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EXPORT DIVERSIFICATION AND ECONOMIC GROWTH IN KUWAIT

EVIDENCE FROM TIME SERIES AND FIELD SURVEY ANALYSES

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Export Diversification and Economic Growth in Kuwait: Evidence from Time Series and Field Survey Analyses

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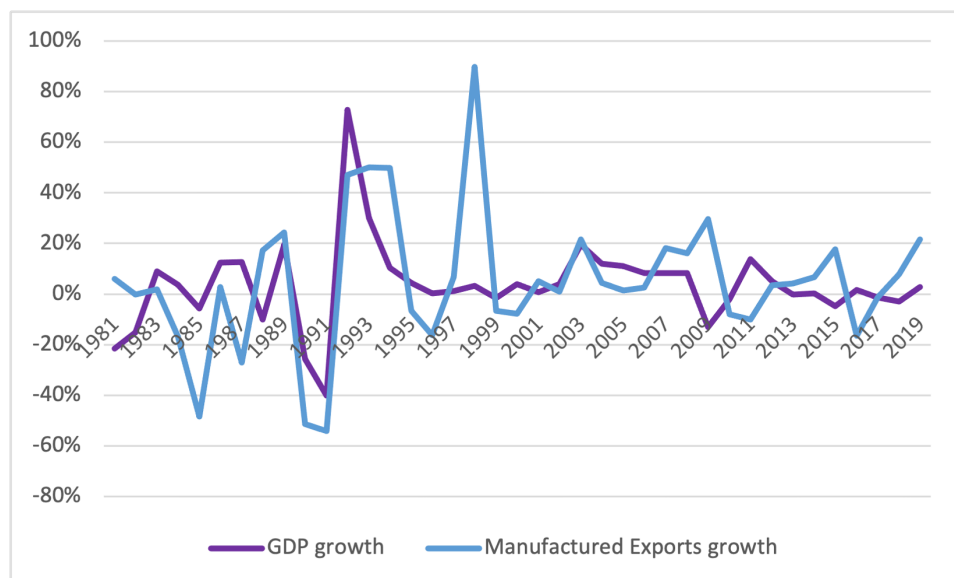
Abstract

This study examines whether export diversification can foster sustained economic growth in Kuwait, using time series analysis for the period 1980–2019 and a field survey of one hundred Kuwait business leaders engaged in import and export of goods and services. The time series analysis reveals that there is no causality between export diversification and economic growth in the short-run. However, an indirect causality runs from export diversification to economic growth, and vice versa, via imports. In the long-run, no causality runs from export diversification to economic growth, but economic growth does cause export diversification. The field survey results indicate that there is a consensus among Kuwaiti CEOs that there are positive spillover effects from exports and imports to producers of local goods and services, and that imports are conducive to economic diversification.

Introduction

Over the period 1980–2019, the real gross domestic product of Kuwait increased from \$57.56 billion in 1980 to \$131.39 billion in 2019, representing an average annual growth rate of 3.5 percent.¹ In addition, real manufactured exports increased from \$4.10 billion in 1980 to \$6.31 billion in 2019, an average annual growth rate of 4.8 percent (Figure 1). However, the share of manufactured exports in total merchandise exports decreased from 10.4 percent in 1980 to 10.1 percent in 2019. As for real imports, they increased from \$13.12 billion in 1980 to \$32.39 in 2019, an average annual growth rate of 3.6 percent.²

Figure 1: Real GDP and Manufactured Exports Growth, 1980–2019



Source: World Bank, World Development Indicators; World Trade Organization.

This research investigates whether an increase in the degree of export diversification will foster further economic growth in Kuwait in an effort to inform the process of designing future policies for fostering economic growth as the economy moves away from its dependence on oil. Given Kuwait's Vision 2035, the case for studying the relationship between export diversification and economic growth is timely and compelling. To do so, the study uses advanced econometric techniques based on time series data for Kuwait over the period 1980–2019 and a field survey of one hundred Kuwait business leaders engaged in the import and export of goods and services. The remaining sections of this paper are organised as follows: Section two reviews the literature on the relationship between export diversification and economic growth. Section three presents the empirical findings on the causality between export diversification and growth. Section four discusses the field survey results, while Section five presents the summary, conclusion and policy implications.

¹ 'World Development Indicators', World Bank. Available at: <https://data.worldbank.org/> (accessed 22 November 2022).

² 'WTO Data - Information on Trade and Trade Policy Measures', World Trade Organization. Available at: <https://data.wto.org/> (accessed 22 November 2022).

Export Diversification and Economic Growth

The debate on the trade-growth nexus dates back to the late 1940s and early 1950s, when many economists believed that import substitution-policies to restrict imports of manufactured goods, through tariff and non-tariff means, was the best trade strategy to promote industrialisation and economic growth. However, ten years later, import substitution policies began to fall out of favour as results emerging from developing countries that followed these policies were largely disappointing.³ If anything, import substitution slowed growth through poor allocation of resources and the negative effect of exchange rate on exports.⁴

In the late 1970s and through the 1980s and 1990s, trade openness became the favoured developmental policy for growth, innovation, transfer of technology and the global competition for talent in startups and foreign direct investment inflows.⁵ During the years leading up to the creation of the World Trade Organization (WTO) in 1995, mainstream economists strongly favoured trade liberalisation and bilateral and multilateral trade agreements. While endorsing the growth-enhancing effects of trade particularly through importation of goods and services, Rodrik (2018)⁶ notes that trade arguments ignore the role of domestic and global business interests and that trade agreements may empower rent-seeking interests and politically well-connected firms. He argues that, as trade agreements focusing less on tariffs and nontariff barriers and more on domestic rules and regulations, the consequences of the latter must be examined.⁷

The positive impact of exports on economic growth, through increased investment and the expansion of imports, has been described by numerous authors.⁸ Economic growth, in turn, improves the country's capacity to import goods for the export-oriented production, fostering export expansion and further growth.⁹

The economic literature on the relationship between exports and gross domestic product (GDP) growth is abundant. Early studies focused on the relationship between export concentration (specialising in certain commodities/industries) and economic growth. The World Bank credited the strong economic growth of the Asian Tigers (Hong Kong, Taiwan,

³ Douglas A. Irwin, 'The Rise and Fall of Import Substitution', *World Development* 139/1 (2020), pp. 1–10.

⁴ Werner Baer, 'Import Substitution and Industrialization in Latin America: Experiences and Interpretations', *Latin American Review* 7/1 (1972), pp. 95–122.

⁵ Klaus Wälde and Christina A. Wood, 'The Empirics of Trade and Growth: Where Are the Policy Recommendations?', *International Economics and Economic Policy* 1/2 (2004), pp. 275–92.

⁶ Dani Rodrik, 'What Do Trade Agreements Really Do?', *Journal of Economic Perspectives* 32/2 (2018), pp. 73–90.

⁷ Ibid.

⁸ Ronald I. McKinnon, 'Foreign Exchange Constraints in Economic Development and Efficient Aid Allocation', *The Economic Journal* 74/294 (1964), pp. 388–409; Thorvaldur Gylfason, 'Exports, Inflation and Growth', *World Development* 27/6 (1999), pp. 1031–57. Athanasia S. Kalaitzi and Emmanuel Cleeve, 'Export-Led Growth in the UAE: Multivariate Causality Between Primary Exports, Manufactured Exports and Economic Growth', *Eurasian Business Review* 8/3 (2017), pp. 341–65.

⁹ Athanasia S. Kalaitzi and Trevor W. Chamberlain, 'The Validity of the Export-led Growth Hypothesis: Some Evidence from the GCC', *The Journal of International Trade & Economic Development* 30/2 (2021), pp. 224–45.

South Korea and Singapore between 1965 and 1990) to the specialisation in manufactured exports.¹⁰ Later studies have shifted the literature's focus to the link between diversification of exports and economic growth.

Al-Marhubi (2000)¹¹ explores the relationship between export diversification and economic growth using growth theory. The model measures growth using changes in output per capita and numerous export commodities to represent diversification. Three different indexes of diversification are used: 1) the actual number of product types exported; 2) an index of the absolute deviation of a country's commodity shares from the global averages and 3) the Hirschmann concentration index for exports. Using a sample of 91 countries for the period (1961–88), Al-Marhubi finds a statistically significant positive relationship between number of products exported and economic growth. Also, a significant negative relationship exists between country's commodity share deviation from that of the rest of the world. The results for the Hirschmann index also indicate that diversification is associated with higher economic growth. The analysis is extended further by specifying the model estimation for a number of developing countries in Latin America and Asia. The results corroborate the original results, indicating a positive and significant relationship between export diversification and growth for developing countries.

In a review of the theory of natural resource abundance and its impact on economic growth, Gylfason (2006)¹² demonstrates channels in which economic growth can be hindered due to the exploitation of natural resources in natural resource abundant countries. The study uses data from OPEC and non-OPEC oil producing countries and finds a similar pattern across countries: that is, the dominance of oil exports as a share of total exports and a decline in non-oil exports over time. Further, comparing manufacturing exports from oil producing and non-oil producing countries, the author finds that manufacturing-based exports from non-oil producing countries are much higher than those of oil producing countries and that this pattern is persistent.

McIntyre et al. (2018)¹³ study export diversification including services as a route to economic growth for small countries. The authors use a sample of 33 small countries – classified as upper middle, lower middle- and low-income countries – and apply the Solow Growth Model to investigate the relationship between exports diversification and economic growth. The study also investigates the impact of diversification on growth volatility measured by the standard deviation of real growth over three years. The Herfindahl index for country-level export flows is used as a proxy for diversification, while the data cover two different time periods (1990–2004 and 2005–15). Using fixed effects estimation

¹⁰ 'The East Asian Miracle: Economic Growth and Public Policy', *World Bank Policy Research Report* 12351 (1993).

¹¹ Fahim Al-Marhubi, 'Export Diversification and Growth: An Empirical Investigation', *Applied Economics Letters* 7/9 (2000), pp. 559–62.

¹² Thorvaldur Gylfason, 'Natural Resources and Economic Growth: From Dependence to Diversification', in Harry G. Broadman, Riiu Paas, and Paul J.J. Welfens (eds), *Economic Liberalization and Integration Policy* (Berlin: Springer, 2006).

¹³ Arnold McIntyre, Mike Xin Li, Ke Wang, and Hanlei Yun, 'Economic Benefits of Export Diversification in Small States', *International Monetary Fund Working Paper* 18/86 (2018).

technique, the authors find that de-diversification as indicated by exports of goods of a particular type has a negative impact on growth. Moreover, they find that the volatility of economic growth increases as exports of un-diversified products increase.

As for country-specific studies, Herzer and Nowak-Lehman (2006)¹⁴ test the diversification-led growth hypothesis by estimating an augmented Cobb-Douglas production function using annual data for constant GDP, capital stock (calculated as accumulated capital expenditure), labour (number employed per year), the ratio of manufactured exports to total exports, and the number of export sectors classified by the Standard International Trade Classification at the three-digit level over the period 1962–2001 for Chile. The authors use a multivariate error correction model and dynamic ordinary least squares (DOLS). Given structural changes in the Chilean economy, time series techniques considering structural breaks are applied. The findings suggest that export diversification plays an important role in economic growth in Chile.

Arip et al. (2010)¹⁵ examine the relationship between export diversification and economic growth in Malaysia. The study uses annual data for GDP, degree of specialisation and diversification (DSD), employment and capital expenditure covering the period 1980–2007. The authors find that the degree of specialisation and diversification is negatively associated with economic growth, implying that export diversification plays a significant role in economic growth. Granger causality tests indicate one-way causality from employment to GDP and from employment to DSD and two-way causality between employment and capital expenditure. Their results support the theory of diversification-led growth for Malaysia.

Onodugo et. al (2013)¹⁶ examine data for Nigeria on GDP, labour force (size of employable population), capital stock (gross fixed capital formation), oil exports, non-oil exports and an index of trade openness (ratio of non-oil exports plus non-oil imports to GDP) over the period 1981–2012. Their results suggest that non-oil exports contribute to growth, but the impact is very small, with 1 percent increase in non-oil exports leading to a 0.03 percent increase in GDP. They conclude that to stimulate growth of the Nigerian economy, a fast-growing non-oil export sector is required.

Mudenda et al. (2014)¹⁷ study the role of export diversification in South Africa for the period (1980–2010) using the vector error correction (VECM) estimation method. They investigate the effects of exports diversification and related factors on South Africa's trade competitiveness and economic growth. The authors estimate a model where the

¹⁴ Dierk Herzer and Felicitas D. Nowak-Lehmann, 'Export Diversification, Externalities and Growth: Evidence for Chile', in *Proceedings of the German Development Economics Conference 12* (Berlin: German Economic Association, 2006).

¹⁵ Mohammad A. Arip, Sim L. Yee, and Bakri Abdul Karim, 'Export Diversification and Economic Growth in Malaysia', *University Library of Munich MPRA Paper 20588* (2010).

¹⁶ Vincent A. Onodugo, Marius Ikpe, and Oluchukwu F. Anowor, 'Non-Oil Export and Economic Growth in Nigeria: A Time Series Econometric Model', *International Journal of Business Management & Research* 3/2 (2013), pp. 115–24.

¹⁷ Caroline Mudenda, Ireen Choga, and Cleopas Chigamba, 'The Role of Export Diversification on Economic Growth in South Africa', *Mediterranean Journal of Social Sciences* 5/9 (2014), pp. 705–12.

dependent variable is GDP per capita and the independent variables are a normalised Hirschmann Index to indicate diversification, human capital formation, capital formation, real exchange rate, and openness to trade. The VECM results show that both human capital and capital formation had a negative influence on economic growth in South Africa. However, the authors expect this relationship would be reversed by upgrading towards a more educated and highly skilled labour force. The normalised Hirschmann Index and openness to trade exhibited a robust positive relationship with GDP growth. The real exchange rate showed a negative relationship with GDP growth, as expected. The study concludes that export diversification plays an important role in promoting South Africa's economic growth.

Kalaitzi and Cleeve (2017)¹⁸, addressed the validity of the export-led growth hypothesis in the United Arab Emirates (UAE) over the period 1981–2012. Their study investigated the causal relationship between primary exports, manufactured exports and economic growth. Additionally, their model included other growth determinants: imports, population (proxy for labour) and gross capital formation (proxy for capital). The Johansen cointegration test was performed to confirm the long-run relationship between the variables, while the Granger causality test and a modified version of the Wald test were used to determine the direction of the short-run and long-run causality respectively. The cointegration tests suggested that manufactured exports contribute more to economic growth than primary exports in the long run. In addition, this research provides evidence in support of a bi-directional causality between manufactured exports and economic growth in the short run, and the growth-led exports (GLE) hypothesis is valid in the long run.

In the case of Kuwait, a number of studies have examined the relationship between exports and economic growth. Al-Yousif (1997)¹⁹ and El-Sakka and Al-Mutairi (2000)²⁰ find that there is no long-run relationship between exports and economic growth in Kuwait. However, their results are conflicting, as Al-Yousif indicates that exports positively affect economic growth in the short run, while El-Sakka and Al-Mutairi find that exports do not cause economic growth in the short run. A more recent study by Merza (2007)²¹ disaggregates exports into oil and non-oil exports and finds that a bi-directional causality exists between oil exports and economic growth in Kuwait, while a unidirectional relationship runs from non-oil exports to growth. Similarly, studies such as Esfahani et al. (2014)²² and Burney et al. (2018)²³ find a positive relationship between oil exports and GDP growth.

¹⁸ Athanasia S. Kalaitzi and Emmanuel Cleeve, 'Export-Led Growth in the UAE: Multivariate Causality between Primary Exports, Manufactured Exports and Economic Growth', *Eurasian Business Review* 8/3 (2017), pp. 341–65.

¹⁹ Yousif K. Al-Yousif, 'Exports and Economic Growth: Some Empirical Evidence from the Arab Gulf Countries', *Applied Economics* 29/6 (1997), pp. 693–7.

²⁰ Mohammed I. El-Sakka and Naief H. Al-Mutairi, 'Exports and Economic Growth: The Arab Experience', *The Pakistan Development Review* 39/2 (2000), pp. 153–69.

²¹ Ebrahim Merza, 'Oil Exports, Non-Oil Exports and Economic Growth: Time Series Analysis for Kuwait (1970–2004)', *Kansas State University Doctoral Dissertation* (2007).

²² Hadi S. Esfahani, Kamiar Mohaddes, and M. H. Pesaran, 'An Empirical Growth Model for Major Oil Exporters', *Journal of Applied Econometrics* 29/1 (2014), pp. 1–21.

²³ Nadeem A. Burney, Kamiar Mohaddes, Ahmad Alawadhi, and Marwa Al-Musallam, 'The Dynamics and

The above studies focus on the relationship between exports and economic growth in Kuwait, but what is the causality between export diversification and economic growth? In the next section, the empirical analysis of the causality between export diversification and economic growth is presented.

Empirical Investigation

Methodology

To investigate the causality between export diversification and economic growth, this study starts with an augmented neoclassical production function:

$$Y_t = F [(K_t, L_t) (DX_t, IMP_t, C_t)] = K_t^\alpha L_t^\beta DX_t^\gamma IMP_t^\delta C_t \quad (1)$$

Y_t , K_t and L_t represent national production, capital and labour force respectively; DX_t and IMP_t denote vertical export diversification and imports of goods respectively,²⁴ while C_t represents other exogenous factors; α , β , γ and δ represent the elasticities of production with respect to K_t , L_t , DX_t and IMP_t . Equation (2) is obtained by taking the natural logs of both sides:

$$LY_t = c + \alpha LK_t + \beta LL_t + \gamma LDX_t + \delta LIMP_t + \varepsilon_t \quad (2)$$

c is a constant, α , β , γ and δ are elasticities, and ε_t is the error term.

The study uses annual time series data for the period 1980–2019, obtained from international sources. In particular, gross domestic product (Y_t) and working age population (L_t) are obtained from the World Bank, while gross fixed capital formation (K_t) and imports of goods (IMP_t) are taken from the International Monetary Fund and World Trade Organization respectively. In addition, export diversification (DX_t) corresponds to the share of manufactured exports to merchandise exports²⁵ taken from the World Trade Organization. All variables are expressed in logarithmic form and real terms.²⁶

Determinants of Kuwait's Long-Run Economic Growth', *Economic Modelling* 71/1 (2018), pp. 289–304.

²⁴ The theoretical framework is based on Kalaitzi and Cleeve (2017) and Shadab (2021); Athanasia S. Kalaitzi and Emmanuel Cleeve, 'Export-Led Growth in the UAE: Multivariate Causality between Primary Exports, Manufactured Exports and Economic Growth', *Eurasian Business Review* 8/3 (2017), pp. 341–65; Saima Shadab, 'The Nexus between Export Diversification, Imports, Capital and Economic Growth in the United Arab Emirates: An Empirical Investigation', *Cogent Economics & Finance* 9/1 (2021), pp. 1–15.

²⁵ This study follows Herzer and Nowak-Lehman (2006) and Matthee and Naude (2007) in defining the export diversification variable. Dierk Herzer and Felicitas D. Nowak-Lehmann, 'Export Diversification, Externalities and Growth: Evidence for Chile', in *Proceedings of the German Development Economics Conference* 12. (Berlin: German Economic Association, 2006); Marianne Matthee and Wim Naudé, 'Export Diversity and Regional Growth: Empirical Evidence from South Africa', United Nations University, *World Institute for Development Economics Research*, (2007/11).

²⁶ The plots of the variables used in the model are presented in the Appendix, Figure A.

Before testing the causality between export diversification and economic growth, the stationary properties of the data are examined, using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test and the ADF test with a breakpoint (ADFBP). In addition, the existence of a long-run relationship between the model variables is investigated by applying the Johansen cointegration test.²⁷ Providing that the variables are cointegrated, the Granger causality test²⁸ is performed²⁹ within VECM³⁰ based on equation (2). To ensure that the estimated parameters of the equations are stable during the examined period, the cumulative sum of recursive residuals (CUSUM) is performed.³¹ In addition, this study examines the long-run causality between export diversification and economic growth, by applying the Toda-Yamamoto modified Wald³² test in an augmented VAR model (AVAR)³³ and the Chisquared test is applied.³⁴

²⁷ Soren Joahnsen, 'Statistical Analysis of Cointegrating Vectors', *Journal of Economic Dynamics and Control* 12/2-3 (1988), pp. 231-54.

²⁸ Clive W. J. Granger, 'Investigating Causal Relations by Economic Models and Cross-Spectral Models', *Econometrica* 37/3 (1969), pp. 424-38; Clive W. J. Granger, 'Some Recent Development in a Concept of Causality', *Journal of Econometrics* 39/1-2 (1988), pp. 199-211.

²⁹ To examine the direct causality between vertical export diversification and economic growth the following hypotheses are tested: Ho: "vertical export diversification does not Granger cause economic growth"; Ho "economic growth does not Granger cause vertical export diversification".

³⁰
$$\Delta Y_t = \mu + \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

where $\Gamma_i = - \sum_{j=i+1}^p A_j$, $\Pi = \sum_{i=1}^p A_i - I$

Δ is the difference operator, Γ_i and Π are the coefficient matrices, where the coefficient matrix Π provides information about the long-run relationships between the variables.

³¹ There are some studies noting the limitations of the Granger causality tests. For instance, Kołtuniak (2016a, 2016b) note that the Granger causality tests 'are not adequate to analyse data in terms of recurring structural changes, which may cause temporal reversals of causality directions between economic phenomena' (p. 253). For this reason, the wavelet analysis could also be used in future studies to check instability both in the time and frequency domains. Marcin Kołtuniak, 'Examination of the Directions of Spillover Effects between the Real Estate and Stock Prices in Poland Using Wavelet Analysis.' *Bank and Credit (Bank i Kredyt)* 47/3 (2016a), pp. 251-66; Marcin Koltuniak, 'Examination of the International Causal Directions between Rates of Return on the Price Indices of the Selected Real Estate Markets in the CEE Region Using Wavelet Analysis.' *Acta Physica Polonica A* 130/6 (2016b), pp. 1420-30.

³² Hiro Y. Toda and Taku Yamamoto, 'Statistical Inferences in Vector Autoregressions with Possibly Integrated Processes', *Journal of Econometrics* 66/1-2 (1995), pp. 225-50.

³³
$$Y_t = \alpha_{it} + \sum_{j=1}^{p+dmax} \beta_{ij} Y_{t-j} + \sum_{j=1}^{p+dmax} \beta_{ij} X_{t-j} + \dots + \varepsilon_{it}$$

where p is the optimal lag length, while $dmax$ is the maximum integration order of the variables. The selected lag length (p) is augmented by the integration order ($dmax$) and the chi-square test is applied to the first p VAR coefficients.

³⁴ To examine the direct long-run causality between vertical export diversification and economic growth, the following hypotheses are tested: Ho: "vertical export diversification do not Granger cause economic growth"; Ho "economic growth does not Granger cause vertical export diversification".

Empirical Findings

The unit root test results are presented in Tables 1 and 2. In particular, the KPSS test at level suggests that all the variables are non-stationary at conventional levels of significance. The ADFBP test confirms the KPSS results that the variables at level are non-stationary.³⁵ When the first differenced variables are used, the KPSS and ADFBP tests indicate that all the variables are stationary at conventional levels. Therefore the variables are integrated of order one, I(1).

The cointegration test results, reported in Table 3, show that a long-run relationship exists between the variables in the model, as the null hypothesis for no cointegration is rejected at the 1 percent significance level. Therefore, a VECM is estimated, and the Granger causality test is applied (Table 4).

Table 1: KPSS and ADFBP Tests at Level

	KPSS	ADFBP	
<i>LY</i>	0.12{3}*	-4.29 [1]	2002
<i>LK</i>	0.16{4}**	-4.44 [6]*	2006
<i>LL</i>	0.15{5}*	-2.70 [2]	2005
<i>LDX</i>	0.17{4}**	-4.12 [0]	2014
<i>LIMP</i>	0.12{3}*	-3.50 [8]	2003

Notes: * and **denote the rejection of the null hypothesis at 10% and 5% respectively. The null hypothesis for the KPSS test is H_0 : the series is stationary, while for ADFBP it is H_0 : the series is non-stationary. Numbers in [] are the optimal lags, while the bandwidth in { } uses the Bartlett kernel estimation method. The series are tested for unit root using an intercept and trend (following Dolado et al., 1990).³⁶

Table 2: KPSS and ADFBP Tests at First Difference

	KPSS	ADFBP	
ΔLY	0.18 {5}	-9.67 *** [0]	1991
ΔLK	0.16 {7}	-4.79 *** [5]	1999
ΔLL	0.10 {4}	-5.59 *** [6]	1999
ΔLDX	0.19 {7}	-6.91 *** [1]	1997
$\Delta LIMP$	0.19 {8}	-5.80 *** [7]	1992

Notes: * and **denote the rejection of the null hypothesis at 10% and 5% respectively. The null hypothesis for the KPSS test is H_0 : the series is stationary, while for ADFBP it is H_0 : the series is non-stationary. Numbers in [] are the optimal lags, while the bandwidth in { } uses the Bartlett kernel estimation method. The series are tested for unit root using an intercept only, except for ΔLY , which is tested using an intercept and trend (following Dolado et al. 1990).³⁷

³⁵ Graphical inspection and correlogram analysis also confirm that all the variables are non-stationary at level.

³⁶ Juan J. Dolado, Tim Jenkinson and Simon Sosvilla-Rivero, 'Cointegration and Unit Roots', *Journal of Economic Surveys* 4/3 (1990), pp. 33-49.

³⁷ Ibid.

Table 3: Cointegration Test

Ho	Trace Statistic	Critical Value	
		1%	5%
No cointegration	90.81***	85.33	76.97
One cointegrating eq.	45.53	61.27	54.08

Notes: *** indicate rejection at 1%. The Trace statistic is adjusted for a small sample. The diagnostic tests show that the residuals are multivariate normal and homoscedastic, while no serial correlation exists.

As can be seen from Table 4, the null hypothesis that export diversification does not cause economic growth cannot be rejected at the 5 percent significance level. Likewise, the null hypothesis that economic growth does not cause export diversification cannot be rejected at 5 percent. However, an indirect causality runs from export diversification to economic growth, and vice versa, through imports. In addition, all the variables jointly cause economic growth and export diversification in the short run. The stability of the estimated parameters during the oil crisis years is confirmed by the CUSUM stability tests (see Appendix, Figures B and C).

Table 4: Short-run Granger Causality Test

Source of Causality	Dependent Variables				
	ΔLY_t	ΔLK_t	ΔLL_t	ΔLDX_t	$\Delta LIMP_t$
ΔLY	-	2.43	9.30***	0.16	7.44***
ΔLK	0.00	-	2.38	0.41	2.87*
ΔLL	0.01	0.77	-	0.87	0.06
ΔLDX	0.57	4.86**	4.35**	-	5.45**
$\Delta LIMP$	10.46***	0.12	5.81**	4.15**	-
ALL	15.96***	5.49	13.57***	9.07*	9.38*

Notes: *, ** and *** indicate significance at 10%, 5% and 1% respectively ($\chi^2_{df(1)}$ and $\chi^2_{df(4)}$ for the joint causality). The diagnostic tests show that the model is well specified and stable.

As for the long run, the Toda-Yamamoto causality test indicates that the null hypothesis of non-causality from export diversification to economic growth cannot be rejected at the 5 percent level. In contrast, the null hypothesis that economic growth does not cause export diversification is rejected at 5 percent, indicating that economic growth contributes to export diversification in the long run. Moreover, in addition to the direct causality running from imports to export diversification and economic growth, an indirect causality runs from imports to export diversification through economic growth. Moreover, all the variables jointly cause export diversification and economic growth in the long run. The results are presented in Table 5.

Table 5: Long-run Toda-Yamamoto Granger Causality Test

Source of Causality	Dependent Variables				
	LY_t	LK_t	LL_t	LDX_t	$LIMP_t$
LY_t	-	5.68*	3.25	6.66**	1.61
LK_t	2.81	-	5.83*	0.79	3.01
LL_t	2.96	3.87	-	7.06**	1.15
LDX_t	0.82	11.60***	1.53	-	1.37
$LIMP_t$	5.92*	7.69**	7.92**	10.05***	-
ALL	17.90**	23.63***	26.83***	17.00**	14.10*

Notes: *, ** and *** indicate significance at 10%, 5% and 1% respectively ($\chi^2_{df(2)}$ and $\chi^2_{df(8)}$ for the joint causality). The diagnostic tests show that the model is well specified and stable.

The above analysis shows that, in the short run, export diversification causes economic growth, but only indirectly through imports.³⁸ In the long run, the causality runs from economic growth to export diversification,³⁹ indicating that economic growth fosters export diversification in the long run. It should be noted that the important role of imports in diversifying Kuwait's economy away from oil is confirmed both in the short run and long run. These findings⁴⁰ agree with previous studies presented in the literature, such as those of McKinnon (1964), Gylfason (1999), Kalaitzi and Cleeve (2017) and Kalaitzi and Chamberlain (2021).⁴¹ But what are the perceptions and visions of business leaders regarding the role of exports and imports in export diversification and economic growth? The next section presents the field survey findings.

³⁸ The development literature notes the important role of imports in the economic growth process (Import-Led Growth Hypothesis). Imports are a channel for technology transfer and are used as inputs for the domestic production (raw material, intermediate goods and capital goods), contributing to further economic growth; Titus, O. Awokuse, 'Causality Between Exports, Imports and Economic Growth: Evidence from Transition Economies', *Economic Letters*, 94/3 (2007), pp. 389–95; David T. Coe and Elhanan Helpman, 'International R&D Spillovers', *Eurasian Economic Review* 39/1 (1995), pp. 859–87.

³⁹ The so-called Growth-Led Exports hypothesis (GLE) notes that further growth increases the need for more imports, which in turn, provides raw materials and technology for the national production, leading to the expansion of manufacturing exports (Kindleberger, 1962; Boggio and Barbieri, 2017); Charles P. Kindleberger, *Foreign Trade and the National Economy*; Luciano Boggio and Laura Barbieri, 'International Competitiveness in Post-Keynesian Growth Theory: Controversies and Empirical Evidence', *Cambridge Journal of Economics* 41/1 (2017), pp. 25–47.

⁴⁰ Robustness check is undertaken with the inclusion of crude oil price in the empirical model. The estimates verify that the above causal relationships remain unchanged. The crude oil prices are taken from the BP (2021) Statistical Review of World Energy. Available at: <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html> (accessed 2 November 2022).

⁴¹ Ronald I. McKinnon, 'Foreign Exchange Constraints in Economic Development and Efficient Aid Allocation', *The Economic Journal* 74/294 (1964), pp. 388–409; Thorvaldur Gylfason, 'Exports, Inflation and Growth', *World Development* 27/6 (1999), pp. 1031–57; Athanasia S. Kalaitzi and Emmanuel Cleeve, 'Export-Led Growth in the UAE: Multivariate Causality Between Primary Exports, Manufactured Exports and Economic Growth', *Eurasian Business Review* 8/3 (2017), pp. 341–65; Athanasia S. Kalaitzi and Trevor W. Chamberlain, 'The Validity of the Export-led Growth Hypothesis: Some Evidence from the GCC', *The Journal of International Trade & Economic Development* 30/2 (2021), pp. 224–45.

Potential Role of Exports and Imports

Kuwait remains heavily dependent on oil export revenues as sources of national income and government revenues. Commodity, mainly oil, exports represented about 95 percent during the 1970's. In 2019, oil exports represent about 90 percent of total revenues—indicating that the country has made little progress in reducing its reliance on oil. The concentration of Kuwait's exports around oil and, to a lesser degree, a few other commodities, the prices of which fluctuate widely, translates into unstable income, which, in turn, precipitates a high level of growth volatility. The experience of other nations suggests that a plausible escape path away from what is sometimes referred to as a commodity trap may be fashioned around enhanced human capital, structural changes and elevated labour and total factor productivity.⁴²

While IMF indices of export diversity suggest that Kuwait's exports diversity has remained largely unchanged for a long period of time, there is a notable exception. The index gauging Kuwait's intensive margin, has recorded values of less than one for the period 2015–2020, suggesting departure from long-term trend.⁴³ To escape from its heavy dependence on commodity exports revenues, Kuwait must undertake structural changes that lead to enhanced labour productivity and elevated sustainable economic growth, with a view to competing successfully in international non-oil product markets.

Export diversification in this setting offers the opportunity to create more stable export revenues and national income. More stable and sustainable income may be realised as a result of product diversification.⁴⁴ For this strategy to succeed, business leaders must recognise its importance. Here, the study examines their perceptions and understanding of whether and how exports and imports contribute to trade and economic diversification and, in turn, sustainable economic growth.

The Sample

A sample of 100 CEOs was drawn up from records of the Public Authority for Industry (PAI), 75 percent of which are engaged in the export of manufactured products. For comparison purposes, the sample also included other companies, including nearly 30 that do not specialise in exports but engage mainly in imports of a wide range of products and services. As such, our small sample is not comparable to the sample of 6,000 annual establishments covered by Kuwait's CSB survey annually. That is, the CSB Annual Economic Establishments Survey represents all firms in all sectors, including financial, hospitality and restaurants, in addition to construction, communications, trade and manufacturing. The CEOs were probed on issues pertinent to the role of exports in diversification, development, competition, innovation and destination to international markets. Interviewed CEOs revealed strong perceptions about the positive role of manufactured exports on export diversifications and as a vehicle to help the Kuwaiti economy diversify and grow.

⁴² 'Escaping from the Commodity Dependence Trap through Technology and Innovation', (2021).

⁴³ 'UNCTAD STAT', *United Nations Conference on Trade and Development Statistics Database* (2021). Available at: <https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=120>

⁴⁴ Alberto Amurgo-Pacheco and Martha Denisse Pierola, 'Patterns of Export Diversification in Developing Countries: Intensive and Extensive Margins', *World Bank Policy Research Working Paper* 4473 (2008).

By and large, CEOs also revealed that Kuwaiti ports are not competitive nor efficient relative to GCC and international ports with downside effect on export diversification and growth. Most CEOs believe that competition for export markets results in the introduction of more product innovations, as well as process, and marketing innovations which embed clear developmental implications. In all cases however, the CEOs in our sample overwhelmingly indicated that trade and particularly exports diversification requires high level of talent and augmented quality of human capital to foster firms' innovation and paths of diversification and sustainable growth. This perception is noteworthy given the overall low-quality human capital in Kuwait and low and declining productivity levels in Kuwait as corroborated by a recent study.

The CEOs were probed on issues pertinent to the role of exports in diversification, development, competition, innovation and destination to international markets. The responses are analysed and their implications are discussed below. Export products included in the survey are displayed in Table 6.

Sixteen percent of exporting firms in 2019 are engaged in food production. A close second are companies that export various chemical products, with a share of 15 percent, followed by companies engaged in exporting equipment, 8 percent, while 5 percent are in the business of exporting furniture products. The remaining exporting companies are classified under the category 'other'.

Table 6: Types of Goods Exported by the Company at the Beginning of its Activity⁴⁵

Export Products	Count	%
Food commodities	12	16
Furniture	4	5
Household appliances and equipment (washing machine, dryer, oven, TV, etc.)	1	1
Computers, printing and related equipment	0	0
Smartphones and the Internet	0	0
Automobiles, tractors, bicycles and other land vehicles, their parts and accessories	0	0
Pharmacy products	0	0
Clothes, fabrics and accessories (shoes, handbags, etc.)	2	3
Various chemical products	11	15
Other devices and equipment	6	8
Other	42	56
Total Exporting Companies	75	-

⁴⁵ The number of exporting companies in sample is 75, for this question a company can operate in more than one sector which explains the total adds up to 78 companies rather than 75.

Findings of the Survey

Overall, the CEOs indicated that manufactured exports are conducive to export diversification and to economic diversification and overall economic growth. There is a consensus among Kuwaiti CEOs that trade transmits positive effects. Specifically, they agree that there are positive spillover effects from international export and imports to producers of local goods and services.

The responses indicate that companies engaged in manufactured exports are more likely to experience export diversification benefits than are other companies. This implies that catering to external markets embeds efficiency and broadens exporters' awareness of potential additional products and market share that could be cultivated in global markets relative to those offered by local markets.

The findings reveal that manufactured exports require augmented human capital, with workers being offered higher wages in order to motivate them to upgrade their capabilities. Policy makers, in turn, must design programs that will provide workers with the skills they require.

Most of the polled companies (Table 7), 72 percent, were established prior to 2000. Twelve percent of the sampled companies were established during the 1960's or earlier. Overall, Kuwaiti export-import companies included in sample are quite experienced. Thirty-nine percent were formed before 1980, while 33 percent were established between 1980 and 1999. The age structure of capital, gauged by establishment year, has important implications for measuring total factor productivity.

Table 7: Firms by Sector and Year of Formation

Established Year	Government		Joint		Private		Total	
	Count	%	Count	%	Count	%	Count	%
<1960	0	0	0	0	2	2	2	2
1960–69	0	0	1	50	9	9	10	10
1970–79	0	0	1	50	26	27	27	27
1980–89	1	100	0	0	16	16	17	17
1990–99	0	0	0	0	16	16	16	16
2000–09	0	0	0	0	19	20	19	19
2010–20	0	0	0	0	9	9	9	9
Grand Total	1	100	2	100	97	100	100	100

About 45 percent of companies started exporting manufactured products in the first five years of their formation and an additional 39 percent did so after ten years (Table 8). Companies that were established during the period 1970–1989, which were modern Kuwait’s formative years, generated more innovations than companies established after that date. About 40 percent of all innovations were made by companies established during the 1970s and 1980s. Companies established during the 1990–2009 period undertook 35.4 percent of all innovations and 12.3 percent of all innovations were made by companies established between 2010 and 2020. The remaining innovations were made by companies established prior to 1970. Another finding is that most innovations (70.8 percent) by exporting companies are made during the first 15 years. This suggests that younger companies are more innovative relative to older companies (Table 9).

Table 8: Number of Years Company Started Exporting after Formation

Years	Count	%
Same year	6	8
1	6	8
2	8	11
3	2	3
4	5	7
5	6	8
6	3	4
7	1	1
8	4	5
9	2	3
10	3	4
>10	29	39
Grand Total	75	100

Table 9: Exporting Companies

Year Established	Number of Years Before Firm Starts Exporting	Company Innovations During the Last Three Years					
		Yes		No		Total	
		Count	%	Count	%	Count	%
<1970	Same year	2	3.08	1	10	3	4
	1-5	1	1.54	0	0	1	1.33
	21-25	1	1.54	0	0	1	1.33
	41-45	2	3.08	0	0	2	2.67
	46-50	1	1.54	0	0	1	1.33
	86-91	1	1.54	0	0	1	1.33
1970-89	1-5	9	13.85	1	10	10	13.33
	6-10	1	1.54	0	0	1	1.33
	11-15	3	4.62	0	0	3	4
	16-20	2	3.08	1	10	3	4
	21-25	3	4.62	0	0	3	4
	26-30	1	1.54	3	30	4	5.33
	31-35	3	4.62	0	0	3	4
	36-40	2	3.08	0	0	2	2.67
	46-50	2	3.08	0	0	2	2.67
1990-09	Same year	2	3.08	0	0	2	2.67
	1-5	8	12.31	2	20	10	13.33
	6-10	9	13.85	2	20	11	14.67
	11-15	3	4.62	0	0	3	4
	16-20	1	1.54	0	0	1	1.33
2010-20	Same year	1	1.54	0	0	1	1.33
	1-5	6	9.23	0	0	6	8
	6-10	1	1.54	0	0	1	1.33
Grand Total		65	100	10	100	75	100

A significant characteristic of polled companies is that they tend to be well capitalised, with the paid-up capital per company exceeding KD one million for 37 percent of companies at the time they are formed. About 9 percent of all companies had paid up capital of KD five million or more (Table 10). This is noteworthy as well-capitalised companies tend to deploy more innovative technology and higher calibre talent and human capital. Eighty-five percent of all companies surveyed made innovations during the last three years. The remaining 15 percent indicated that they did not conduct innovations or did not respond (Table 11).

Table 10: Paid up Capital

Range	Paid at Establishment		Between 2017–19	
	Count	%	Count	%
Less than half a million	33	33	13	13
Half a million – less than a million	16	16	15	15
1 million – less than 2 million	15	15	19	19
2 million – less than 5 million	13	13	25	25
5 million – less than 10 million	3	3	7	7
10 million – less than 20 million	4	4	5	5
20 million or more	2	2	1	1
No response	14	14	15	15
Grand Total	100	100	100	100

Table 11: Innovation Status

Company Innovations During the Last Three Years	Exporting		Non-Exporting		Total	
	Count	%	Count	%	Count	%
Yes	65	87	20	80	85	85
No	10	13	5	20	15	15
Grand Total	75	100	25	100	100	100

The sales volume of companies ranged from less than KD half a million to more than KD 20 million per year. About 37 of the companies had annual sales ranging between KD one and five million and 23 had annual sales volume of KD five million or more per year (Table 12).

Table 12: Annual Company Sales

Annual Sales	Government		Joint		Private		Total	
	Count	%	Count	%	Count	%	Count	%
Less than half a million	0	0	0	0	11	11	11	11
Half a million – less than a million	0	0	0	0	15	15	15	15
1 million – less than 2 million	0	0	0	0	16	16	16	16
2 million – less than 5 million	1	100	1	50	19	20	21	21
5 million – less than 10 million	0	0	0	0	11	11	11	11
10 million – less than 20 million	0	0	0	0	6	6	6	6
20 million or more	0	0	0	0	6	6	6	6
No response	0	0	1	50	13	13	14	14
Grand Total	1	100	2	100	97	100	100	100

Kuwait's firms seem to be capable of exporting (44 percent began exporting within five years of establishment). Twenty percent of companies export KD one million or more annually. Thirty-eight percent of the companies exported less than KD half a million in 2019 (Table 13).

Table 13: Value of Exports

Value of Export Invoice	Upon Beginning to Export		in 2019	
	Count	%	Count	%
Less than half a million	53	53	38	38
Half a million – less than a million	5	5	4	4
1 million – less than 2 million	3	3	5	5
2 million – less than 5 million	0	0	9	9
5 million – less than 10 million	0	0	5	5
10 million – less than 20 million	1	1	1	1
20 million or more	0	0	0	0
No response	38	38	38	38
Grand Total	100	100	100	100

As for imports, CEOs indicated that over time changes had occurred. Since establishment, the volume of imports decreased for 10 percent of all surveyed companies; 36 percent indicated that the volume of imports did not change and 25 percent of companies experienced increased imports. These data must be interpreted in the content of periodic shocks, especially the impact of the Coronavirus pandemic (Table 14).

Table 14: Import Changes Between 2019 and Year of Formation

Import Change Since Established	Count	%
Decreased	10	10
No change	36	36
Increased	25	25
No information	29	29
Grand Total	100	100

Responding to the query about the quality of imports over time, about 43 percent of CEOs indicated that import quality had improved over time. Only 7 percent stated that import quality had deteriorated, while 39 percent indicated that it remained essentially the same stable. Eleven percent did not respond (Table 15).

Table 15: Quality of Imports

Quality Rating of Imported Goods ⁴⁶	Exports		Doesn't Export		Total	
	Count	%	Count	%	Count	%
Increased and improved	35	47	8	32	43	43
It got worse over time	5	7	2	8	7	7
The quality has remained stable	28	37	11	44	39	39
No response	7	9	4	16	11	11
Grand Total	75	100	25	100	100	100

Imports have had a highly positive impact on local Kuwaiti producers with respect to production process development and enhancement of product quality. About forty-nine of CEOs indicated that imports enhanced the capabilities of local producers, 27 percent replied that import did not have a measurable positive impact, and 24 did not reply. This suggests that the majority of Kuwaiti CEOs agree that trade induce positive spillover effects for domestic producers of goods and services including, for example, improved product quality, production efficiencies and diversification opportunities (Table 16).

⁴⁶ We asked 100 companies 'How Do You Rate the Quality of Imported Goods During the Past Years?'

Table 16: Impact of Imports on Domestic Producers

Response	Count	%
Yes	49	49
No	27	27
No response	24	24
Grand Total	100	100

The above inference is strengthened by the responses of CEOs to the question: ‘Has the technology you use in your import and export operations changed?’. The majority, 68 percent, indicated that it had, 23 percent replied that it had not, and 9 percent did not respond. Positive responses are higher for exporting companies compared to non-exporting ones (Table 17).

Table 17: Technology Changes in Import and Export Operations

Technology Changes Noticed	Exports		Doesn't Export		Total	
	Count	%	Count	%	Count	%
Yes	55	73	13	52	68	68
No	16	21	7	28	23	23
No response	4	5	5	20	9	9
Grand Total	75	100	25	100	100	100

Likewise, about 75 percent of CEOs indicated that exports and imports contribute positively to elevating technical know-how in Kuwait. Only 13 percent indicated that trade does not enhance technical know-how while 12 percent did not answer.

As shown in the tables, 43 percent of CEO's believe that the quality of imports had improved over time, while 75 percent indicated that exports and imports contributed to enhancing the role of technology in Kuwait. The corresponding proportion is slightly higher (79 percent) for manufacturing exporting companies (Table 18).

Table 18: Import (Export) Impact on Technology Usage

Import (Export) Increased Level of Technology Usage	Exports		Doesn't Export		Grand Total	
	Count	%	Count	%	Count	%
Yes	59	79	16	64	75	75
No	9	12	4	16	13	13
No response	7	9	5	20	12	12
Grand Total	75	100	25	100	100	100

When CEOs were asked about the nature of innovation made during the past three years, they responded that products (65 percent) processes (57 percent) and marketing (45 percent) had been most affected, while 27 percent replied that there had been improvements in administrative regulations and 13 percent did not respond (Table 19).

Table 19: Innovation Over Last Three Years

Sectors Where Innovations Were Made	Count	%
Product	49	65
Process	43	57
Marketing	34	45
Administrative regulation	20	27
No response	10	13
Total Exporting Firms	75	-

Since our sample consists mainly of PAI companies who specialise in manufacturing products and do export to international markets, responding CEOs indicated that they believe that trade in manufactured exports do contribute to diversifying the sources of income in the Kuwaiti economy. As well, they overwhelmingly consider that manufactured exports are a strong causal force for employing higher level human capital. These findings seem to be in line with recent international evidence showing that mineral commodity dependence is associated with low levels of labour productivity, low productivity growth, high volatility of productivity growth and a high frequency of negative productivity shocks.⁴⁷ Findings of this study here corroborate findings of a recent KISR study that estimated productivity using firm level data from establishment surveys covering 2003–2018. According to KISR's study, total factor productivity (TFP) and labour productivity (LP) grew at either minute or negative annual rates during much of the past 20 years.⁴⁸ This led

⁴⁷ UNCTAD, 'Escaping from the Commodity Dependence Trap through Technology and Innovation', Issue No. 13 (2021).

⁴⁸ S. Al-Qudsi et. al, *The 2020 Coronavirus Outbreak and Global Growth and Trade Collapse: Impact on Kuwait's Overall Economy And Society, Its Sectors And Business Firms And Vital Fiscal Recovery Plan* (CORO-NAPROP-92) KISR-TEO62C (Kuwait City: Government of Kuwait, 2021).

KISR's study to conclude that productivity anemia is at the heart of Kuwait's poor record in diversifying into new innovative manufactured products and services and realise higher sustainable growth. During the past 15 years, Kuwait succeeded to diversify into three manufactured export products only compared with 19 in the case of Saudi Arabia and 16 in the case of the UAE. As succinctly indicated by the Harvard Growth Lab's index of innovation, exports, and diversity, the corresponding diversity into innovative manufacturing export products is much higher in the case of South Korea and Malaysia, exceeding 30.⁴⁹

Finally, 72 percent of the CEOs surveyed believe that imports help Kuwait diversify its sources of income, while 21 percent indicated that imports do not lead to income diversification and 7 percent did not reply (Table 20).

Table 20: Imports Relationship to Diversification

CEOs Opinions on Importing Helping Diversification	Exports		Doesn't Export		Grand Total	
	Count	%	Count	%	Count	%
Yes	56	75	16	64	72	72
No	16	21	5	20	21	21
No response	3	4	4	16	7	7
Grand Total	75	100	25	100	100	100

These findings corroborate in broad terms Kuwait's exports record. Data on Kuwait's individual commodity exports and their destination over time are sparse and what are available are mostly about broad commodity groups. But based on available data, the following graphs display crude proxies for the extent of success of Kuwait in intensive margin, growth of exports of old products and extensive margin or growth of exports in new categories. These are largely in line with the aforementioned productivity and diversity findings.

⁴⁹ 'The Atlas of Economic Complexity', *Harvard Growth Lab*, 2021. Available at: <https://atlas.cid.harvard.edu/countries/122/new-products> (accessed 2 November 2022).

Conclusion

The present study examines whether export diversification could accelerate economic growth in Kuwait, using time series data over the period 1980–2019, complemented by a field survey of one hundred Kuwait business leaders, engaged mainly in imports and exports. The survey findings enrich the conclusions indicated by the econometric analysis.

The time series analysis provides evidence that a long-run relationship exists between export diversification and economic growth in Kuwait. A causality test indicates that export diversification does not directly cause economic growth in the short run. However, indirect causality runs from export diversification to economic growth, and vice versa, through imports. In the long run, no causality runs from export diversification to economic growth, but economic growth does cause export diversification, indicating that further economic growth contributes to export diversification in the long run. In addition, an indirect causality also runs from imports to export diversification through economic growth, indicating the important role of imports in diversifying Kuwait's economy away from oil.

The field survey results indicate that there is a balance of opinion among Kuwaiti CEOs that trade transmits positive effects. Specifically, they agree that there are positive spillover effects from international exports and imports to producers of local goods and services and that imports are conducive to economic diversification.

The perceptions of Kuwaiti CEO's confirm the results of the econometric analysis. Export diversification and economic growth go hand in hand in the short run, while growth is a necessary ingredient for diversification in the long run. Imports also have a critical role to play in diversifying Kuwait's economy in the long run. The message for policy makers is clear. Institutional arrangements are necessary to insulate the economy from oil price volatility and the inevitable decline in the secular demand for oil. Diversification into manufactured exports for sustainable economic growth requires significant investments in talent acquisition and human capital development, along with steadily upgrading digital skill competencies especially of fresh graduates. A framework is also needed to unlock the private sector's potential, with particular emphasis on those industries offering the best opportunities for innovation in either vertical or horizontal diversification. High-value and internationally competitive export production will also require highly skilled workers and state-of-the-art technology. The former can be developed internally and through competition for and attraction of international talent, while the latter will come from abroad through imports, possibly augmented by foreign direct investment.

Appendix

Figure A: Plots of the Model Variables

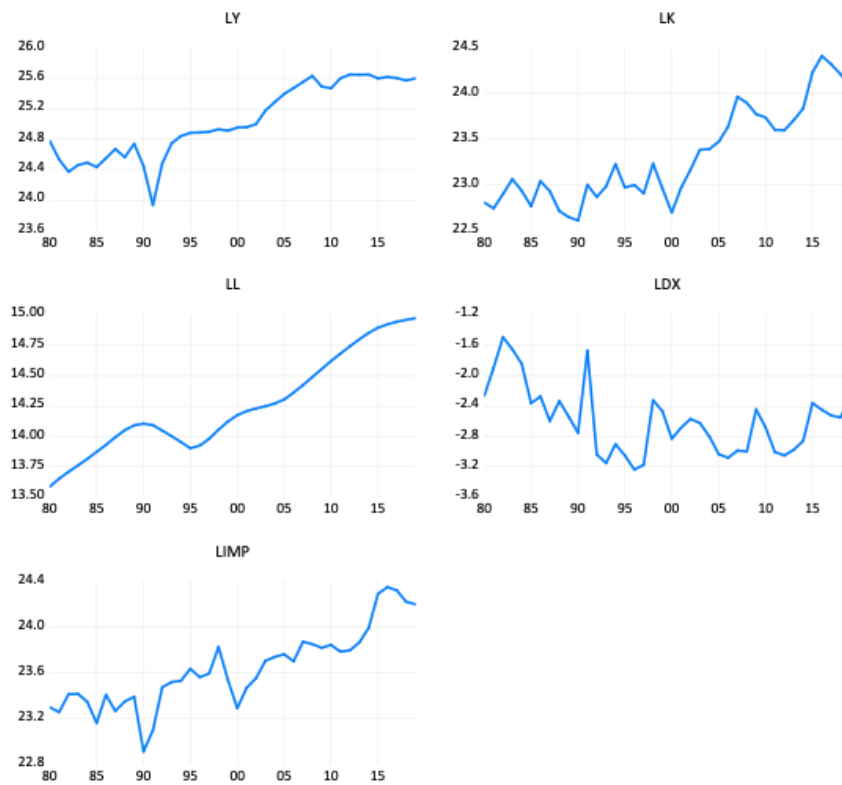


Figure B: CUSUM Stability Test for the Economic Growth (ΔLY) Equation

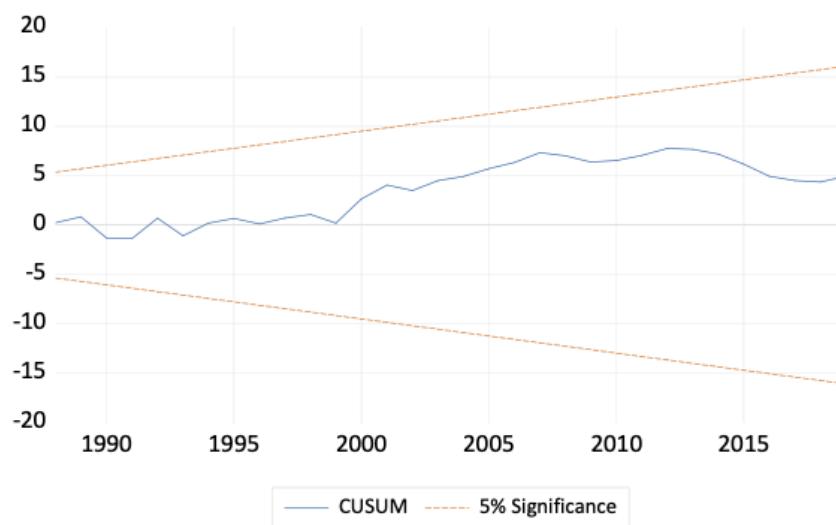
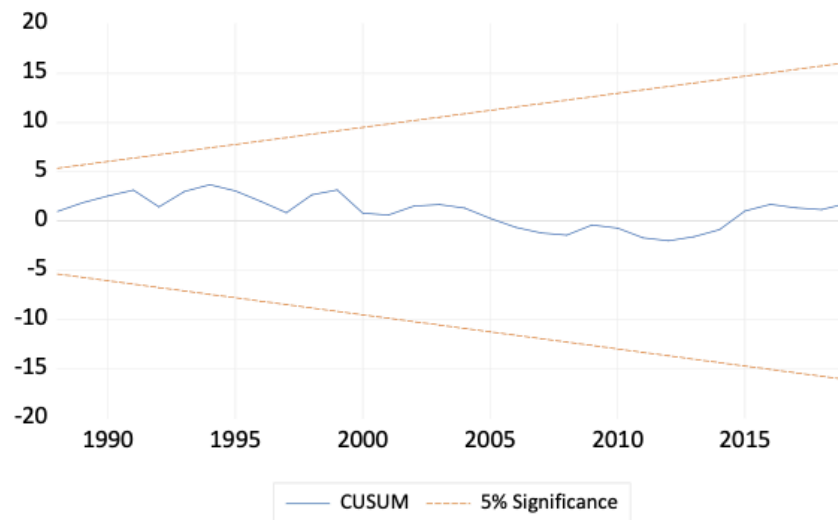


Figure C: CUSUM Stability Test for the Export Diversification (ΔLDX) Equation

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