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The Role of the Manufacturing Sector in Promoting Economic Growth in the Saudi Economy: A Cointegration and VECM Approach*

Mohamed A. M. SALLAM[1]

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Abstract

This study examines the role of the manufacturing sector in stimulating economic growth in the Saudi economy. Even though the economic literature shows how the manufacturing sector stimulates economic growth, it does not clearly show the role of the manufacturing sector in economic growth. The study employed annual time-series data spanning the 1980–2018 period from the databases of the Saudi Arabian Monetary Authority. Moreover, the cointegration and VECM approaches were employed to examine the short- and long-run relationship causality between variables. The results show a two-way causal relationship exists between the manufacturing sector and economic growth. Furthermore, the results indicate that a unidirectional causal relationship exists, running from the manufacturing sector to the services sector. The study recommends that the determinants of the growth of the Saudi manufacturing sector must be investigated. Moreover, the most productive Saudi manufacturing industries must be identified, and the productivity of other sectors must be increased in a way that contributes to economic plans and policies. Thus, adopting economic policies that stimulate investment in the manufacturing sector contributes to increasing non-oil exports to diversify sources of income to achieve vision 2030 of the Kingdom of Saudi Arabia.

Keywords: Kaldor's Law, Economic Growth, Manufacturing Sector, Cointegration, VECM Approach

JEL Classification Code: C22, O14, O47

1. Introduction

The economic literature highlights how the manufacturing sector stimulates economic growth. Development experiences worldwide include many indications of the role of the industrial sector in formulating and achieving the objectives of development plans. This situation called for the majority of countries to develop and diversify their production base to contribute to increasing economic growth rates, thereby improving societal and economic welfare.

Since the great industrial revolution of Great Britain, manufacturing has acted as the engine of high and sustainable growth. Strong and sustainable growth has come to be associated with industrialization and growth in manufacturing output relative to total output. Several studies have shown that the manufacturing sector has strong forward and backward linkages with other sectors that spur economic diversification.

Moreover, Szirmai et al. (2013) summarized the main arguments supporting the case for manufacturing as an engine of development, such as higher productivity in manufacturing, as compared with other sectors; a strong positive correlation between the degree of industrialization and levels of per capita income; economies of scale and technological progress, and more opportunities for capital accumulation.

The manufacturing sector has many characteristics, making it a key determinant of economic growth. It is the fastest-growing sector, as compared to other economic sectors. Its productivity is higher than the agricultural and service sectors. The possibility of specialization is greater in the manufacturing sector. Moreover, it has forward and backward linkages with other sectors. Given industrial

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[1]First Author and Corresponding Author. [1] Associate Professor, Department of Economics, Faculty of Commerce, Kafr Elsheikh University, Egypt [2] Department of Economics, College of Economics and Administrative Sciences, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia [Postal Address: P.O. Box 5701, Riyadh, 11432, Saudi Arabia]
Email: Mohamedsallam_2010@yahoo.com; Mohamedsallam68@gmail.com

products tradable and access to international markets, the manufacturing sector has better opportunities for increasing demand (Tunali & Boru, 2019).

The various schools of economic thought did not clearly show the role of the manufacturing sector in economic growth. Kaldor's laws highlight the importance of the industrial sector in economic growth. Kaldor's first law states that the higher the growth of industrial output, the greater the rate of growth of the economy. Meanwhile, the second law, known as the Kaldor–Verdoorn law, emphasizes a deterministic relation between the growth of manufacturing productivity and manufacturing output growth (Marconi et al., 2016).

The economic development plans of the Kingdom of Saudi Arabia (KSA) focused on the industrial sector to achieve economic and social development by diversifying the production base and eliminating the effects of dependence on oil as the sole source of national income.

The efforts of the state in supporting industrial development included several basic axes, including the provision of the necessary infrastructure, the establishment of the industrial cities of Jubail and Yanbu, the establishment of industrial cities in various regions of the Kingdom, as well as the establishment of the Saudi Industrial Development Fund. These efforts resulted in the development of the manufacturing sector.

According to the data spanning the past four decades, the industrial base in the Kingdom has expanded considerably, increasing the number of factories from 206 in 1974 to 7630 by the end of the first quarter of 2018. This development was accompanied by an increase in invested capital from about 4.3 billion riyals in 1974 to about 1.1 trillion riyals in 2018.

The number of workers increased from about 10,000 in 1974 to more than one million in 2018. Industrial production in the Kingdom also grew steadily during the same period. The GDP, where the manufacturing industries maintained constant prices, rose from 32 billion riyals in 1974 to about 319.5 billion riyals by the end of 2018. The growth rate of the industrial sector saw an upward trend throughout this period, with an average annual growth of real manufacturing output of about 5.8%, which is one of the highest and most sustainable growth rates.

Thus, the share of the manufacturing sector in the GDP increased from 3% in 1974 to 12% by the end of 2018.

In line with the Kingdom's comprehensive economic development strategies in expanding the production base and diversifying sources of income, Saudi industrial exports achieved rapid and significant growth during the past years. Saudi industrial exports grew at a rate of 9.3% annually during the 1995–2017 period, thus increasing their value from SR 22.558 million in 1995. Considering the ratio of industrial exports to the non-oil GDP of the Kingdom, this percentage increased from 6.6% in 1995 to 8.7% in 2017, confirming the importance of export as an essential factor of industrial development.

The development of the industrial sector and the diversification of the local industrial base contributes to the strength and durability of the Saudi economy.

According to the Saudi Industrial Development Fund, the Saudi manufacturing sector faces many challenges, such as the following: (i) developing the competitiveness of national products, (ii) keeping pace with developments in global markets, (iii) technology transfer and localization, (iv) industrial environment and sustainable development framework, (v) capacity development of the Saudi workforce, (vi) development of industrial management, (vii) implementation and development of the concept of integration, and (viii) increased availability of resources and investments in the industrial sector.

Since the manufacturing sector is the main engine of the economic growth process, this study determines the extent of the contribution and importance of the role of the industrial sector in promoting GDP growth. Moreover, it enables the expansion of the production base and diversifies the sources of income to contribute to achieving vision 2030 of the Kingdom. Therefore, this study determines the relationship between the industrial sector and the GDP in the short and long term and the direction of the causal relationship between them.

Hence, this study proposes the hypothesis that manufacturing industries have a positive impact on the economic growth rate of Saudi Arabia. The study is divided into five sections. Section 1 is the introduction. Section 2 reviews the literature. Section 3 presents the methodology. Section 4 concludes.

2. Literature Review

2.1. Theoretical Literature

Many empirical and theoretical arguments note that manufacturing is the main engine of economic growth. Key arguments are often summarized as follows. (1) There is a positive relationship between the degree of industrialization and the levels of per capita income in developing countries. Industrialized developing countries became richer than less industrialized developing countries. (2) The manufacturing sector has high productivity. (3) It is fertile for technological advancement and integrates with other sectors, such as services. (4) It offers scope for entering international markets, which is not available to agricultural and primary production countries. (5) The manufacturing sector allows for capital accumulation that is easily spaced, as compared to the spatially dispersed capital of the agricultural sector. Thus, manufacturing is essential to growth and development.

(6) Direct and backward linkages between different sectors are stronger in the manufacturing sector than in other sectors (Szirmai et al., 2013).

Kaldor (1966) investigated the reasons for the slow growth rate in the United Kingdom, from which is the first formulation of Kaldor's hypothesis. Agriculture, to the most productive industrial sector, determines the rate of output. Consequently, Kaldor concluded that industrial output is the engine of growth. Thirlwall (1983) also validated Kaldor's hypothesis on the role of the industrial sector in economic growth and its applicability in industrialized countries (Al-Qudair, 2005).

Kaldor's laws (Kaldor, 1957, 1966, 1968) stated that the manufacturing sector is the main engine of growth. This finding was based on Kaldor's econometric analysis of productivity, employment growth rates, and output for twelve OECD countries in the fifties and sixties. Kaldor's second law provided a novel explanation to Verdoorn's Law, which assumed that labor productivity growth determines output growth. Kaldor's second law assumed that, given static and dynamic increasing returns to scale, the increase in labor productivity in manufacturing positively relates to manufacturing output growth. Moreover, Kaldor's laws contend that the impact of labor productivity on economic productivity growth is not only due to increased economies of larger production but also a consequence of the benefits derived from technical progress (Keho, 2018).

The Kingdom followed an industrial policy whose main objective to diversify the production base of the Saudi economy. Thus, the Kingdom has established several principles for this policy, such as encouraging and expanding the fields of manufacturing and industries dependent on the agricultural sector, providing government support to the industrial sector, and allowing capital to participate in industrial projects (Almosabbeh & Almoree, 2018).

These policies resulted in an increase in manufacturing sector production from about 25 billion Saudi riyals in 1970 to about 318 billion Saudi riyals in 2018 (i.e., manufacturing sector production increased more than 13 times, as shown in Figure 1).

Figure 1 shows that the increase in the production of the manufacturing sector is associated with the increase in the non-oil gross domestic product of Saudi Arabia at current prices, which indicates the positive effect of the manufacturing sector on the non-oil GDP.

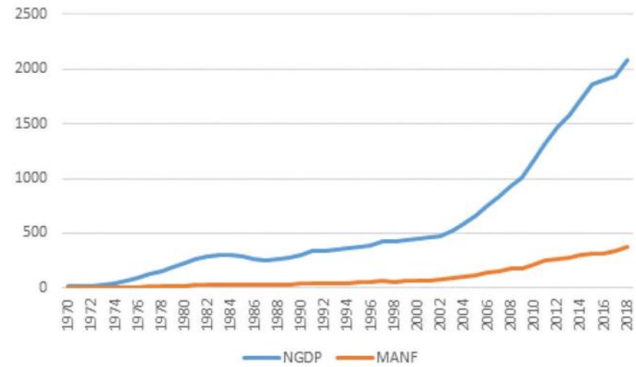

Figure 1: Non-Oil GDP & Manufacturing

Source: Prepared by the author from Saudi Arabian Monetary Authority

2.2. Empirical Literature

The economic literature is rich in numerous studies that examine the effect of the manufacturing sector on economic growth. The relationship between industrial production and economic growth has attracted economic researchers. Moreover, the intellectual contributions of Kaldor (1957, 1966) are the theoretical basis for many modern economic studies that examine the leading role of the industrial sector in economic growth.

Tunali and Boru (2019) investigated the causality effects of the manufacturing sector on macroeconomic variables, such as gross fixed capital formation, services sector, savings, and economic growth in Turkey. They provided new evidence regarding the causality relationship between these variables. Their results indicated a one-way causality between manufacturing and savings and manufacturing and gross fixed capital formation. Moreover, causality existed between manufacturing and services and manufacturing and economic growth. Furthermore, no causality existed between the manufacturing and services and manufacturing sector and economic growth.

Gabriel and De Santana (2019) investigated how manufacturing affects economic growth over time by applying panel vector autoregression (PVAR) for the fixed effects approach for 115 countries during the 1990–2011 period, as well as estimated impulse-response functions (IRF) and forecast error variance decomposition (FEVD). Additionally, they applied Hirschman-Rasmussen (HRs) Index for 29 countries for the years 1995, 2000, 2005, and 2010, as well as the field of influence for 1995 and 2010. Their results indicated that the manufacturing industry could work as an "engine of growth" in developing countries. Furthermore, manufacturing was the only strategic key sector for economic growth for most developing countries.

Haraguchi et al. (2019) investigated the factors that led to increased manufacturing growth rates in a sample of

134 developing countries over the 1970 to 2014 period. Their findings showed that human capital and institutions represent factors that support the growth of manufacturing industries, given macroeconomic policies regarding openness to foreign trade, capital, and investment. They also found that most factors are not alone in promoting industry growth. They contribute as well to a sustained process of industrialization that characterized the process of economic growth of some successful countries over the 1970–2014 period.

Olanrewaju (2018) examined the relationship between manufacturing output and economic growth in Nigeria during 1980–2017 via a cointegration approach and a granger causality test to investigate the long and short run. The results of the study indicated that a long-run relationship exists among the variables employed in the estimation. The causality test suggests a one-way relationship between economic growth and manufacturing output. Thus, to raise the potential of productivity while reducing poverty, the study recommended that more resources must be channeled to manufacturing activities.

Mongale and Tafadzwa (2018) tested Kaldor's first law in South Africa and investigated the relationship between the manufacturing sector and economic growth. Thus, to estimate the annual time series data from 1980 to 2016, they employed vector error correction. The findings of the study showed that the manufacturing sector proxied by the manufacturing output has a significant positive coefficient, which confirms that the sector contributes positively to economic growth. The study recommended that policymakers must develop and promote the manufacturing sector. Policies should be geared towards creating a more conducive environment to attract business, invest in capital formation, and create more jobs.

Almosabbeh and Almoree (2018) examined the long-term relationship between the performance of the manufacturing sector and economic growth in Saudi Arabia by testing Kaldor–Verdoorn and Thirlwall's laws. The findings show that Kaldor's law applies to data on KSA but with decreasing returns to scale. Moreover, Verdoorn's law is applicable at both macro and sectoral levels with decreasing returns to scale. The results of Thirlwall's model, have shown that the relationship was negative, contrary to what was expected. Almosabbeh and Almoree (2018) recommended the KSA's policymakers to focus on the industrial sector because of its impact on other sectors of the economy.

Meyer and McCamel (2017) determined the relationship between the manufacturing sector, economic output, and employment in South Africa during the 1994–2015 period. They employed the Vector Autoregressive (VAR) model with a multivariate cointegration approach. The results indicated a positive long-run relationship between the manufacturing sector, GDP, and employment. There was no short-run between the variables according to the vector error correction model (VECM). The manufacturing sector could create an enabling environment for employment creation. Moreover, an increase in manufacturing led to GDP growth.

Su and Yao (2017) investigated the main role of the manufacturing sector as the key engine of economic growth for middle-income economies. They found that in the middle-income stage, manufacturing influences all the other sectors, including the services sector. Moreover, a positive correlation exists between the manufacturing sector and other sectors in both the short-run and long run. Furthermore, a larger manufacturing share not only induces the gross private saving ratio but also accelerates the pace of technological accumulation. The empirical findings confirmed that the manufacturing sector is still the key engine of economic growth for middle-income economies.

Marconi et al. (2016) evaluated the role of the manufacturing sector in the development process based on two laws of Kaldor. The first law states that the higher the growth of the manufacturing output, the more significant is the growth rate of the economy's product as a whole. The second law, known as the Kaldor–Verdoorn law, establishes a deterministic relation between the growth of manufacturing productivity and manufacturing output growth. This paper begins by showing stylized facts of the production and exports of manufactured goods to show that these remain related to the income level of countries in recent years. Thereafter, a theoretical reflection on the importance of manufacturing in the process of economic development is performed, associating it to the manufacturing exports and the exchange rate regime. Then, the paper performed a Kaldorian model systematization to assess the importance of manufacturing and its exports on economic development. Econometric tests are performed based on dynamic panel data for a sample of 63 middle and high-income countries, excluding major exporters of fuels for the period between 1990 and 2011, to analyze whether there is any difference in growth dynamics between these two groups. Estimates attest to the occurrence of the two Kaldor laws, demonstrating that output growth in the manufacturing sector is essential to increasing economic growth and productivity, particularly in middle-income economies. The results also confirmed that manufacturing exports are relevant to the development process and that the exchange rate contributes to this process in middle-income countries.

Mercan et al. (2015) tested and investigated Kaldor's Laws in newly industrialized countries (NIC) via second-generation panel data methods with a structural break under cross-section dependency for annual data during the 1965–2012 period. They employed in-country cross-sectional dependence (CD) and the cross-sectionally dependency Lagrange multiplier (CDLM) test. The stationary series was searched via the cross-sectionally augmented Dickey-Fuller (CADF) test. Additionally, the cointegration relationship among series was examined via the panel cointegration test with multiple structural breaks. The results showed a cointegration relationship between the variables. Moreover, the validity of Kaldor's Law was determined.

Szirmai and Verspagen (2015) used a panel data set of annual value-added shares for manufacturing, industry, agriculture, and services for the 1950–2005 period to answer questions concerning the continued importance of the manufacturing sector for economic development. The study found a positive impact of manufacturing on growth in line with the engine of growth hypothesis. By splitting the period into three sub-periods, during the 1970–1990 period, only a direct effect of manufacturing on growth existed for the middle-income economies. There were interesting interaction effects of manufacturing with education and income gaps. However, since 1990, manufacturing is becoming a more challenging route to growth than before.

Szirmai et al. (2013) investigated an overview of the main arguments supporting the engine of growth hypothesis via a mix of statistical analysis of secondary data and literature. They concluded that manufacturing remains important in accelerating growth in developing countries. By comparing the results achieved over the past six decades, the market services sector will become the most important sector and catch up with the progress of countries.

Guo et al. (2013) examined whether Kaldor's law is true in the case of the Chinese regions during the 1996–2006 period. They showed that GDP growth rates and living standards could be increased by focusing on the manufacturing sector. The study recommended that Chinese authorities should draft a strategy to curb the uneven distribution of economic activities.

Libanio and Moro (2006) discussed the important role of manufacturing industries for the growth trajectories of developing countries from Kaldor's first and second growth laws, with a focus on seven Latin American economies during the 1985–2001 period. The effects of manufacturing on productivity levels explain the relationship between industrial growth and GDP growth, given the transfer of labor from low productivity sectors to the industrial sector and the existence of static and dynamic economies of scale in manufacturing. The results agree with the "manufacturing is the engine of growth" hypothesis. It also indicated the existence of increasing returns in the manufacturing sector in the largest Latin American economies.

Thus, the conclusions can be summarized as follows. (a) The first and second decades of the twenty-first century witnessed a growing interest in testing Kaldor's hypotheses of the relationship between the industrial sector growth and economic growth and analyzing this relationship. (b) The results confirmed support for Kaldor's assumptions for growth, and the majority indicated that the growth of industrial output has a positive impact on the economic growth. (c) Contrary to the results that emphasized support for Kaldor's assumptions, other studies found that the service sector effect on GDP has an increasing role in economic growth, especially in the more advanced economies.

3. Method and Estimated Model

This study employs annual time-series data from the Saudi Arabian Monetary Authority (SAMA) statistics spanning the 1980–2018 period to determine the role of the manufacturing sector in promoting economic growth. It applies Kaldor's first law, the "engine of the hypothesis of growth," which states that there is a positive relationship between the growth rate of GDP and the output of the manufacturing sector. The law can be represented as follows:

$$\mathrm{NGDP}_t = c + \beta \mathrm{MANF}_t + \varepsilon \tag{1}$$

Thus, to show the extent of the services sector contribution to achieving Saudi economic growth, adjust Equation (1) by adding the output of the services sector as follows:

$$\mathrm{NGDP}_t = c + \gamma_1 \mathrm{MANF}_t + \gamma_2 \mathrm{SERV}_t + \varepsilon \tag{2}$$

where NGDP_t is the non-oil GDP at time t, MANF_t denotes aggregate manufacturing output at time t, and SERV_t denotes aggregate services sector output at time t.

Given the logarithmic formula of Equation (2), Equation (3) is as follows:

$$\mathrm{LnNGDP}_t = c + \gamma_1 \,\mathrm{Ln\ MANF}_t + \gamma_2 \mathrm{Ln\ SERV}_t + \varepsilon \tag{3}$$

4. Results

4.1. Unit Root Test

Many econometrics techniques to investigate long-run equilibrium (cointegration) among variables exist. However, the time series often suffer from a spurious regression. This problem can be relaxed by testing the stationarity of the time series and applying the unit root test. Thus, we must test the time series data for stationarity before the analysis.

We use the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests, which are estimated as follows:

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \alpha \sum_{i=1}^{m} Y_{t-1} + \mu_t \tag{4}$$

Test results of ADF are presented in Table 1, which shows that all variables (LNGDP, LMANF and, LSERV) are stationary at the level $I(0)$ with the trend and intercept.

Table 1: Unit Root Test

Variables	Test in	Augmented Dickey-Fuller					Philips-Perron				
		t-stat.	Prob.	Critical Values			*t*-stat.	Prob.	Critical Values		
				1%	5%	10%			1%	5%	10%
LNGDP	Level	1.42	0.96	–2.63	–1.95	–1.61	1.12	0.93	–2.63	–1.95	–1.61
	1st difference	–4.65	0.00	–2.63	–1.95	–1.61	–4.80	0.00	–2.63	–1.95	–1.61
LMANF	Level	0.48	0.82	–2.63	–1.95	–1.61	0.41	0.80	–2.63	–1.95	–1.61
	1st difference	–5.24	0.00	–2.63	–1.95	–1.61	–5.31	0.00	–2.63	–1.95	–1.61
LSERV	Level	1.32	0.95	–2.64	–1.95	–1.61	1.09	0.93	–2.63	–1.95	–1.61
	1st difference	–4.68	0.00	–2.63	–1.95	–1.61	–3.54	0.00	–2.63	–1.95	–1.61

4.2. Cointegration and Error-Correction Models

According to the results of the unit root test for the variables, we find that the appropriate model is a Johansen test cointegration. Therefore, to assess the short- and long-run relationship among the non-oil GDP Saudi, manufacturing sector output, and services sector output, the cointegration approach is utilized, following the Johansen approach (Enders, 2008).

This test determines the number of cointegration equations and is dependent on the trace statistic. By minimizing the Akaike information criterion (AIC), we determine the lag period to the cointegration test. Cointegration of the Johansen approach is modeled via the VAR framework:

$$\Delta X_t = c + \sum_{i=1}^{k} \Gamma_i \Delta X_{t-1} + \Pi X_{t-1} + \eta_t \tag{5}$$

where X_t is a vector of non-stationary variables, $\Delta X_t = X_t - X_{t-1}$; c is a constant; k denotes the lag length, and Π and Γ are the coefficient matrices. The information in the coefficient matrix between the levels of the Π is decomposed as $\Pi = \alpha\beta$, where the relevant elements α matrix are adjustment coefficients, and the β matrix contains cointegrating vectors. The Johansen test relies on two types of tests: (i) trace test (λ_{trace}) and (ii) maximum eigenvalue test ($\lambda_{\max}$).

The trace test (λ_{trace}) is defined as:

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} \log(1 - \hat{\lambda}_i), \tag{6}$$

where T is the number of unusable observations, $\hat{\lambda}$ is the estimated values of the eigenvalues, and n is the number of separate series to be analyzed. The null hypothesis states that the number of cointegration vectors is $\leq r$, where $r = 0$, 1, or 2 against the alternative hypothesis where the number of cointegration vectors $= r$.

The maximum eigenvalue test ($\lambda_{\max}$) is defined as $\lambda_{\max} = -S + \log(1 - \hat{\lambda}_{i+1})$.

It tests the null hypothesis where the number of cointegration vectors $= r$, as against the alternative where there are $r + 1$ cointegration vectors; the null hypothesis where r = 0, as against the alternative where $r = 1$; and $r = 0$, as against $r = 2$. The $\lambda_{\max}$ test has a sharper alternative hypothesis. It is usually preferred for obtaining the number of cointegration vectors (Enders, 2010; Mills, 2019).

A critical step for applying the Johansen approach determines the lag length for the VAR model, where we could select lag length using a multivariate generalization of the AIC or Schwarz criterion (SC).

Before applying Johansen's approach of cointegration, a check for cointegration among non-oil GDP, manufacturing output, and serving sector output was applied. The lag length of the estimation must be small enough to allow for the estimation and high enough to ensure that errors are approximately white noise. The lag length is selected by minimizing both AIC and SC.

Table 2 shows the results of the different criteria of lag length order selection. The optimum lag for the model is 2.

Table 3 contains the results of two tests: Trace and Maximum Eigenvalue. The calculated value of the trace test (λ_{trace}), which is estimated at 90.70790, is greater than the scheduled value estimated at 42.91525 at a 5% level of significance for the first hypothesis (none). Thus, the null hypothesis of no cointegrating vector is rejected; that is, there is a cointegration relationship. The calculated value of the trace test, which is estimated at 26.19140, is greater than the scheduled value of 25.87211 at the 5% level of significance for the second hypothesis (at most 1). Thus, there is a cointegration relationship regarding the second hypothesis (at most 2). The calculated value of the trace test, which is 6.769043, is lower than the scheduled value of 12.51798 at the 5% level of significance. Therefore, there are two cointegration relationships between the study variables according to the effect test.

Table 2: Optimum Lag Length in Unrestricted Var

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.50030	NA	3.58e–06	–4.027795	–3.895835	–3.981737
1	223.4421	263.0076	1.59e–09	–11.74678	–11.21894	–11.56255
2	249.7304	42.35339*	6.17e–10*	–12.70724*	–11.78352*	–12.38484*
3	257.5639	11.31507	6.79e–10	–12.64244	–11.32284	–12.18186

Table 3: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.825126	90.70790	42.91525	0.0000
At most 1*	0.408402	26.19140	25.87211	0.0456
At most 2	0.167188	6.769043	12.51798	0.3692

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) *p*-values.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.825126	64.51650	25.82321	0.0000
At most 1 *	0.408402	19.42236	19.38704	0.0494
At most 2	0.167188	6.769043	12.51798	0.3692

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) *p*-values.

Error Correction	D(LNGDP)	D(LMANF)	D(LSERV)	
CointEq1	–0.841782	–1.425654	0.542627	
	(0.31932)	(0.54132)	(0.18952)	
	[–2.63615]	[–2.63365]	[2.86319]	

The maximum eigenvalue test yields the same results: there are two long-run relationships between the study variables. For the first hypothesis (none), the calculated value, which is estimated at 64.51650, is greater than the scheduled value estimated at 25.82321 at a 5% level. Thus, the null hypothesis of no cointegrating vector is rejected. In the second hypothesis (at most 1), the calculated value, which is estimated at 19.42236, is greater than the scheduled value estimated at 19.38704 at a 5% level. Moreover, the second hypothesis (at most 2), the calculated value, which is estimated at 6.769043, is lower than the scheduled value estimated at 12.51798 at a 5% level.

The causal Granger test is applied to investigate the existence of a causal relationship between two variables. It mainly depends on the F test where the variable X affects the variable Y if the probability value of the F-statistic is less than 0.05, and the variable X does not affect the variable Y if the value of the statistical probability of F is greater than 0.05.

Also, Table 3 shows that the error correction factor (CointEq1) is negative and significant at the level of significance of 5%. It means that 0.841782 of short-term errors are automatically corrected over time to achieve long-term balance; it requires about 1.19 years.

Table 4: Causality Test Results (Granger)

Pairwise Granger Causality Tests			
Sample: 1980 2018			
Lags: 2			
Null Hypothesis	**Obs**	***F*-statistic**	**Prob.**
LMANF does not Granger Cause LNGDP	37	6.54456	0.0041
LNGDP does not Granger Cause LMANF		6.24557	0.0051
LSERV does not Granger Cause LNGDP	37	1.73764	0.1921
LNGDP does not Granger Cause LSERV		8.95912	0.0008
LSERV does not Granger Cause LMANF	37	1.83522	0.1760
LMANF does not Granger Cause LSERV		7.24916	0.0025

Table 4 shows that the probability value (Prob.) of the *F*-statistic is less than 0.05 for the relationship between lMANF and lNGDP; thus, MANF affects NGDP. Regarding the inverse relationship between the lNGDP and lMANF variable, the probability value (Prob.) of the *F*-statistic is less than 0.05. Hence, NGDP affects MANF. Likewise, there is a one-way causal relationship between lNGDP and LSERV; thus, NGDP affects SERV from lMANF to LSERV. It means that MANF affects SERV.

Given the long-term joint integration relationship between model variables and knowing the direction of influence between them through causality testing, the VECM can be estimated. The VECM estimates and measures the short-term relationship between model variables. It also measures the speed of modification, correction, or adaptation to restore long-term balance in the dynamic model.

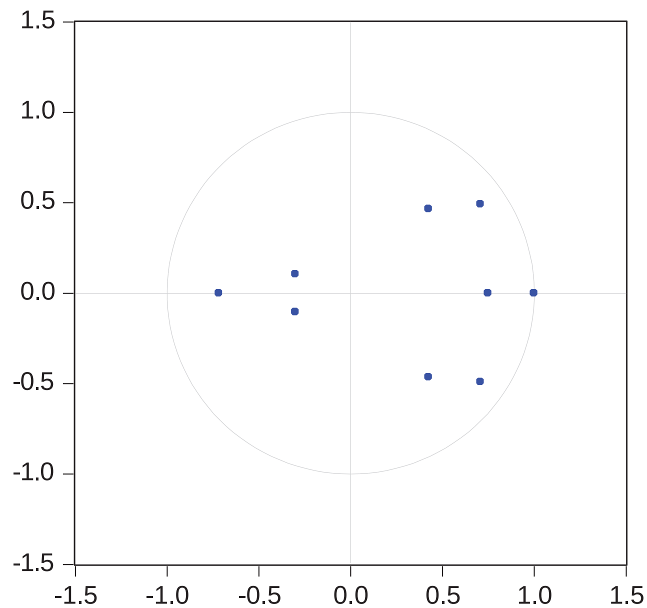

Figure 2: Inverse Roots of AR Characteristic Polynomial

4.3. Post Estimation Specification Testing

The estimated model for forecasting must be validated by performing a series of tests.

4.3.1. Roots Test

Figure 2 indicates that the estimated VECM model fulfills the condition of stability, as all roots are located within or in the vicinity of a single circle.

4.3.2. Diagnostics Test Result

In this step, to ensure the suitability of the estimated model used to measure the estimated elasticities in the long term, the estimation of the model has undergone several diagnostic tests to ensure the appropriateness of the estimated model. We adopted the normality, heteroskedasticity, and serial correlation LM. Table 5 shows the results of the diagnostic

Table 5: Diagnostic Tests

Test series	**Coefficient**	**Prob.**
Normality test (Jarque–Bera test)	7.291349	0.2947
White heteroskedasticity	118.6336	0.0585
Wald Test	30.41194	0.0000
Serial correlation LM test	0.949972	0.4909
	0.803968	0.6144

tests conducted on the estimated model. The results indicate that this study has passed all the diagnostic tests indicating that residuals of the model are normally distributed, have no heteroskedasticity or serial Correlation.

Regarding Residual Normality Tests in Table 5, given the calculated Jarque-Berra value (7.291349), which is less than the critical value ($X^2_{0.05}$) 12.592 at (df = 6), the null hypothesis is accepted. That is, the residual chain follows the normal distribution.

As for Residual Heteroskedasticity Tests, Table 5 shows that the corresponding probability of the calculated value of (Chi-sq) is greater than 0.05 at the 5% significance level. Thus, we reject the problem of Heteroskedasticity and accept the Hypothesis of variance constant for error limits in the estimated model.

Regarding Residual Serial Correlation LM tests, Table 5 shows that the corresponding probability of the calculated value of *F*-statistics in all delay degrees of 1 and 2 is greater than 0.05 at the 5% significance level. Thus, the null hypothesis, where the estimated model is free from the problem of self-correlation of errors, is accepted.

As for Wald Test, Table 5 shows that the probability value of the Chi-square statistic is less than 0.05 from zero. Thus, the parameters for the independent variables in the equation for the dependent variable in the short term cannot be absent.

5. Conclusion

This study empirically investigates the role of the manufacturing sector in promoting economic growth in the Saudi economy for the 1980–2018 period. Thus, the cointegration and VECM approaches were used to examine the short- and long-run relationship causality between variables of the study. The findings of the analysis can be summarized as follows.

There is a two-way causal relationship between the manufacturing sector and economic growth. Moreover, the growth of the manufacturing sector leads to economic growth (which is consistent with the law as the first role), and economic growth leads to the growth of the manufacturing sector. Furthermore, there is a unidirectional causal relationship that is directed from the manufacturing sector to the services sector. The growth of the manufacturing sector leads to the growth of the services sector. The causal tests show that the growth of the manufacturing sector output achieves its positive impact on economic growth in two ways: a direct impact and an indirect effect on the services sector, which are sources of the output of goods and services of the previous causal tests.

Thus, the study recommends the following. Future studies can explore the determinants of the growth of the Saudi manufacturing sector, identify the most productive Saudi manufacturing industries, and contribute to raising the productivity of other sectors in a way that contributes to economic plans and policies. Hence, adopting economic policies that stimulate investment in the manufacturing sector contributes to increasing non-oil exports to diversify sources of income to achieve vision 2030 of the Kingdom of Saudi Arabia.

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