revealed that Kaldor's first law is valid for the Turkish economy. In the third model, the industrial added value was within the gross domestic product; thus, we obtained the independent variable by subtracting the value-added growth rate of the other two sectors from the industrial value-added growth rate and determined that this variable had a positive and significant effect on the gross domestic product. Kaldor-Verdoorn's law states that an increase in industrial output also increases industrial productivity. The results of the TY-VAR analysis also support Kaldor's second law. The findings obtained from the Hacker-Hatemi-J (2006) bootstrap process-based causality analysis confirmed to those of the VAR causality analysis. Finally, we used the Hatemi-J (2012) asymmetric causality test to divide the variables into positive and negative shocks and found Kaldor's first law valid, but Kaldor-Verdoorn's law invalid. The findings of the asymmetric causality test are more reliable than those of the other two tests.

In terms of the first law, the results of the study are in line with the findings of Terzi and Oltulular (2004), Cetin (2009), Doruk et al. (2013), and Marconi et al. (2016). However, in terms of the Kaldor-Verdoorn law, the findings of this study contrast with most studies in the literature. According to the results of our study, Turkish industrial growth does not contribute to labor productivity. This is an indicator that the income from the industrial sector cannot be used effectively for employment. To increase labor productivity in the industrial sector, Turkey should increase the share of education spending in national income.

In light of the findings obtained for the first law, the industrial sector is vital for achieving sustainable economic growth in Turkey. Therefore, firms working in the industrial sector should be encouraged to increase production. The industrial sector is responsible for almost all exports. Turkey's exports must be shaped by technical advancements and knowledge in the industrial sector. The countries aim mainly to produce high-value-added goods and export products with high-technology intensity. In Turkey, the export of goods with high-technology intensity amounts to only 3% of all exports. As Turkey aims to become one of the world's top 10 economies, it is of great importance to move investments in the industrial sector to productive fields, to increase labor productivity, to produce high-value-added products, and to export these products to the existing markets.

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