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Determinants of industrial output in Syria

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Abstract

This study attempts to investigate the determinants of industrial output in Syria over the period 1980–2010. The ADF unit root test, Johansen cointegration test, Granger causality test, impulse response functions, variance decomposition analysis, and stability tests are used in this study. The Johansen cointegration test indicates that industrial output is positively related to capital, manufactured exports, population and agricultural output, but negatively related to the oil price. Agricultural output has the biggest effect on industrial output. The Granger causality test indicates bidirectional causality between capital, oil price, manufacturing exports, population, agricultural output, and industrial output in the short and long run.

Keywords: Oil-dependent economy, Industrial output, Capital, Manufactured exports, Oil price, VAR

JEL Classifications: O11, E20

1 Background

The industrial sector plays a crucial role in the development of the Syrian economy, and it accounts for about 25 % of its GDP. This sector has a diversified base, and the most important industries in Syria are oil refining, basic metal, metal products, chemicals, electricity, water, paper, food and textiles (Syrian Investment Agency (SIA) 2009). The food and textile industries have the largest percentage share of total manufacturing output. However, the productivity and competitiveness of the Syrian industrial sector in the global markets are low, which led to the decline in the volume of industrial exports (Naser et al. 2006). There is lack of modern management, technology, training, education, and research and development. The inadequate support by the government to enhance its competitiveness, lack of industrial investments and high cost of industrial funding further hampered the growth of this sector (Lahham 2010).

Figure 1 shows the trend in mining and manufacturing output in Syria, at constant 2000 prices, from 1980 to 2010. In the first half of the 1980s, Syrian industrial output expanded from SYP 67,920 million in 1980 to SYP 89,220 million in 1985. In the second half of the 1980s, the government worked to improve the domestic economy by decreasing imports, attracting foreign investment, and encouraging the private sector to participate more actively in the economy. Moreover, at the end of the 1980s, oil production

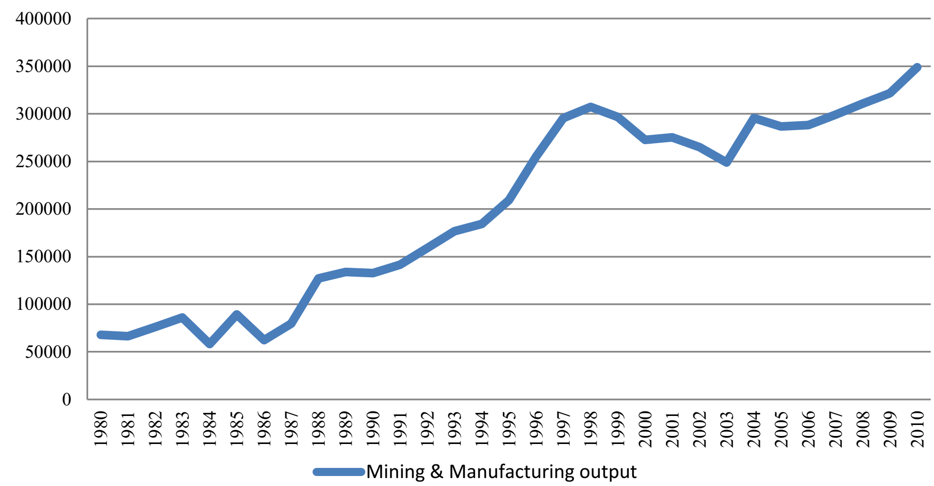

Fig. 1 Mining and Manufacturing output in Syria, at constant 2000 prices, in millions of Syrian pounds, 1980–2010

increased, and Syrian exports to the Soviet Union and Eastern European markets increased. These developments led to the increase in industrial output from SYP 98,220 million in 1985 to SYP 132,707 million in 1990.

During the 1990s, the Syrian economy experienced increases in agricultural output, private sector activities, foreign direct investment (FDI), and oil production. Moreover, public sector companies resumed to produce goods and services after a break in the 1980s (Dagher 2000). In addition, large quantities of gas were discovered, and it has been mainly used in power and manufacturing plants (Kafri 2004). The government also created an attractive climate for investment by improving the infrastructure and passing new laws. The political environment at that time such as the initiation of peace negotiations with Israel, and improved relations with the European Union and the US also made Syria more attractive to the private sector and foreign investments. These led to the increase in industrial output during this period. Industrial output increased from SYP 132,707 million in 1990 to SYP 307, 138 million in 1998. However, the industrial output dropped to SYP 296,658 million and SYP 272,514 million in 1999 and 2000, respectively. The decline in industrial output was due to reduced oil production and agricultural output.

During the first decade of the twenty-first century, the government worked to develop and improve the efficiency of the industrial sector by enacting laws and regulations that encourage private investment and more involvement of the private sector in the country's economic development. In 2009, the government created four industrial cities to provide the necessary infrastructure and services for the establishment of industrial projects. This has encouraged the local private and foreign investors to embark on several large industrial projects in Syria. Furthermore, the government tried to push the Syrian economy towards a social market economy by reducing its dependence on the oil production sector and engaging the private sector in different economic activities. The government has allowed the private sector to invest in the industries that earlier were exclusively owned by the public sector, such as cement and sugar (Syrian Investment

Agency (SIA) 2009). Moreover, to complete the economic and administrative reforms, the government has worked to reduce the bureaucracy and administrative obstacles, reform the industrial public sector, open the Syrian economy to foreign investment, modernize industry, upgrade productivity, and transform the structure of the Syrian economy from an oil and agriculture based economy to an industrial economy (Kafri 2010). All of these efforts have led to the increase in mining and manufacturing output during this period from SYP 275,152 million in 2001 to SYP 348,729 million in 2010.

The main objective of this study is to investigate the key determinants of industrial output in Syria over the period 1980–2010. The organization of this study is as follows: the next section is the literature review, Sect. 3 provides a brief discussion on the methodology, Sect. 4 reports the empirical results, and Sect. 5 presents the conclusion and recommendations.

2 Previous studies

The industrial sector plays an important role in the economic growth of any country, and there are many factors affecting its growth such as oil price, exchange rate, exports and FDI. While many studies have investigated the determinants of industrial production, studies on the determinants of Syria's industrial sector are still limited.

Infrastructure and financial development are crucial in industrial production. According to Zegeye (2000); Hulten et al. (2006); Sharma and Sehgal (2010) studies, infrastructure development has a positive impact on industrial output. McGrath (2006) found that financial deregulation affects positively the industrial development in the Czech Republic, Hungary and Poland. However, David et al. (2010) revealed that currency depreciation has a negative effect on manufacturing output in Nigeria, because Nigerian manufacturing activities depend heavily on imported inputs and capital goods.

Oil plays an important role in the industrial activities and the effect of oil price changes on industrial production can be either positive or negative. Jiranyakul (2006) found a positive relationship between oil prices and industrial production in Thailand. Farzanegan and Markwardt (2007) also indicated that oil price affects positively the industrial output in Iran. Besides, Mehrara and Sarem (2009) revealed that there is a strong causal relationship moving from oil price shocks to industrial output in Iran and Saudi Arabia. However, they discovered that oil price has a limited role in industrial production in the case of Indonesia, which is due to the Indonesian government's involvement in diversifying the real sector to reduce the harmful effects of oil booms. But, Lee and Ni (2002) argued that oil price shocks have negative effects on the supply of oil-intensive industries and the demand of other industries.

Furthermore, exports have a positive relationship with industrial production. Mamun and Nath (2005) argued that there is a positive long-run causality running from exports to industrial production in Bangladesh. However, in a more recent study, Uddin and Noman (2011) found the relationship to be bidirectional for the same country. In contrast, Akpan et al. (2012) discovered a positive unidirectional causality moving from industrial production to non-oil exports in Nigeria.

Regarding the relationship between agricultural output and industrial production, Gollin et al. (2002) argued that industries are dependent on agricultural production for

62 developing countries, improvement in agricultural yield hastens industrialization, and low agricultural yield leads to a decline in industrialization of these countries.

3 Methodology and data

In this study, the long run industrial output model consists of six variables, namely industrial output (IO), gross fixed capital formation in industry (GFCFI), oil price (OP), manufacturing exports (MX), population growth (GPOP), and agricultural output (AO). The long-run model for lnIO is as follows:

$$\ln \mathrm{IO} = \alpha + \beta_1 \ln \mathrm{GFCFI} + \beta_2 \ln \mathrm{OP} + \beta_3 \ln \mathrm{MX} + \beta_4 \mathrm{GPOP} + \beta_5 \ln \mathrm{AO} + \varepsilon_t \quad (1)$$

where α is the intercept; β_1, β_2, β_3, β_4, and β_5 are the coefficients of the variables; lnIO is the natural log of industrial output in real value (millions of SYP); lnGFCFI is the natural log of gross fixed capital formation of industry in real value (millions of SYP); lnOP is the natural log of oil price (US dollars per barrel); lnMX is the natural log of manufactured exports in real value (millions of SYP); GPOP is the population growth rate; lnAO is the natural log of agricultural output in real value (millions of SYP); and ε_t is the error term.

The analysis begins with the Augmented Dickey Fuller (ADF) unit root test to determine whether the time series data are stationary at levels or first difference. If all the variables are stationary in the first difference, the Johansen multivariate cointegration test will be used to determine whether there is any long-run or equilibrium relationship between industrial output and the other variables in the model (Engle and Granger, 1987; Johansen 1991). If the variables are cointegrated, the Granger causality tests based on the vector error correction model (VECM) will be used to determine the short and long run causality relationship among the variables. However, if the variables are not cointegrated, the vector autoregressive (VAR) approach will be employed to test for short run Granger causality (Sims 1980). Furthermore, the VECM will be subjected to a number of statistical diagnostic tests, namely the normality, serial correlation, heteroscedasticity and Ramsey RESET tests to ascertain its statistical adequacy. Impulse response functions (IRF) and variance decomposition (VD) analysis are used in this study to help in determining whether the independent variables are significant in explaining the variation of industrial output at short and long forecasting horizons. Lastly, stability tests based on the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) of recursive residuals will determine whether the parameters of the model are stable over the period of the study.

This study uses annual time series data of Syria from 1980 to 2010. The sources of the data are the Central Bureau of Statistics in Syria and the World Bank. All the variables in this study are in real values (constant 2000 prices), except for the oil price. Moreover, all the variables are expressed in the logarithmic form, except for the population growth rate variable.

4 Empirical results and discussion

The results from the ADF unit root test in Additional file 1: Table S1, shows that none of the six variables is stationary at the levels, but became stationary after first differencing at either the 5 or 1 per cent level of significance. This means that all the variables are integrated of order one, that is I(1).

4.1 Johansen cointegration test results

Since all the variables are stationary in the first difference, we run the Johansen cointegration test to determine the presence of any cointegration or long run relationship among the variables. However, before running the cointegration test, we need to run the VAR model first to determine the optimal lag length based on the minimum Akaike Information Criterion (AIC). Due to the limited number of observations, the maximum lag has been set to two in the lag length selection process. The optimal number of lags is two based on the AIC results.

After having determined the number of lags, we proceed with the cointegration test for the model. Additional file 2: Table S2 shows that there are five cointegration equations based on the trace test, and three cointegration equations based on the maximum eigenvalue test. In other words, the results indicate the existence of more than one long run relationship among the variables in the system comprising lnIO, lnGFCFI, lnOP, lnMX, GPOP and lnAO.

Since there are more than one cointegration relationship among the variables lnIO, lnGFCFI, lnOP, lnMX, GPOP and lnAO, there is the problem of selecting the appropriate cointegration relationship. However, since the main objective of this study is to examine the main determinants of industrial output of Syria, we have identified the first cointegrating equation to be normalized with respect to the real industrial output variable as it meets the theoretical, a priori expectations with respect to the signs of the coefficients. Additional file3: Table S3 shows the normalized cointegrating vector.

From Additional file 3: Table S3, the long-run equation for industrial output is as follows:

$$\begin{aligned}\ln \mathrm{IO} = {} & -56.32602 + 0.626022 \ln \mathrm{GFCFI} - 0.627859 \ln \mathrm{OP} + 0.402981 \ln \mathrm{MX} \\ & + 0.525604\, \mathrm{GPOP} + 2.244837 \ln \mathrm{AO}\end{aligned} \tag{2}$$

The cointegration equation given by Eq. (2) above shows that lnIO is positively related to lnGFCFI, lnMX, GPOP and lnAO, and negatively related to lnOP in the long run.

The positive coefficient of 0.626 for lnGFCFI indicates that over the long run when the gross fixed capital formation of industry increases by one percent, industrial output will increase by 0.63 percent, ceteris paribus. It is noteworthy that when the amount of capital invested in industrial activities increase, industrial production in the country will increase because it can support these activities with more and better machines and spare parts. The Syrian government has worked to make the industrial sector the locomotive of economic growth in the country by encouraging local and foreign investments in the industrial activities, as well as establishing the Industrial Bank of Syria in order to develop the industrial sector by providing credit facilities and loans to finance the industrial activities.

The negative coefficient of 0.628 for lnOP indicates that when the oil price increases by one percent, industrial output will decrease by 0.63 percent, ceteris paribus. This outcome is as expected since production requires fuel for transportation of raw materials to the factories, and the finished products to the markets. Oil is also an input in the chemical industries. Therefore, any increase in oil prices affects the cost of industrial production, and that affects negatively the industrial production in the country. Moreover, the rise in the cost of transportation and production activities after oil price increases will increase the prices of industrial products in the global market, which will lead to a decline in the international competitiveness and external demand for these products. This will drive producers to reduce their production, which has a negative impact on the industrial production in the country.

Our result seems to agree with Lee and Ni (2002). Their findings indicated a reduction in the demand for non-oil-intensive industries because of oil price shocks. However, it contradicts with the findings of Farzanegan and Markwardt (2007) for Iran, and Mehrara and Sarem (2009) for Iran, Saudi Arabia and Indonesia. The latter two studies found that oil price has a positive effect on the industrial production of Iran and Saudi Arabia, because they are oil-producing and exporting countries, and oil industries have an important role in their industrial activities. For Indonesia, oil price has no significant effect on industrial production due to the successful diversification of the real sector to reduce the harmful impact of oil booms. In Syria's case, the oil sector has a vital role in the economy. However, oil production has been declining continuously since 1996, and the government has been trying to reduce its dependence on the oil sector, by promoting industrial diversification and making the industrial sector the locomotive of economic growth.

The positive coefficient of 0.403 for lnMX indicates that when manufactured exports increase by one percent, industrial output will increase by 0.40 percent, ceteris paribus. It is noteworthy that producers can utilize the returns from manufacturing exports to increase and improve their production. Moreover, exporting to global markets increases the degree of competition, which leads producers to be more enthusiastic to improve the quality of their production. By the end of the 1980s, Syrian exports to the Soviet Union and Eastern European markets have increased. Furthermore, the new Syrian government's strategy to diversify Syrian exports, open up the Syrian economy to foreign trade, and reduce the percentage share of raw materials in total Syrian exports have motivated the Syrian producers to increase and improve their production in order to achieve higher profits from exporting abroad. Our finding is in line with that of Mamun and Nath (2005); Uddin and Noman (2011); Akpan et al. (2012) who argued that exports have a positive effect on industrial production.

The positive coefficient of 0.527 for GPOP indicates that for every 0.1 percentage point increase in population growth, industrial output will increase by 5.3 %, ceteris paribus. This suggests that population growth has an important role in improving and increasing the industrial production in the country. When the population increases, domestic consumption and demand for different goods and services will rise in the country, which will induce producers to increase and improve their production to meet the increase in local demand. Furthermore, most of the industrial activities in Syria are labor-intensive, so increases in population growth can play a crucial role in providing the necessary manpower for the industries. Besides that, the Syrian government has worked to upgrade the skill of workers in the industrial sector to improve and increase the industrial production in the country.

The positive coefficient of 2.245 for lnAO indicates that when agricultural output increases by one percent, industrial output will increase by 2.25 %, ceteris paribus. This result is as expected, as the agriculture sector is one of the main sources of raw materials and semi-finished products for different industries such as the food, clothing, and textile industries. The output of the food and textile industries has the largest percentage share of total manufacturing output in Syria, where it accounts for about 51–61 % of the total manufacturing output in the country. When agricultural production increases, inputs available for industrial activities will also increase, which motivate industrial producers to increase their production. This result clearly shows the importance of the agricultural sector in supplying these industries with inputs needed in their production activities. Hence, increasing agricultural output will boost the industrial production in Syria, while low agricultural production leads to a decline in industrial production in the country. This result concurs with that of Gollin et al. (2002) who found that industries are dependent on agricultural production.

4.2 Results from the Granger causality tests

The Granger causality test based on the VECM is used to determine the short and long run causal relationships among the variables. Additional file 4: Table S4 shows the Granger causality test results based on the VECM. The Wald F-test results show the significance of the short run causal effects, while the significance of the coefficient of the error correction term [ect (−1)] indicates the long run causal effect.

It is clear from Additional file 4: Table S4 that there is bidirectional causality between lnGFCFI and lnIO in the short and long run. The result implies that capital supplies producers with funds to buy industrial equipment, and any change in industrial output leads to a change in the return from industrial production, which in turn affects the gross fixed capital formation of industry. Besides, there is bidirectional short run and long run causality between lnOP and lnIO, suggesting feedback effects between oil prices and industrial production in both the short run and long run. Furthermore, there is bidirectional causal relationship between lnMX and lnIO in the short and long run. This implies that exports motivate producers to increase their production, and changes in industrial output cause changes in the manufacturing exports of the country. The results also indicate bidirectional causality between GPOP and lnIO in the short and long run. It implies that population growth will lead to a larger labor force and this will eventually improve the industrial output in the country. Moreover, there is bidirectional causality between lnAO and lnIO in the short and long run. The agricultural sector is one of the main sources of raw materials for various industries including the food and textile industries in Syria. Besides, when industrial output increases, the demand for raw materials will increase and this will motivate farmers to increase their production.

4.3 Statistical diagnostic tests results

In order to check for model adequacy, the VECM is subjected to a number of diagnostic tests, namely the normality, serial correlation, heteroscedasticity (BPG and ARCH) and Ramsey RESET tests to ascertain its statistical adequacy. A 5 % level of significance is used in all these tests.

Additional file 5: Table S5 reports the results of the diagnostic tests. The lnIO, lnOP and lnAO equations in the VECM passed the normality, heteroscedasticity and Ramsey RESET tests, except the serial correlation test. However, the lnGFCFI, lnMX and GPOP equations passed all the four tests. The serial correlation problem may be due to the insufficient number of lags in the VECM. However, even after increasing the lag length, the serial correlation problem persists. Given the limited number of observations, it is not possible to increase further the lag length. Therefore, the serial correlation problem has been corrected using the Newey-West HAC standard errors before proceeding with the t and F tests for long-run and short-run Granger causality.

4.4 Impulse response functions (IRF)

Impulse response functions (IRF) is used to examine the dynamic behavior of the times series over 10-year forecast horizons. This study used the generalized impulse response functions (GIRF).

Figure 2 shows that lnIO responds positively to a shock to lnGFCFI in the first 7 years, then the effect dies down after the 8th year. This indicates the necessity to improve the exploitation of capital in industrial production activities in the future, so that it could have a positive effect on the industrial output of the country. Besides, the negative response of lnIO to a shock to lnOP implies that industrial production costs will increase when the oil price increases, which in turn affects negatively the industrial production in the country. Moreover, when there is a shock to lnMX, lnIO will respond negatively in the 2nd year, with no significant response in the 3rd, 4th and 5th years, followed with positive responses in the remaining years. This indicates that manufacturing exports play an important role in boosting industrial production in the country through motivating producers to increase and improve their production to reap higher profits. Furthermore, lnIO responds negatively to a shock to GPOP, but the effect of the shock dies down gradually. Therefore, it is imperative to improve the quality of human capital in the country, and apply modern technology in the industrial production activities. Lastly, when there is a shock to lnAO, the response of lnIO is positive, which

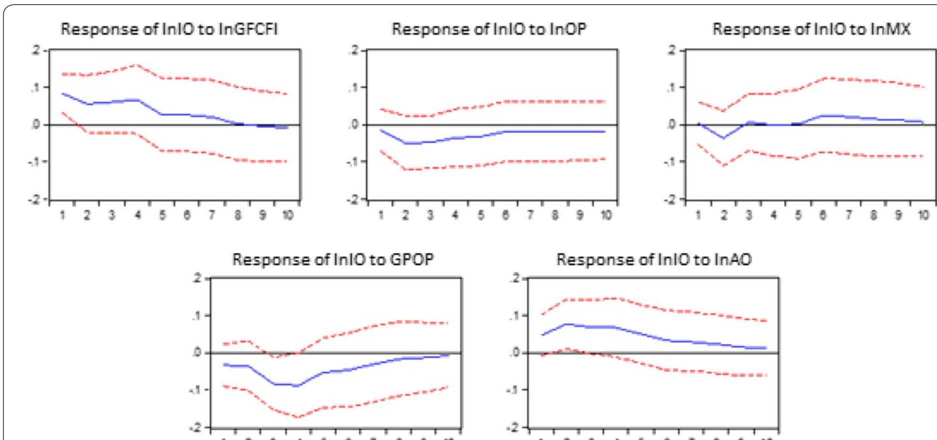

Fig. 2 Generalized impulse response functions (GIRF) results

reflects the importance of the agricultural sector in supporting the industrial sector in the country.

4.5 Variance decomposition (VD) analysis results

The variance decompositions (VD) for 1-year to 10-year forecast horizons indicate the amount of information each variable contributes to the other variables in the VAR.

Additional file 6: Table S6 gives the decomposition of the forecast error variance of the variables in the industrial output model. In the 1st year, the error variance of industrial output is exclusively generated by its own innovations and its' contribution has been decreasing since then for the various forecast horizons. However, at the 10th year forecast horizon, its own shocks contribute about 63 % of the forecast error variance. On the other hand, GPOP, lnGFCFI, lnMX, lnOP and lnAO shocks explain 11.4, 6.7, 4.7, 7.1 and 7.5 %, respectively to the forecast error variance of industrial output. Furthermore, the contributions of lnOP and lnAO in explaining lnIO forecast error variance have increased during the 10-year forecast period, but there are no significant changes in the contribution of lnMX. The relative importance of lnGFCFI, however, has decreased at the 2- to 6-year forecast horizon and then increased at the 7- to 10-year horizon. The contribution of GPOP shocks in explaining lnIO error variance at first increased from the 2- to 5-year horizon, but it started to decline in the 6- to 10-year horizon; however, it remained the highest contributor after lnIO.

4.6 Stability test results

CUSUM and CUSUMSQ statistics are used in determining the parameter stability of the model in this study. The decision about parameter stability is based on the position of the plots relative to the 5 % critical bounds. If the plots of the CUSUM or CUSUMSQ statistics stay within the area in the two critical lines, then the parameters of the model are stable over the period of the study.

Figures 3 and 4 indicate that the position of both CUSUM and CUSUMSQ plots stay within the area in the two critical lines, which means there are no structural changes in the model.

5 Conclusion

This study investigated the determinants of industrial output in Syria, using annual time series data from 1980 to 2010. The model has six variables, with the industrial output as the dependent variable and gross fixed capital formation in industry, oil price, manufacturing exports, population growth, and agricultural output as the independent variables.

The ADF test results indicate all variables are I(1). The Johansen cointegration test shows that industrial output are positively related to gross fixed capital formation in industry, manufacturing exports, population growth and agricultural output, but it is negatively related to oil price. Furthermore, from the Granger causality test, we found

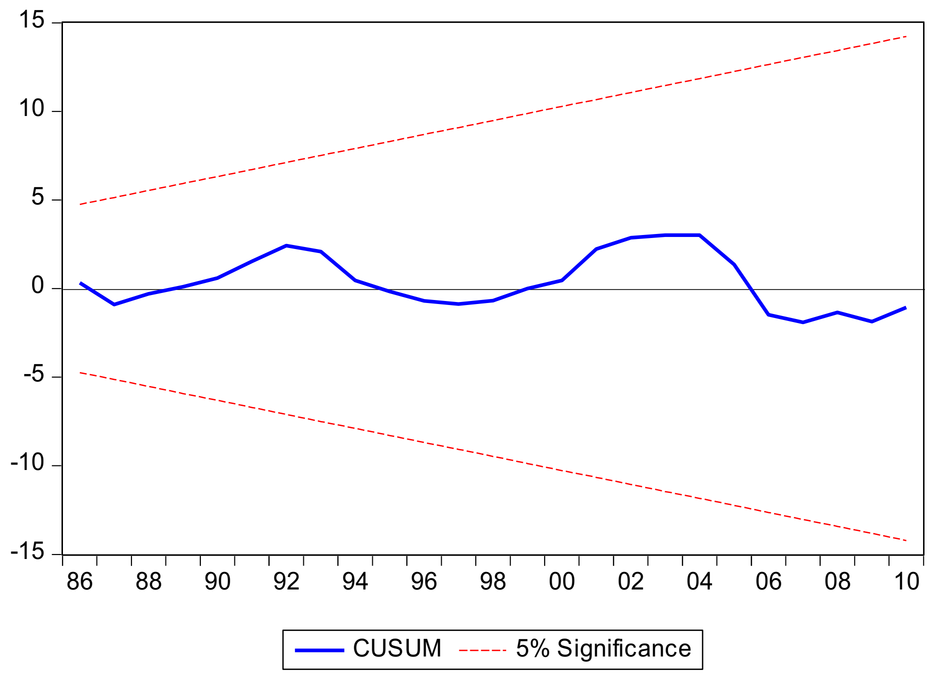

Fig. 3 CUSUM test results

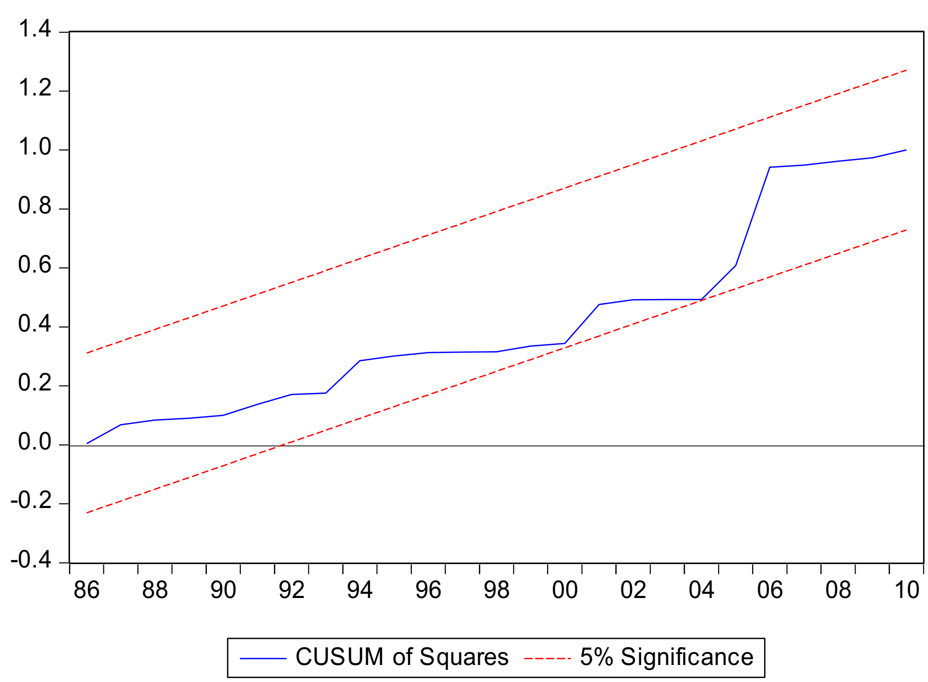

Fig. 4 CUSUMSQ test results

that there are bidirectional causality relationships between gross fixed capital formation in industry, oil price, manufacturing exports, population growth, agricultural output, and industrial output in the short and long run.

The impulse response functions indicated that when there is a shock to gross fixed capital formation in industry, industrial output will respond positively in the first 7 years, and then the effect dies down after the 8th year. However, when there is a shock to oil price or population growth, industrial output will respond negatively over the 10-year period. The industrial output will respond positively to a shock on agricultural output. However, when there is a shock to manufacturing exports, industrial output will respond negatively in the 2nd year, and no significant response in the 3rd, 4th and 5th years, and then it will respond positively in the following years.

Moreover, the variance decomposition analysis showed that over a 10-year forecast period, 11.4 % of the forecast error variance of industrial output is explained by population growth, while 7.5, 7.1, 6.7 and 4.7 % of its forecast error variance are explained by agricultural output, oil price, gross fixed capital formation in industry and manufacturing exports shocks, respectively. The results of the CUSUM and CUSUMSQ tests showed that the parameters are stable over the period of the study, implying that there are no structural changes.

Based on the results of this study, we recommend that the Syrian government increase the industrial funding and improve the quality of manufacturing output to raise its level of competitiveness in the local and global markets. Furthermore, it is important to improve the quantity and quality of agricultural production in Syria, which in turn will reflect positively on the industrial sector. The government should also strive to upgrade the human capital in Syria, which will boost industrial production in the country, and that will enhance the economic growth in Syria.

Additional files

Additional file 1: Table S1. ADF unit root test results.
Additional file 2: Table S2. Johansen cointegration test results.
Additional file 3: Table S3. Cointegration equation normalized with respect to lnIO.
Additional file 4: Table S4. Granger causality test results.
Additional file 5: Table S5. Results of the statistical diagnostic tests on the VECM.
Additional file 6: Table S6. Variance decomposition (VD) analysis results.

Authors' contribution
The main idea of the paper was proposed by ASM. All authors contributed to the analysis and preparation of the manuscript. All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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