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Article

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Cogent Economics & Finance

Provided in Cooperation with:

Taylor & Francis Group

Suggested Citation: Gouider, Abdessalem; Ben Haddad, Hedi (2020) : Manufactured goods' export diversification in Saudi Arabia: a spatial panel approach, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 8, Iss. 1, pp. 1-16, <https://doi.org/10.1080/23322039.2020.1741309>

This Version is available at:

<https://hdl.handle.net/10419/245298>

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To cite this article: Abdessalem Gouider & Hedi Ben Haddad | (2020) Manufactured goods' export diversification in Saudi Arabia: A spatial panel approach, Cogent Economics & Finance, 8:1, 1741309, DOI: [10.1080/23322039.2020.1741309](https://doi.org/10.1080/23322039.2020.1741309)

To link to this article: <https://doi.org/10.1080/23322039.2020.1741309>



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Received: 25 May 2019
Accepted: 04 January 2020

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Reviewing editor:
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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Manufactured goods' export diversification in Saudi Arabia: A spatial panel approach

Abdessalem Gouider^{1,2} and Hedi Ben Haddad^{2,3*}

Abstract: This paper explores the potential spatial diversification of manufactured goods' exports in Saudi Arabia. To account for the spatial interactions of Saudi's manufactured goods' exports, we use a panel Spatial Autoregressive (SAR) model for 77 trade partners over the period 2000–2016. The empirical results suggest, firstly, the existence of spatial interdependence among Saudi's manufactured goods' exports. Secondly, we find that the exogenous variables including GDP, GDP per capita, trade freedom, bilateral exchange rate, and trade intensity index exert strong spillover effects on bilateral Saudi's manufactured goods' exports. Finally, the study demonstrates evidence of the highest potential with 34 out of 77 partners. This finding has important implications for policymakers, mainly in terms of development of the domestic manufacturing sector and geographic reallocation of Saudi's manufactured goods' exports.

Subjects: Statistics & Probability; Statistics for Social Sciences; Economics

Keywords: panel Spatial autoregressive model; diversification; manufactured goods' exports; spillover effects; Saudi Arabia



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PUBLIC INTEREST STATEMENT

This article provides an empirical investigation of the importance of spatial diversification in boosting Saudi Arabia's manufactured goods exports using a panel Spatial Autoregressive (SAR) model for 77 trade partners over the period 2000–2016. Our findings show the existence of spatial interdependence among Saudi's manufactured goods' exports. In addition, we found that the exports of manufactured products in Saudi Arabia are dominated heavily by a spillover effect. Finally, our results demonstrate that Saudi Arabia has an immense export potential with 34 countries while actual manufactured goods' exports are exhausted with 43 countries. Thus, Saudi Arabia needs not only the diversification of domestic manufactured goods' sector but also a geographic diversification that leads to the reallocation of its exports of manufactured goods.

1. Introduction

Saudi Arabia's economy highly depends on oil exports. The oil sector contributed nearly 87% of government revenue, 42% of GDP, and 90% of export earnings in 2016 (The World factbook, 2018).¹ The economic predominance of the oil sector is revealing the low level of economic diversification in Saudi Arabia.

Considering the durability of lower oil-prices, it has become imperative for the Saudi government to look at diversifying its domestic economy. In this way, the International Monetary Fund [IMF] (2016) considers that economic diversification is an inevitable policy in oil-exporting Arab countries because it reduces the impact of the external shocks associated with oil markets on the economy.

To ensure the economy's resistance to unpredictable fluctuations in oil prices and to achieve economic transition to the post-oil era, one of the main pillars of 2030 Vision's goals, export diversification, can be considered as the new driving engine of economic growth in Saudi Arabia. Low oil-prices force the government to undergo structural reforms to diversify sources of income, and policy makers in Saudi Arabia acknowledge that the sustained drop in oil prices requires various economic diversification measures. Thus, sustainable growth will need the eventual reallocation of resources toward the high value-added manufacturing sector. This policy leads to the creation of more jobs, extends government revenue, and protects the economy against external shocks (Mudenda et al., 2014; Sannassee et al., 2014).

The importance of the manufacturing sector in the development process having been studied by Kaldor (1966). The author highlighted the importance of the manufacturing sector and mainly the manufactured goods' exports in the economic development process. Also, Marconi et al. (2016) suggested that the improvement of the manufacturing sector increases economic growth and productivity, while manufacturing exports support the development process. Therefore, it is accepted that countries that have experienced high growth rates have diversified manufacturing. On the one hand, the higher the growth of the manufacturing sector, the greater the economic growth rate (Harding & Javorcik, 2011; Herzer & Nowak-Lehmann, 2006). On the other hand, export diversification toward manufactured goods leads to a higher growth rate, more productivity, and increased welfare (Chenery, 1980; Haussman et al., 2007; Palma, 2005).

Since 2014, the share of the non-oil sector in GDP has increased rapidly. In 2016, the non-oil sector contributed 74% of Saudi's GDP, as compared to approximately 57% in 2014.² This contribution is mainly due to the government sector, which generates 51% of GDP. Meanwhile, the private sector contributes only 23% of GDP. Furthermore, the share of non-oil industrial exports has risen steadily, especially since the fall of the oil price in 2014. The share of non-oil industrial exports reached approximately 26% of total exports in 2016, compared to 11% in 2006 and 13% in 2011.³

The manufacturing sector in Saudi Arabia has experienced reliable progress over the past few years. According to the Saudi Industrial Development Fund, the Saudi GDP from manufacturing goods increased from SR 32 billion in 1974 to more than SR 310 billion by the end of 2016. In addition, the manufacturing sector contributed 12% of GDP in 2016 compared to 3% in 1974.⁴ Accordingly, the increase of the share of manufacturing sector in both GDP and total exports, diversification towards manufacturing exports in Saudi Arabia can constitute the catalyst for economic growth in the post-oil era.

Besides, the changing of the existing basket of exported commodities, the extending of the number of markets that a country exports to can also constitute other form of export diversification (Hinlo & Arranguéz, 2017). In this way, some studies (e.g. Amurgo-Pacheco & Pierola, 2008; Brenton & Newfarmer, 2007; Hinlo & Arranguéz, 2017) highlighted the importance of spatial exports diversification through expanding export markets destinations, reducing trade-shocks and thus enhancing economic growth via spillover effects.

To our knowledge, there has been no research into the spatial dimension of Saudi's manufactured goods' exports. Thus, our research will contribute to the existing literature in two ways. First, to analyze the potential growth of Saudi's manufactured goods' exports through spatial diversification to achieve the transition of the economy away from the oil-sector, we apply a panel Spatial Autoregressive (SAR) model to account for both contemporaneous and spillovers effects of exogenous variables on Saudi's manufactured goods' exports. Hence, we consider a panel of 77 partners over the period 2000–2016. Second, we seek to identify the club of countries that constitute the potential markets for Saudi's manufactured goods' exports by applying a potential export indicator introduced by Irshad et al. (2018a), (2018b).

The remainder of the paper is organized as follows: Section 2 briefly reviews the existing literature about the positive impact of economic diversification. In Section 3, we present the methodology and the data sources. Section 4 presents the empirical results. Section 5 concludes.

2. Literature review

2.1. Positive impact of diversification on economic growth

The nexus between export diversification and economic growth continues to receive interest in both theoretical and empirical literature. Defined as the change of the composition of a country's export mix (Ali et al., 1991), some studies have stated that export diversification leads to many positive externalities, such as higher per capita income (Ferreira, 2009), diversifying government revenue (Sannassee et al., 2014), increasing welfare (Harding & Javorcik, 2011), job creation (Samen, 2010) and increasing productivity (Marconi et al., 2016). Diversification⁵ generally has three interrelated objectives: stabilizing earnings, expanding export revenues, and upgrading value-added (Alemu, 2008).

Several studies have confirmed the positive relationship between export diversification and economic growth (Ferreira, 2009; Harding & Javorcik, 2011; Herzer & Nowak-Lehmann, 2006; Lotfi & Karim, 2017; Mejia, 2011; Olaleye et al., 2013; Sannassee et al., 2014). In addition, the Asian countries experienced higher economic growth rates due to significant increases of manufactured goods' exports during the last few decades, demonstrating that export development and diversification are the new engine of growth (Samen, 2010). Thus, countries need to adopt appropriate policies to diversify their economies (especially exports) and accelerate growth.

To study the relationship between export diversification and economic growth, Herzer and Nowak-Lehmann (2006) estimated an augmented Cobb–Douglas production function based on time series data from Chile over the period 1962–2001. Their results show that horizontal and vertical export diversification can accelerate economic growth.

Harding and Javorcik (2011) considered that export diversification, when it concerns more sophisticated products, would enhance economic development. In addition, export diversification can generate higher growth rates and contribute to raising the welfare of a nation. It contributes to higher per capita income growth (Ferreira, 2009). In a related study, Mejia (2011) argues that export diversification has been proposed as a policy mechanism seeking to stabilize export earnings, mainly in developing countries.

Recent empirical studies in this field confirm the argument that export diversification has a positive effect on an economy's performance. Based on applying the Granger Causality test to a 30-year dataset, Olaleye et al. (2013) found that economic diversification is inevitable for Nigeria to enhance the contribution of other sectors to socio-economic development. This finding is supported by Sannassee et al. (2014) who concluded that export diversification permits governments to realize economic growth, a satisfactory balance of payments situation, employment, and redistribution of income. Similar evidence was provided by Lotfi and Karim (2017) for the case of Morocco. Using a vector error correction model, they demonstrated that export diversification has

a positive effect on economic growth and drives a higher level of economic development in Morocco.

Moreover, export diversification plays an important role in stabilizing revenue and in protecting an economy from unpredictable shocks (Lotfi & Karim, 2017; Mudenda et al., 2014; Sannasse et al., 2014). As stated by Sannasse et al. (2014), the broadening of the export base through a more diversified national trade portfolio can stabilize export earnings and contribute to long-term economic growth. So, it allows investment risks to be spread over more economic sectors. A similar result was obtained by Mudenda et al. (2014), who concluded that export diversification can stabilize export revenue and, consequently, make countries less sensitive to unpredictable external shocks. These findings are supported by Lotfi and Karim (2017) who affirmed that the more that economies are diversified, the less sensitive they are to cyclical fluctuations.

However, the absence of export diversification induces decline and fluctuations in export earnings, which has negative effects on income, investment, and employment in developing countries ((FAO), 2004). In the same way, Hammouda et al. (2009), associate the fragile growth of African economies and their marginalization in the global economy with the poor diversification of these economies. In addition, Samen (2010) highlighted that the diversification of exports can contribute to reducing unemployment and boosting growth in many developing countries.

Export diversification is an important determinant of productivity growth (Hammouda et al., 2009; Hatemi and Irounsout 2001; Rath & Akram, 2017). Using annual data from 1995 to 2014, Rath and Akram (2017) found a positive relationship between export diversification and total factor productivity (TFP) growth in the South Asian region. The results based on DOLS showed that export diversification generates TFP growth in the long-run. This finding is supported by evidence provided by Hatemi and Irounsout (2001), who demonstrated that export diversification increases the TFP through the improvement of skills and technology.

On the other hand, export diversification can be stimulated by good choice of trading partners. Indeed, similarities between trading partners in physical capital and land and human capital endowments per worker, along with low bilateral trade costs, are necessary for diversified exports (Régolo, 2013).

Herzer and Nowak-Lehmann (2006) considered that diversifying manufactured goods' exports brings more opportunities for spillover effects than does primary commodity trade. Furthermore, Ali et al. (1991) opined that there is greater potential for value-added activities when the manufacturing sector is developed. More recently, Marconi et al. (2016), based on a dynamic panel dataset for a sample of 63 middle and high-income countries between 1990–2011, concluded that enhancement of the manufacturing sector leads to increased economic growth and productivity and that manufacturing exports is a main determinant of the development process. Basile et al. (2018) used a spatial dynamic panel data approach to study the relationship between export diversification and economic development. They found that there are strong spatial spillover effects of economic development on the degree of export diversification.

2.2. The importance of spatial diversification

The recent trade literature provides some evidence supporting the importance of spatial diversification in economic growth. The spatial diversification-growth nexus is widely documented. For instance, using a data of 99 countries over 1995–2004, Brenton and Newfarmer (2007) argue that discover new geographic markets is more important than the discovery of new export products. This result is in line with Amurgo-Pacheco and Pierola (2008). Based on a sample of 24 developed and developing economies over the period 1990–2005, authors found that spatial diversification must be more important than product diversification, especially for developing countries. In more recent work, Hinlo and Arranguéz (2017) corroborate that spatial export diversification is a key

determinant of economic growth because it expands export markets destinations reduces trade-shocks as well as produces spillover effects and enhances economic growth.

Considering the Saudi's manufacturing exports, we observe that they are very low and concentrated mainly on chemical and refined petroleum products. Furthermore, geographical destination of Saudi's manufacturing exports is limited to few countries (in 2017, 10 out of 77 partners absorb about 60% of Saudi's manufacturing exports⁶). In addition, one of the most pillar of the 2030 Saudi's vision is to look for new markets to overcome the low international demand of Saudi's manufactured goods.

Thus, we focus on the spatial diversification to look for new markets by calculating the potential trade to know which countries can constitute the significant export destination to Saudi's manufactured exports.

A few studies have focused on the importance of spatial diversification by calculating the potential trade (e.g. Irshad et al., 2018a, 2018b; Yang et al., 2017). Using data covering the period 1992–2015, Irshad et al. (2018a) have estimated the Pakistan's trade potential for China. They conclude that Pakistan's export to China are always below the potential. In the same way, Irshad et al. (2018b) used the pooled ordinary least square method to calculate the potential export flow for South Korean exports to 189 partners over the period 2001–2016. They found that South Korea have a potential trade with 94 countries (especially with China, Japan, Hong Kong, Germany, France, Indian and the UK). However, exports have exceeded with other countries (Viet Nam, USA, Singapore, Mexico and Australia are the countries with exhausted potentials).

Yang et al. (2017) investigated the spatial configuration of Japanese exports from 1995 to 2014. Based on the Moran's I, results show that Japanese exports were affected by the geographic location of the export partner country. Furthermore, Yang et al. (2017) argue that Japan extended exports mainly to East-Asia countries while Japan's exports to USA are exhausted.

To our Knowledge, there is no research investigating the spatial configuration of Saudi's manufacturing exports by estimating the potential markets. The present study represents a contribution in the field. On the one hand, we focus on the spatial diversification of Saudi's manufactured goods' exports to test for the presence of spillover effects. On the other hand, we seek to determine which country has the capacity to absorb the Saudi's manufactured goods' exports.

3. Methodology

3.1. Data and preliminary analysis

The dataset is a yearly balanced panel containing annual Saudi Arabia exports, from 2001 to 2016, to 77 trading partners, who received approximately 92% of Saudi's manufactured goods' exports. The set of variables includes the Saudi's manufactured goods' exports (EXP), the product of GDP of Saudi Arabia and its trade partner (GDPP) as a proxy of the joint economic size, the ratio of the partner's GDP per capita to Saudi Arabia's GDP per capita (GDPK) as a proxy of Purchasing Power Parity (PPP), the product of Saudi's index of trade freedom and the partner's trade freedom index (TRFP), the nominal bilateral exchange rate (EXR), and the trade intensity index (TII), which reflects the intensity of the trade between Saudi Arabia and its partner.⁷ All variables, except for the TII variable, are log-transformed. We use the product of the two countries' exogenous variables to account for the economic interactions between Saudi Arabia and its partners. The trade freedom index is obtained from the Heritage Foundation (2018), and the remaining variables are retrieved from World Development Indicators database (WDI, 2018).

Table 1. Descriptive statistics

| Variable | EXP | EXR | TREP | GDPK | GDPP | TII |
|-----------|-------|-------|-------|-------|-------|------|
| Mean | 3.76 | 2.56 | 4.29 | −0.98 | 6.54 | 0.74 |
| Median | 4.19 | 1.87 | 4.35 | −0.80 | 6.55 | 0.72 |
| Maximum | 9.09 | 10.02 | 4.55 | 1.62 | 6.72 | 2.94 |
| Minimum | −3.60 | −1.20 | 2.98 | −4.53 | 6.36 | 0.01 |
| Std. Dev. | 2.63 | 2.75 | 0.21 | 1.64 | 0.08 | 0.57 |
| Skewness | −0.51 | 0.70 | −2.42 | −0.29 | −0.18 | 0.36 |
| Kurtosis | 2.56 | 2.45 | 11.47 | 1.79 | 2.38 | 2.04 |

Table 2. Pesaran cross-section dependence tests

| Variables | EXP | EXR | TREP | GDPK | GDPP | TII |
|-----------|----------|----------|----------|----------|----------|----------|
| CD-test | 40.23*** | 64.83*** | 75.47*** | 26.17*** | 20.53*** | 14.32*** |

Tables 1 and 2 display the descriptive statistics of the variables and the results of Pesaran cross-section dependence tests (Pesaran, 2004), respectively. The CD-test rejects the null hypothesis of no spatial dependence for all variables, confirming the usefulness of the panel spatial model.

In addition, we apply the IPS (Im et al., 2003) and CIPS (Pesaran, 2007) panel unit root tests to check the panel stationarity of the variables. The results are summarized in Table 3. Both IPS and CIPS tests reject the null hypothesis of unit root, which indicates that all the variables are stationary.

3.2. The construction of the model

The general specification of the spatial lag panel models (SLM) is defined as:

$$Y_t = \rho WY_t + X_t\beta + \mu + \gamma_t\iota_N + \varepsilon_t \quad (1)$$

where Y_t is the $N \times 1$ vector of Saudi manufactured goods' exports to partner i ($i = 1, \dots, N$) at time t ($t = 1, \dots, T$), X_t denotes a $N \times K$ matrix of the explanatory variables included in the model and β is a vector $K \times 1$ of unknown parameters. The scalar ρ represents the spatial lag parameter that characterizes the strength of contemporaneous spatial correlation between one country and other geographically proximate countries (You & Zhike, 2018; Zheng et al., 2014). This parameter also reflects the spatial dependence between partners. W is nonnegative $N \times N$ matrix of known constants describing the arrangements of the units in the sample.

Specifically, the vector WY_t records the Saudi's manufactured goods' exports weighted by the bilateral distance between partner i and partner j . The weighted spatial matrix W brings out the potential of interaction (substitution or complementarity) between observations of each pair of partners i, j . μ is an $N \times 1$ vector of time-invariant effects, γ_t is an $N \times 1$ vector of time-period specific effects, and ε_t is the $N \times 1$ vector of the error term, which is assumed to be independently and identically distributed.

There are many methods to construct the spatial weighting matrix W allowing for direct interactions between all partners (Corrado & Fingleton, 2012; Lesage & Fischer, 2008). The intensity of geographical spillover depends on the distance (Bottazzi & Peri, 1999). This suggests that spillovers become more important if two partners are more neighboring.

The spatial weighted matrix W is computed using the row-standardized inverse-distance method, where the nearest partners have the greatest weights. The general term w_{ij} is defined as:

Table 3. Panel unit root tests

| Variable | IPS | | CIPS | |
|----------|------------|------------------|--------|------------------|
| | Level | First difference | Level | First difference |
| EXP | −6.5679*** | −10.5538*** | −3.119 | −4.781 |
| | (0.0000) | (0.0000) | | |
| GDPK | −3.3111*** | −5.1301*** | −2.242 | −2.552 |
| | (0.0005) | (0.0000) | | |
| GDPP | −2.4973*** | −8.5862*** | −2.485 | −3.887 |
| | (0.0063) | (0.0000) | | |
| EXR | −2.5137*** | −5.2572*** | −2.334 | −3.174 |
| | (0.0060) | (0.0000) | | |
| TREP | −6.9976*** | −11.8139*** | −3.289 | −4.527 |
| | (0.0000) | (0.0000) | | |
| TII | −6.9386*** | −13.0013*** | −2.323 | −4.292 |
| | (0.0000) | (0.0000) | | |

Notes: Entries in parentheses are the p-values and the asterisks *, ** and *** are the level of significance at 10%, 5% and 1%, respectively. The CIPS's critical values are −2, −2.07 and −2.18 for 10%, 5% and 1% level, respectively.

$$w_{ij} = \begin{cases} 0 & \text{if } i = j \text{ and if } d_{ij} > \bar{d} \\ \frac{d_{ij}^{-1}}{\sum_{i \neq j} d_{ij}^{-1}} & \text{otherwise} \end{cases}$$

\bar{d} is the threshold distance obtained by the latitude and longitude coordinates and the average of the shortest distance between two partners (Anselin, 1994; Yang et al., 2017). Accordingly, the spatial weighted matrix W is defined as:

$$W = \begin{pmatrix} 0 & w_{12} & \cdots & w_{1j} & \cdots & w_{1N} \\ w_{21} & 0 & \cdots & w_{2j} & \cdots & w_{2N} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ w_{i1} & w_{i2} & \cdots & \cdots & \cdots & w_{iN} \\ \vdots & \vdots & \cdots & \cdots & \cdots & \vdots \\ w_{N1} & w_{N2} & \cdots & w_{Nj} & \cdots & 0 \end{pmatrix}$$

Therefore, based on the equation (1), the spatial econometric model can be written as:

$$\begin{aligned} \ln(EXP_{it}) = & \rho \sum_{j=1}^N w_{ij} EXP_{jt} + \beta_1 \ln(GDPP_{it}) + \beta_2 \ln(GDPK_{it}) + \beta_3 \ln(TRFP_{it}) + \beta_4 \ln(EXR_{it}) \\ & + \beta_5 \ln(TII_{it}) + \mu_i + \vartheta_t + \varepsilon_{it} \end{aligned} \quad (2)$$

Where:

EXP_{it} : Saudi's manufactured goods' exports to partner i .

w_{ij} : Saudi's manufactured goods' exports weighted by the bilateral distance between partner i and partner j .

$GDPP_{it}$: the product of GDP of Saudi Arabia and its trade partner i .

$GDPK_{it}$: the ratio of the GDP per capita of partner i to Saudi Arabia's GDP per capita.

$TRFP_{it}$: the product of Saudi's index of trade freedom and the partner's trade freedom index.

EXR_{it} : the nominal bilateral exchange rate.

III_{it} : the intensity of the trade between Saudi Arabia and its partner i .

μ_i : time-invariant effects and ϑ_t : time-period specific effects.

The above model is estimated using the Quasi-Maximum likelihood estimators (Yu et al., 2008). The different estimations were carried using the xsmle Stata module provided by Belotti et al. (2017).

However, according to LeSage and Pace (2009), the estimated coefficients of the SAR model do not provide the direct marginal effect of the exogenous variables on the dependent variable. Hence, we proceed to decompose the total marginal effects into direct and indirect effects. In turn, we can deduce deeply the eventual spillover effect of the patterner's economic conditions on Saudi's manufactured goods' exports.

The direct effects measure the impact on Saudi's manufactured goods' exports to a particular partner i as the result of a change in an exogenous variable of this partner, whereas the indirect effects capture the impact of a change in the exogenous variables of all neighboring partners j on Saudi's manufactured goods' exports to partner i (LeSage & Pace, 2009). The indirect effect measures the strength of interregional spillover effects of manufactured goods' exports between Saudi Arabia and her partners. Therefore, the total effect is the sum of the direct and indirect effects. According to LeSage and Pace (2009), the derivation of the direct and indirect effects is based on the following matrix of partial derivatives, called the impact matrix, of the expectation of the endogenous variable Y with respect to each k^{th} explanatory variable of X :

$$\begin{bmatrix} \frac{\partial E(Y)}{\partial X_{1k}} & \dots & \frac{\partial E(Y)}{\partial X_{Nk}} \end{bmatrix} = \begin{bmatrix} \frac{\partial E(y_1)}{\partial X_{1k}} & \dots & \frac{\partial E(y_1)}{\partial X_{Nk}} \\ \vdots & \ddots & \vdots \\ \frac{\partial E(y_N)}{\partial X_{1k}} & \dots & \frac{\partial E(y_N)}{\partial X_{Nk}} \end{bmatrix} = (I_N - \hat{\rho}W)^{-1} \hat{\beta}_k$$

Thus, the direct effect of the k^{th} explanatory variable of X on Y is given by the average of the diagonal elements of the impact matrix while the average row-sum of off-diagonal elements of the impact matrix is a measure of the indirect effect of the k^{th} explanatory variable of X on Y .

4. Panel spatial estimation results

Table 4 summarizes the estimation results of both fixed and random effects models. We apply the Hausman and Lagrange multiplier (LM) tests proposed by Lee and Yu (2012) for testing the random model versus the fixed effect model. The Hausman test (with value 77.66 and P-value = 0.0000) and the LM test (with value 67.432 and P-value 0.0000) suggest that the spatial fixed effect model is more appropriate then the spatial random effect model.

The coefficient regression results show that ρ , which means the spatial lag coefficient, is statistically significant at the 1% level, indicating the existence of spatial dependence in terms of manufactured goods' exports between Saudi Arabia and its partners. This result suggests that an increase in Saudi's export of manufactured goods to neighboring countries of a partner i would cause an increase of Saudi's manufactured goods' exports to a partner i .

Consistent with the model's estimation, Saudi's export of manufactured goods is positively related with the five variables used in the spatial gravity model applied above. All variables are statistically significant and have the expected sign. Several implications can be deduced from these positive relationships. First, in conformity with theoretical predictions, economy size and income have positive impacts on Saudi's manufactured goods' exports to its 77 partners. As for the joint GDP, the results reveal that exports of manufactured goods will be enlarged by 0.74% when the joint GDP in Saudi Arabia and its partners increases by 1%. This positive relationship between GDP and manufactured goods' exports is in conformity with the basic assumption that trade volume increases with increasing the economic size (Sohn, 2001; Irshad et al., 2018a, 2018b).

Table 4. Results of spatial fixed and random effects models

| | Spatial Fixed Effect Model | Spatial Random Effect Model |
|--------------------------|-----------------------------------|------------------------------------|
| ρ | 0.568*** (0.0567) | 0.608*** (0.0451) |
| GDP | 0.743*** (0.139) | 0.672*** (0.100) |
| GDPK | 0.564*** (0.194) | 0.307** (0.137) |
| TREP | 0.359* (0.189) | 0.349* (0.192) |
| EXR | 0.209** (0.105) | 0.158** (0.0694) |
| TII | 0.00815*** (0.00209) | 0.00786*** (0.00214) |
| sigma2_e | 0.696*** (0.0265) | 0.738*** (0.0289) |
| Theta | | 0.108*** (0.0953) |
| Intercept | | -33.11*** (4.991) |
| Observations | 1,309 | 1,309 |
| R-squared | 0.214 | 0.236 |
| Number of countries | 77 | 77 |
| Hausmann test | 77.66*** (0.0000) | |
| LM test fixed Vs. random | 67.432 (0.0000) | |

Notes. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In addition, the difference between income (GDPK), which can reveal the income levels and purchasing abilities of the exporting and importing countries, has a positive effect on the manufactured goods' exports of Saudi Arabia. In other words, a 1% increase in GDPK improves manufactured goods' exports by 0.56%. This result implies that, to enhance manufactured goods' exports, Saudi Arabia will trade with countries with higher incomes. This finding is consistent with the result of several studies that considered that increasing per capita income promotes purchasing power and stimulates consumer demand leading to a rise in commercial trade between countries (Bernasconi & Wuergler, 2012; Elhiraika & Mbate, 2014; Kassa, 2013).

Regarding the coefficient of the joint trade freedom, which reflect the quality of institutions both in Saudi Arabia and its trade partners, the estimation results show that this variable is statistically significant and has the expected sign. In conformity with theoretical predictions that suppose that economic freedom improves trade (Ajide and Eregba, 2014; Berggren, 2003; Sonora, 2008), the results suggest that trade freedom is positively correlated with the manufactured goods' exports. The index of trade freedom is positive and statistically significant both for Saudi Arabia and for its trade partners. Indeed, a 1% increase of the joint trade freedom index boosts exports of manufactured goods by 0.36%.

Concerning the bilateral exchange rate, the results reveal that the bilateral exchange rate is statistically significant and has a positive impact. Indeed, a 1% depreciation of the Saudi Arabian riyal against its partners' currencies leads to an approximate 0.21% improvement of Saudi Arabia's manufactured goods' exports. This empirical result is consistent with the findings of Kang and

Dagli (2018) and Thorpe and Zhang (2005), who have highlighted the positive relationship between exchange rate depreciation and increased exports.

In the case of the trade intensity index (TII), the coefficient is positive and significant, but the TII improves slightly Saudi's export of manufactured goods as much as a 1% increase of trade intensity index increases export of manufactured goods by only 0.008%. The low effect of trade intensity index on Saudi's export of manufactured goods implies that Saudi's trade with partners is less than the world does in average. Also, it may be due to the low demand of Saudi's manufactured goods by partners revealing a comparative disadvantage. In addition, the Saudi's export of manufactured goods is concentrated on few products such chemicals and refined petroleum products characterized by a lower level of competition in international markets. Hence, Saudi's manufactured goods' exports should be directed to value-added industrial activities that will lead to export diversification (Ahmed Al Bakr, 2015).

4.1. Direct and indirect effects

The estimated direct and indirect effects of the exogenous variables as well as their total effects on Saudi's manufactured goods' exports are summarized in Table 5. The results show that, for all variables, there is a significant positive total effect, which can be mainly due to indirect effect. This finding provides support for the importance of the spillover effects that characterize the bilateral trade between Saudi Arabia and its partners. Thus, the increase of Saudi's manufactured goods' exports to one partner boosts the manufactured goods' exports of Saudi Arabia to other partners.

In addition, the results indicate that the estimated coefficients are different from their direct effects. Hence, there are feedback effects resulting from the lagged spatial dependent variable. Indeed, the estimated coefficient of the joint GDP is 0.672, while its direct effect is 0.694, implying a feed-back effect of 0.022. In addition, the greatest feedback effect is observed for the relative GDPK, with a magnitude equal to 0.001.

Regarding the indirect effect, the results show that the greatest spillover effect occurs with a GDPP with a value of 1.034. This finding implies that an increase in economic size (proxied by GDP) in all neighboring countries improves Saudi's manufactured goods' exports. The spillover effects of the trade freedom index, the relative GDP per capita, the exchange real, and the trade intensity index are 0.514, 0.473, 0.25, and 0.0121, respectively.

Interestingly, our study suggests that the total effect is always positive and that the indirect effects from all variables are larger than the direct effect. The interpretation of this result is that if all the partner countries (77 countries in our study) experience a change in the GDP, the GDP per capita, the

Table 5. Direct, indirect and total effects

| | Direct Effect | Indirect Effect | Total Effect |
|------|---------------|-----------------|--------------|
| GDPP | 0.694*** | 1.034*** | 1.729*** |
| | (0.0959) | (0.124) | (0.158) |
| GDPK | 0.306** | 0.473** | 0.780** |
| | (0.130) | (0.232) | (0.355) |
| TREP | 0.347* | 0.514* | 0.861* |
| | (0.189) | (0.283) | (0.465) |
| EXR | 0.164** | 0.250** | 0.414** |
| | (0.0727) | (0.125) | (0.194) |
| TII | 0.00801*** | 0.0121*** | 0.0201*** |
| | (0.00210) | (0.00391) | (0.00574) |

Source: Author's calculations

Table 6. Potential manufactured exports countries for Saudi Arabia (2010–2016)

| Country | Potential US \$ million | (Predicted/ Actual) | Country | Potential US\$ million | (Predicted/ Actual) | Country | Potential US\$ million | (Predicted/ Actual) |
|---------------|-------------------------|---------------------|------------|------------------------|---------------------|--------------|------------------------|---------------------|
| China | 813.69 | 1.14 | Finland | 3.42 | 1.35 | Yemen | -47.21 | 0.89 |
| Viet Nam | 801.27 | 2.27 | Cameroon | 2.79 | 1.15 | Malta | -55.89 | 0.45 |
| Poland | 527.26 | 2.73 | Sweden | 2.76 | 1.03 | France | -83.51 | 0.66 |
| Algeria | 518.63 | 1.92 | Ireland | 2.20 | 1.23 | Jordan | -93.94 | 0.92 |
| Turkey | 471.63 | 1.27 | Tanzania | 1.75 | 1.02 | Oman | -95.96 | 0.84 |
| Malaysia | 456.97 | 1.46 | Namibia | 1.02 | 1.18 | Morocco | -99.03 | 0.77 |
| Brazil | 315.84 | 2.12 | Malawi | 0.37 | 1.19 | Spain | -115.37 | 0.81 |
| Chile | 312.40 | 5.64 | Norway | 0.04 | 1.00 | South Africa | -126.32 | 0.72 |
| U.A.E. | 309.38 | 1.06 | Rwanda | -0.12 | 0.76 | Australia | -130.89 | 0.61 |
| Togo | 65.62 | 2.74 | Ethiopia | -0.24 | 1.00 | Italy | -130.97 | 0.82 |
| Portugal | 58.03 | 2.35 | Zambia | -0.58 | 0.65 | Indonesia | -132.30 | 0.65 |
| Bangladesh | 37.27 | 1.10 | Uganda | -0.64 | 0.97 | Thailand | -145.06 | 0.74 |
| Russia | 28.02 | 1.98 | Azerbaijan | -0.69 | 0.85 | Japan | -152.61 | 0.58 |
| Ukraine | 26.27 | 2.02 | Denmark | -0.90 | 0.54 | Egypt | -155.86 | 0.91 |
| Nigeria | 23.79 | 1.12 | Mauritius | -1.04 | 0.44 | U.K. | -161.67 | 0.73 |
| Greece | 20.04 | 1.17 | Mauritania | -1.12 | 0.88 | Pakistan | -189.31 | 0.78 |
| Côte d'Ivoire | 17.23 | 1.37 | Romania | -1.91 | 0.74 | Hong Kong | -198.26 | 0.38 |
| Belgium | 10.54 | 1.01 | Cyprus | -2.30 | 0.72 | Bahrain | -200.50 | 0.83 |
| Senegal | 8.13 | 1.36 | Tunisia | -11.11 | 0.95 | Netherlands | -214.48 | 0.57 |
| Argentina | 7.19 | 1.24 | Canada | -12.26 | 0.65 | Qatar | -228.35 | 0.79 |

(Continued)

Table 6. (Continued)

| Country | Potential US \$ million | (Predicted/ Actual) | Country | Potential US\$ million | (Predicted/ Actual) | Country | Potential US\$ million | (Predicted/ Actual) |
|------------|----------------------------|------------------------|-------------|---------------------------|------------------------|-----------|---------------------------|------------------------|
| Ghana | 6.75 | 1.10 | Switzerland | -24.13 | 0.33 | Korea | -246.10 | 0.66 |
| Austria | 6.03 | 1.76 | Germany | -26.86 | 0.89 | Kuwait | -355.62 | 0.68 |
| Kazakhstan | 5.91 | 1.56 | New Zealand | -28.54 | 0.80 | Singapore | -366.20 | 0.87 |
| Mexico | 5.32 | 1.21 | Sri Lanka | -31.36 | 0.60 | India | -399.13 | 0.83 |
| Mozambique | 4.10 | 1.12 | Philippines | -32.99 | 0.46 | U.S. | -410.92 | 0.71 |
| Madagascar | 3.78 | 1.65 | Lebanon | -45.11 | 0.86 | | | |

Source: Author's calculations

exchange rate and the trade intensity index, this will have a stronger effect on Saudi's manufactured goods' exports only if Saudi Arabia experiences a change in proper macroeconomic variables. Therefore, even given the weakness of the domestic manufactured goods' sector, Saudi's manufactured goods' exports depend heavily on the economic situation of its partners. This finding confirms the spatial interdependency characterizing the manufactured goods' exports of Saudi Arabia.

This important finding implies that the good choice of trade partner plays a key role in diversification strategy in Saudi Arabia. Hence, in the next step, we will determine the potential markets for Saudi's manufactured goods' exports among the 77 countries included in the study.

4.2. Spatial diversification: potential export partners

It is important to identify which country has the capacity to absorb Saudi's manufactured goods' exports. According to Irshad et al. (2018), Gul and Yasin (2011), and Helmers and Pasteels (2005), we compute the potential Saudi manufactured goods' exports as follows:

$$\text{Potential exports} = \left(\frac{\text{Predicted exports}}{\text{Actual exports}} - 1 \right) * \text{Actual exports}$$

If $\frac{\text{Predicted exports}}{\text{Actual exports}} > 1$ stands for untapped potential exports, whereas a value less than one implies exhausted potential markets.

The results are summarized in Table 6. Countries with positive potential are the countries to which Saudi's manufactured goods' exports must be increased. However, countries with negative potential are the countries to which Saudi's manufactured goods' exports must be reduced. The results show that Saudi Arabia can increase its manufactured goods' exports to a club of 34 countries. This club of 34 countries appears to be the significant destination of Saudi's manufactured goods' exports. More precisely, we observe that Saudi Arabia has the highest potential with countries such as China, Viet Nam, Poland, Algeria, Turkey, Malaysia, Brazil, Chile, and UAE. Indeed, for the period 2010–2016, 5 out of the 34 potential partners (namely, China, UAE, Belgium, Turkey and Malaysia) absorb 32% of Saudi's manufactured exports, while the remaining partners received only 4% of these exports. This fact shows that this club of 34 countries can constitute the effective destination for Saudi's manufactured exports.

Conversely, manufactured goods' exports of Saudi Arabia are exhausted with the 43 remaining countries, primarily the United States, India, Singapore, Kuwait, Qatar, Korea ... and so on. Saudi Arabia should reduce its exports to these countries.

5. Conclusion

This article is the first attempt to provide an empirical investigation of the importance of spatial diversification in boosting Saudi Arabia's manufactured goods exports. Our findings suggest, firstly, the existence of a spatial interdependence between Saudi Arabia and its partners, which indicates the existence of a spatial association (Yang et al., 2017). Secondly, the manufactured goods' exports from Saudi Arabia are positively related to the partners' economic size, bilateral exchange rate, per capita GDPs, index of trade freedom, and trade intensity index. Thirdly, the exports of manufactured products in Saudi Arabia are dominated heavily by a spillover effect.

Finally, our results demonstrate that Saudi Arabia has immense export potential with 34 countries including China, Viet Nam, Poland, Algeria, Turkey, Malaysia, Brazil, Chile, UAE, Togo, Portugal and Bangladesh. Conversely, actual-manufactured goods' exports are exhausted with 43 countries, including the United States, India, Singapore, Kuwait, Singapore, Qatar, and Korea. This finding has an important implication in terms of economic policy: Saudi Arabia requires a geographic diversification that leads to the reallocation of its exports of manufactured goods. Hence, Saudi Arabia must orient its exports mainly to emerging countries that represent the

highest potential market rather than to exhausted potential markets. Furthermore, to benefit from these potential-manufactured goods' exports, Saudi Arabia should consider domestic economic diversification toward the manufactured goods' sector as a tool to promote exports of manufactured goods. With the changing composition of industrial commodities, Saudi Arabia needs to undergo structural transformation to benefit from its potential markets and, accordingly, move away from the oil sector.

Acknowledgements

This work was supported by the Sheikh Al-Fouzan Macroeconomic Forecasting Chair (SMFChair) at Imam Mohammad Ibn Saud Islamic University. The authors would like to express her great appreciation to professor Khaled Meshaal (Director of SMF Chair) for his valuable and constructive suggestions during the planning and development of this research. Furthermore, we would like to thank the three anonymous reviewers for their constructive comments and suggestions that have greatly improved our manuscript.

Funding

This work was supported by Shiekh Al-Fouzan Macroeconomic Forecasting Chair (SMFChair) at Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia.

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Citation information

Cite this article as: Manufactured goods' export diversification in Saudi Arabia: A spatial panel approach, Abdessalem Gouider & Hedi Ben Haddad, *Cogent Economics & Finance* (2020), 8: 1741309.

Notes

- https://www.indexmundi.com/saudi_arabia/economy_overview.html.
- Author's calculation using Saudi Arabian Monetary Authority's data.
- Author's calculation using Saudi Arabian Monetary Authority's data.
- www.sidf.gov.sa.
- Horizontal diversification and vertical diversification are usually the traditional form of export diversification. Horizontal export diversification is relying on the number of export sectors in the economy, whereas vertical export diversification means the change in the composition of exports from primary to manufactured goods.
- These countries are UAE (14.5%), China (10.36%), Singapore (6.56%), India (5.38%), U.S.A (4.71%), Kuwait (4.18%), Egypt (4.1%), Belgium (3.51%), Bahrain (3.33%) and Qatar (3.22%).
- The index is calculated as: $TII = (X_{si}/X_{st})/((X_{wi}/X_{wt}))$ where x_{si} and x_{wi} are the values of Saudi's manufactured goods' exports and of world exports to partner i ,

and where X_{st} and X_{wt} are Saudi's total manufactured goods' exports and total world exports, respectively.

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