Determinants of Economic Complexity in MENA Countries

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Abstract

The world economy has become increasingly more complex over the last decades. However, Middle East and North Africa (MENA) countries lag behind most other countries in terms of economic complexity, a key indicator with well documented effects on growth and development. In order to design and implement effective policies towards increasing productive capability and product diversification, it is important to understand the underlying factors behind this important concept. As a result, we attempt to contribute to the literature by exploring the determinants of economic complexity in the MENA region with a special emphasis on the role of the composition of human capital. To this end, we employ a system GMM approach based on annual data for 12 countries for the period between 1970-2015. The results reveal that human capital is positively associated with economic complexity, while natural resource rent has a negative influence. The findings also suggest that the adverse effect of natural resource rent disappears when this term is interacted with human capital and democracy.

Keywords: Economic complexity, determinants, MENA, system GMM

Jel Codes: F1, F14, O11

1. Introduction

The immerse transformations in the world economy in the last several decades have created both opportunities as well as challenges for the developing countries. While some countries have managed to adapt to the changing conditions and exploit the opportunities, others have failed to cope with the changes, finding it increasingly difficult to maintain sustainable growth rates. In today's more complex and globalized economic system, adoption of new ways of production and value creation have become essential to catch up with the rest of the world. Recently, a number of studies have emphasized the significance of increasing productive capabilities and diversification of products on economic growth and development. Based on this literature, Hidalgo and Hausman (2009) proposed a new methodology to assess productive capability of a country and initiated the literature on the so called economic complexity. Economic complexity is a concept measuring a country's productive knowledge and capabilities contributing to the production of a good through a comprehensive analysis of its export structure. This implies that countries which have more productive capabilities are also the more complex ones, indicating that they can produce more diverse and sophisticated products**.**

Indeed, recent literature suggests that economic complexity can bring about various important benefits to a given country. There exists robust empirical evidence pointing out that economic complexity increases economic growth (Hausman et al., 2014; Qurens, 2012; Zhu and Li, 2017), decreases output volatility (See Hvidt, 2013; Manama, 2016; Akhtar and Freire, 2014) and reduces income inequality (Hartmann et al., 2017). Furthermore, studies show that economic complexity can help countries escape the middle income trap as well (Felipe et al., 2012; Fortunato and Razo, 2014).

These findings reveal the importance of the design and implementation of various policies to make an economy more diverse and complex. However, currently there are only a few studies empirically examining the determinants of economic complexity. These include Gabrielczak and Serwach (2017), who find that trade integration may promote economic complexity as well as Javorcik et al. (2017), who conclude that foreign direct investment can contribute to product upgrading.

Understanding the determinants of economic complexity is especially important for the MENA countries, which face many challanges in keeping up with the rapid transformation of the world economy. Low and volatile growth rates, low productivity, chronic unemployment, weak integration with the rest of the world, dependence on natural resources, low non-oil sector exports and lack of institutional reforms are often cited as the main structural obstacles for this country group (Abed and Davoodi, 2003). Consequently, economic complexity may be a crucial policy agenda for this region. However, a closer look at the data reveals that MENA countries generally lag behind other countries in terms of economic complexity, meaning that their production structure is not sufficiently diversified. Moreover, relying on just a few products may have several adverse effects on the economy such as inefficient allocation of resources and becoming more vulnerable to external shocks. Such risks are even more pronounced for oil exporting countries, which have limited motivation towards diversification due to their reliance on natural resources. The policy makers in these countries are aware of the problem that as the oil reserves decline it will be more and more difficult to sustain growth, create employment and generate revenue for the government. These goals cannot be reached by producing more of the same product but can only be achieved with a structural transformation toward producing more sophisticated products (Yildirim, 2013). Simply put, MENA countries should start thinking about how to make their economies more complex.

In light of the above discussions, it is of crucial importance to understand the main drivers of economic complexity in the MENA region so that relevant policy actions can be taken to achieve a more advanced and diversified economic system that would increase the rate of growth and reduce volatility. As a result, our objective in this paper is to fill this gap in the literature. To this end, we analyze cross country differences in economic complexity during the period between 1970-2015 for 12 selected MENA countries based on data availability. We employ a dynamic panel data methodology that controls for country-specific effects, while also accounting for the potential endogeneity of the explanatory variables.

Our paper is related with the strand of the literature on the determinants of export diversification as well. Due to the increasing interest and support for high value added production, a number of studies have emerged to assess the factors behind export diversification. This literature has suggested a range of variables as possible determinants of export diversification such as human capital accumulation (Agosin et al.,2011) as well as GDP per capita (Elhiraika and Mbate, 2014), investment (Bebczuk et al. (2016) and foreign direct investment (Iwamoto and Nabeshima, 2012). We also build on this literature by evaluating whether these factors can determine economic complexity as well.

The outline of the study is as follows: Section 2 reviews the definition and measurement issues of the concept of economic complexity. This is followed by Section 3, which discusses possible determinants of economic complexity. Section 4 explains the methodology used and describes the data. Section 5 presents the empirical results. Finally, Section 6 concludes with a discussion of policy implications.

2. Economic Complexity

In the recent years, the concepts of export diversification and economic complexity have received a great deal of attention in the economics literature. Although both of these concepts have proven to be significant for growth and development, there are substantial differences in terms of their definition and measurement. Export diversification refers in general to various policies implemented to change the shares of commodities in the existing export mix and introduce new products (Esanov, 2014). This is mostly assessed by so called concentration indices such as Herfindahl-Hirschman index, Theil's index, Gini-Hirchman Index as well as Shannon entropy. However, it is argued that these measures fail to capture the differences in productive capabilities across different countries (See for example, Hartman et al., 2007). Recently, Hidalgo and Hausman (2009) have analyzed these capabilities and productive knowledge among

countries also introducing the concept of economic complexity to explain the complex structure of an economy[1].

Economic complexity attempts to measure the degree of productive knowledge and capability in a given economy. Naturally, it is not easy to quantify these intangible elements. Hence, Hausman and Hidalgo (2013) propose a method which is based on the assumption that productive knowledge is reflected in the composition of the products that a country makes. Thus, by using data on international trade, they construct economic complexity index (ECI). The ECI measures a country's productive structure by using the concepts of both diversity and ubiquity. While diversity indicates the number of products a country exports, ubiquity refers to the number of the countries that export the same product (Hidalgo & Hausmann, 2009). Based on this definition, sophisticated economies are the ones having a higher diversity but also lower ubiquity. Therefore, a country exporting goods that a few other countries export is considered to be less sophisticated.

To present the calculation of ECI, we follow Hausmann et.al (2011). Using trade data, they first calculate revealed comparative advantage and then define a matrix called M_{xy} with the values of 1if a country *X* exports product *Y* with a revealed comparative advantage (RCA>1), and 0 otherwise. Based on this matrix, diversity and ubiquity are defined as follows:

$$\text{Diversity}= k_{x,0}=\sum_b M_{xy.} \tag{1}$$

$$\text{Ubiquity}=k_{y,0}=\sum_x M_{xy.} \tag{2}$$

As the third step, diversity and ubiquity are used for correcting each other. This is accomplished by calculating the average ubiquity of the products that the country exports and the average diversity of the countries that make those products. This requires the following recursive process:

$$K_{x,N}= (1/k_{x,0})\sum_y M_{x,b}.k_{y,N-1,.} \tag{3}$$

$$K_{y,N}= (1/k_{y,0})\sum_x M_{x,y}.k_{x,N-1.} \tag{4}$$

1Hidalgo and Hausman (2009) and Hartman et al. (2017) show that economic complexity index outperforms other diversification indicators such as Hirschman-Herfindahl or Theil index in measuring the productive structure of the economy.

Substituting equation (3) into (4) yields:

$$K_{x,N}= (1/k_{x,0})\sum_y M_{x,y} (1/k_{y,0}) \sum_{x'} M_{x'y}.k_{x',N-2,} \quad (5)$$

which can be written as:

$$k_{x,N}=\sum_{x'} k_{x',N-2} \sum \frac{MabMa'b}{ka,0kb,0} \quad (6)$$

Finally, the above is denoted as:

$$K_{x,N}=\sum_{x'} \acute{M}_{xx'} k_{x',N-2,} \quad (7)$$

where

$$\acute{M}_{xx}= \sum \frac{MabMa'b}{ka,0kb,0} \quad (8)$$

Equation 7 is satisfied when $k_{x,N}=k_{x,N-2}=1$, which is the eigenvector of $\acute{M}_{xx'}$. However, this is by itself not informative because it is just a vector of ones. Hence, Hausman et al. (2011) look for the eigenvector associated with the second largest eigenvalue. This is the measure of economic complexity obtained as follows:

$$ECI= \frac{\check{K}-<\check{K}>}{stdev(\check{K})} \quad (9)$$

where <K> represents the average, *stdev* stands for standard deviation, and *stdevǨ* is the eigenvector of $\acute{M}_{xx'}$ associated with the second largest eigenvalue.

Table 1 presents the top 20 economies in terms of economic complexity in both 1970 and 2015. According to the table; Japan, Switzerland, Germany and South Korea have the highest ECI in 2015 meaning that these countries produce relatively more differentiated goods and export these to more countries. One striking observation in the table is the remarkable performance of South Korea, Singapore and China. These countries which were not even in the top 20 in 1970, have managed to climb to the top places in 2015. On the other hand, Italy, France and Belgium seem to have lagged behind over the last decades.

Table 1: *20 Countries with the Highest ECI in 1970 and 2015*

The countries with the highest ECI in 1970		**The countries with the highest ECI in 2015**	
Germany	2.309	Japan	2.348
Switzerland	2.135	Switzerland	2.124
United Kingdom	2.057	South Korea	1.974
Austria	1.991	Germany	1.920
Sweden	1.987	Singapore	1.720
Japan	1.970	Austria	1.664
Italy	1.847	Sweden	1.615
United States	1.759	Czech Republic	1.560
France	1.730	Finland	1.458
Belgium	1.464	Hungary	1.407
Finland	1.424	Slovenia	1.392
Denmark	1.388	Hong Kong	1.355
Norway	1.310	United Kingdom	1.345
Hong Kong	1.286	United States	1.326
Netherlands	1.287	Ireland	1.316
Zimbabwe	1.152	Slovakia	1.280
Belgium	1.220	Italy	1.248
Italy	1.214	France	1.207
Israel	1.186	China	1.171

Source: The Observatory of Economic Complexity, https://atlas.media.mit.edu/en/rankings/country/

The economic complexity index in the MENA country group in 1970 and 2015 are presented in Table 2. Here we see that economic complexity is higher in Turkey, Lebanon and Tunisia reflecting that these countries' product space are relatively more diversified. However, even these countries lag behind most other countries in terms of ECI. For example, in 2016 Turkey, Lebanon and Tunisia were ranked in the 40thrd , 44th and 45th place respectively among a total of 108 countries. It is also evident in the table that ECI is the lowest for Sudan and Algeria. Sudan ranked as the 108th country in the world in terms of ECI while Algeria ranked 105th country in 2015.

It must be noted that the somber picture in Table 2 has already started to gain attention in the policy spheres of MENA region. Consequently, several projects have

been undertaken to boost complexity in different countries. A comparison of the performance of the countries in 1970 and 2015 shows that Turkey and Saudi Arabia were able to increase economic complexity over time. UAE and Kuwait also succeeded in improving their economic complexity. The UAE has promoted the development of industrial zones and Kuwait has launched some large infrastructure projects financed by private partnership, which in turn helped increase complexity (Annual Meeting of Arab ministers of Finance, IMF).

Table 2: *MENA Countries with the Highest ECI in 1970 and 2015*

ECI Country Rankings in MENA Region in 1970		**Ranking in the World (In 96 countries)**	**ECI Country Rankings in MENA Region in 2015[2]**		**Ranking in the World (in 108 countries)**
Lebanon	0.648	24	Turkey	0.365	40
Jordan	0.598	28	Tunisia	0.163	44
Qatar	-0.078	46	Lebanon	0.152	45
Tunisia	-0.134	47	Jordan	-0.004	48
Egypt	-0.136	48	UAE	-0.251	59
Morocco	-0.315	54	Egypt	-0.271	61
Algeria	-0.493	58	Saudi Arabia	-0.356	62
Turkey	-0.546	61	Qatar	-0.525	71
UAE	-0.735	69	Oman	-0.671	79
Iran	-0.828	74	Morocco	-0.748	81
Saudi Arabia	-0.880	75	Kuwait	-0.789	83
Kuwait	-0.917	77	Algeria	-1.687	105
Oman	-1.149	88	Sudan	-1.868	108
Sudan	-1.307	95			

Source: The Observatory of Economic Complexity, https://atlas.media.mit.edu/en/rankings/country/

2Economic complexity value was not available for Iran for 2015.

3. Determinants of Economic Complexity

The existing literature reveals that economic complexity is positively related with the accumulation of productive capabilites. Nonetheless, increasing the capabilities and skills necessary to produce sophisticated products usually takes time. According to Hidalgo and Hausman (2009), the diversification is achieved gradually by first moving into those products that use similar capabilities with the existing ones. Only after this, a country can move on to producing more sophisticated products. This process depends on several factors and the speed of diversification can vary from one country to another. This section briefly reviews the possible factors for improving economic complexity. Although a therotecial model regarding the determinants of economic complexity has not yet been developed in the literature, the various studies on the economic diversification and export diversification can be used to identify the possible drivers of economic complexity. This literature suggests a range of factors including macroeconomic variables, human capital and institutional quality. Below we discuss the factors considered also in this study.

One of the most cited determinants of economic diversification is GDP per capita, which is used as a proxy for the country's level of development. It is argued that increases in GDP per capita can lead to a change in the consumer preferences towards more diversified products (Elhiraika and Mbate, 2014). In an influential study, Imbs and Wacziarg (2003) find that GDP size can significantly affect economic complexity. Thus, the subsequent studies use GDP per capita as an additional control variable as well (See Alaya, 2012; Agosin et al.,2012 Longmore et al., 2014).

Investment plays an important role on economic complexity by increasing the amount of capital stock in the economy. In this regard, the influence of public investment is not negligible. The private sector can sometimes hesitate to undertake new investment projects, especially when the return on these projects is uncertain. Thus, governments should design policies that provide incentives for the firms to produce more sophisticated products (Turnovsky, 1996). Furthermore, it is documented in the literature that public investment can cause an improvement in economic diversity if the government invests in infrastructural projects such as education, energy, airports and highways

(Ramirez and Nazmi 2003, Argimon et. al.,1997). Furthermore, government expenditure on infrastructure or human capital can help improve the business environment as well. However, one drawback related with public investment is that it can crowd out private investment if it is financed by borrowing (Khan and Kumar, 1997). Thus, the governments must be cautious in this regard. Indeed, it is argued that in the countries in which export sectors are dominated by the government or foreign investors, private investment may not have a significant effect on complexity (Elhiraika and Mbate, 2014). Bebczuk et al.(2006) also provide evidence on this view and argue that when domestic firms take advantage of specialization based on economies of scale rather than exploring new sectors of the economy, the degree of export diversification falls.

Investment in human capital is identified as another key factor in determining economic complexity. New growth theory argues that human capital increases people's knowledge, capacity and productivity thereby increases economic growth rates. (Romer, 1990). The experience of the South East Asian countries provides a good example regarding the role of human capital on the economy. Human capital can be proxied by education. Through education, the labor force can be embedied with skills and knowledge required for stimulating innovation. It is argued that the effect of education on economy is not uniform in the sense that the different stages of education may have different effects on the economy (Krueger and Lindahl, 2001; Vandenbussche et al., 2006; Grossman and Helpman, 1991). While the primary and secondary education provide individuals with basic skills important for technology adoption and imitation, the higher levels of education are essential for technology creation (Papageorgiou, 2003). However, it is also likely that the effects of the composition of the human capital may vary with different levels of development. The literature has identified that while primary and secondary education are more important for least developed countries (Gemmell, 1996), higher education contributes more to growth in developed countries (Petrakis and Stamatakis, 2002; Bayraktar-Sağlam, 2016). The recent studies also attempt to link the composition of human capital with the distance to technology frontier. Vandenbussche, Aghion and Meghir (2004) propose a model and argue that higher levels of education will have a stronger effect on the economy when a country becomes closer to the technological frontier. For the countries which are distant from the frontier, less skilled

human capital becomes more important. Some studies provide empirical evidence on this view. Pereira and Aubyn (2009) find that increasing education at all levels except tertiary has a positive and significant effect on growth in Portugal. Loening (2005) states primary and secondary education is more important for economic growth in Guetemela.

One should be careful when using education as a proxy for the human capital. Most of the studies in the literature use either the average number of years of formal schooling attained or the expenditure on education. However, recent discussions point out that these indicators do not take into account the quality of the education received by students. Instead, some qualitative measures based on standardized international exams, such as the OECD Programme for International Student Assessment (PISA) can be more informative to assess the role of cognitive skills. Hidalgo and Hausman (2009) argue that the quality of education is more important for economic complexity because the diversity of knowledge can lead to an increase in the productive capacity of the society. Despite this, most of the studies continue to use data on number of years of schooling because of data limitations.

Foreign direct investment has also been recognized as one of the important drivers of the complexity (Iwamoto and Nabeshima, 2012; Jakovic et al. 2017). The research shows that multinational enterprises spend more on research and development activities (UNCTAD, 2003) and have a greater tendency to develop new products than the domestic firms (Brambilla,2009). Therefore, by facilitating technology transfer, know how, working practices, and providing better intermediate inputs and machineries, FDI may promote economic complexity. Nevertheless, the effect of FDI may change based on the country characteristics, and the composition of the FDI. An examination of the FDI flows into MENA region reveals that oil, gas and nontradables sectors have been attracting the great bulk of FDI in most of the MENA countries as natural resource endowments attract resource seeking FDI. The rest of FDI flows is mostly in nontradeables sectors such as tourism and construction (UNCTAD, 2011). Interestingly, the FDI in high tech services is almost zero in this region (Gourdon, 2010). Therefore, especially oil exporting countries may not actually benefit from positive spillovers associated with FDI. Moreover, FDI inflows to oil exporting countries is very low

compared to other developing countries. The governments in this region do not have incentives to encourage FDI because the energy reserves are controlled by government entities and the revenues earned from energy exports can be invested locally by government (Lopez et al., 2005; Rogmans and Ebbers, 2013).

Terms of trade has also been considered as one of the factors associated with complexity. Terms of trade can have two different effects on economic complexity. On the one hand, an increase in terms of trade may increase profitability and encourage more diversification (Agosin et al.,2011). On the other hand, positive terms of trade shocks can discourage export diversification because of the increases in export earnings. The second effect is more evident for resource rich countries.

It has also been proved that a sound institutional environment encourages the successful implementation of more complicated production processes in the economy (Costinot, 2009). Increasing institutional quality may encourage private sector development as well as attract foreign direct investment by helping private enterprises to operate in a transparent environment. In most of the middle east countries, however, the level of corruption and political instability raises the cost of doing business and risks of investment (Strauss, 2015).

Existing research shows that natural resources rent play a significant role in determining economic complexity. Natural resource rents may have a positive impact on the economy if these rents are used to finance government spending on infrastructure. However, it is widely believed that high resource rents ususally affect economies negatively for a number of reasons. First, natural resource rents can cause entrepreneurs to focus more on rent-seeking activities rather than productive tasks. Sachs and Warner (1999) suggest that resource abundance can reduce a country's motivation toward physical and human capital accumulation causing the country to be constrained with low technology industries. Similarly, Leamer et al. (1999) argue that the abundance of natural resources has an adverse effect on technology upgrading. The literature has also documented that the marginal effect of natural resources may also depend on the level of education and institutional quality in the country. The countries that fail to invest in human capital usually find it more difficult to move away from primary dependence

(Maier and Wood, 1998). On the other hand, the countries that can efficiently use their human capital can produce more sophisticated products. Besides education, the role played by institutions on escaping the resource curse has also been heavily discussed. It is argued that resource dependent countries with weak institutions usually have difficulty in diversifying their production and exports (Mehlum et al., 2006).

Within this framework, we now turn to empirically analyze if the abovementioned variables play a significant role in improving economic complexity.

4. Data and Empirical Methodology

In this section, we attempt to explore cross country differences in economic complexity. The empirical model is specified by the following equation:

$$EC_{it} = \beta + \gamma\, EC_{i(t-1)} + \theta\, X_{it} + \varepsilon_{it} \tag{10}$$

where EC_{it} is economic complexity index that varies across countries and over time, X_{it} is the vector of explanatory variables and ε_{it} is the random error term. Economic complexity index is taken from the Observatory of Economic Complexity. After normalizing the economic complexity index, logistic transformation is applied. The lag of the economic complexity index is also included in the analysis to take into account the persistence of economic complexity. In selecting the control variables, we follow the empirical literature on the determinants of diversification and complexity in developing countries. The variables we consider are per capita gross domestic product, investment, human capital, terms of trade, natural resources rent, FDI and institutional quality indicators. Investment data is calculated by the sum of public and private investment obtained from IMF Investment and Capital Stock Database. IMF (2015) compiles data on both public and private investment. Human capital is proxied by education. We use two different data sets on education: Average years of schooling and government expenditure on education. First, we use average years of schooling in the population over 15 years, compiled by Barro and Lee (2013). This data is broken down into three categories as primary, secondary and tertiary education to analyze the importance of different stages of education. Considering the effect of education on a disagregated basis provides helpful

insights regarding the policies to be implemented to increase the positive effect of education. Based on the growing literature on the effect of the composition of human capital, we expect that all of these types of education may affect economic complexity differently. The second data we use is the government expenditure on education, which is used to evaluate the government's commitment for enhancing human capital accumulation. The expenditure on primary, secondary and tertiary education is obtained from World Development Indicators. Data on terms of trade, foreign direct investment, GDP per capita and natural resource rent are also retrieved from World Development Indicators. To analyze the effect of institutional quality, data on democracy obtained from Polity IV database is also used. This indicator considers different dimensions of institutionalized democracy such as the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive (Marshall and Jaggers, 2007).

The data will consist of a panel of 12 countries over the period from 1970-2015[3]. We use five year averages of the data for two purposes: First, taking averages allows us to analyze the determinants of economic complexity in the long run. Second, the use of five year averages help minimize the effect of correlations due to business cycle fluctuations and mitigate endogeneity problems (Chin and Ito, 2002).

The choice of the methodology followed for the specification used in this paper requires special attention due to a number of considerations. First of all, the dynamic nature of the data must be taken into account because the economic complexity may be persistent, meaning that the past values of economic complexity may have an effect on the current economic complexity. However, the inclusion of the lagged dependent variable can lead to auto correlation problem and the method chosen should be able to tackle with this issue. Secondly, there might be a bi-directional relation between economic complexity and some of the explanatory variables causing endogeniety bias. Using OLS estimates or fixed effect model may lead to biased and inconsistent estimates in these circumstances. As a result, to control for country-specific effects, to deal with the autocorrelation problem and to account for the potential endogeneity of the

3The list of the countries included in the study as well as the definition and data sources of the variables are provided in the appendix.

explanatory variables, we employ a dynamic panel data analysis. Specifically, we employ system Generalized Method of Moments (GMM) proposed by Arellano and Bover (1995). This approach is better suited for this kind of analysis because of the persistence of economic complexity. To compute the system estimator, variables in differences are insrumented with lags of their own levels, while variables in levels are instrumented with lags of their own differences (Bond et al., 2001). It is argued that by allowing the use of more instruments, this estimator improves efficiency. Arellano and Bond (1991) suggest two tests to evaluate the soundness of the instruments. The first test is the Sargan test for over-identifying restrictions, where the null hypothesis is the independence of the instruments and error term. In addition to the Sargan test, tests of serial correlations for the error terms are also applied, where the null hypothesis is that there is no second order serial correlation. The failure to reject the null hypothesis for both tests indicate that the instruments are valid.

5. Estimation Results

Following equation (1), the first regression attempts to examine possible determinants of economic complexity. More specifically, the analysis tries to identify the association between various stages of human capital accumulation and economic complexity. The results are presented in Table 3. The coefficients of lagged value of economic complexity, human capital and natural resource rent are significant. While human capital affect economic complexity positively, natural resources rent has a negative impact on complexity. One interesting finding is that tertiary education does not play a significant role on economic complexity, while primary and secondary education matters for economic complexity. This is in line with some of the earlier studies in the literature. The previous literature has also identified that primary and secondary education are more important for developing countries. It is also known that although MENA countries devoted special attention to improve the education system in recent years, there are still certain structural problems in the education system, which make it more difficult to enhance the education capacity at higher levels. This finding is also related with the findings in the literature linking the effect of education with the distance

to technology frontier. Because these countries are far away from the technological frontier, the effect of primary and secondary education seems to be higher. Overall, these results are similar to that of Jetter and Hassan, (2012) who find that the most important variables in predicting long-term export diversification are the fraction of natural resource rents in GDP and the net primary enrollment rate.

Another interesting observation from the results is that natural resources rent tend to reduce economic complexity, indicating that reliance on natural resources actually reduces the incentive for more diversification. This finding confirms the so called "resource curse hypothesis" in the literature.

With regard to the role of FDI, we can not find a significant effect of FDI indicating that MENA region cannot benefit from FDI. This is not surprising for this country group because FDI inflows to this region is very low and most of the FDI is directed towards natural resources and nontradables goods sector.

In table 4, we explore the role of government spending on primary and secondary education. Because various studies on this issue have used different proxies for education, in addition to average years of schooling on primary, secondary and tertiary education, we have also utilized the data on government expenditure on education. Even after using this variable, the main results do not change. The lagged value of economic complexity, natural resources rent, and education are still significant. However, the Sargan test statistic for the first model is very low, indicating that the instruments used for this model may not be valid.

In Table 5, we investigate interaction effects. The main question we ask is whether the effect of natural resources on economic complexity changes with human capital and democracy. In column (1), an interaction term is introduced by multplying the natural resource rent with average total school years. It is seen that this interaction term is significant indicating that the marginal effect of natural resources depend on the level of education. Provided that the country is embeddied with enough human capital, the natural resources rent can also influence economic complexity positively. In columns (2) and (3), we turn to the effect of institutional structure. In column (2), we evaluate if the marginal effect of FDI depends on democracy by interacting FDI with democracy. It is evident

from the tablet hat FDI actually increases economic complexity in relatively more democratic countries. Finally, in column (3) we interact the natural resources rent with democracy. The interaction variable turns out not to be significant indicating that the marginal effect of natural resource rent does not depend on institutional quality for these countries. Table 5 shows that even after including new variables, human capital and natural resources appear to be significant.

Since GMM estimation relies on the assumption that there exists no second-order autocorrelation and that the instruments used are valid, the respective tests are also presented for each specification. The results confirm that the null hypothesis cannot be rejected, implying the validity of instruments.

Table 3: *The effects of different types of education on economic complexity*

VARIABLES	(1) Economic Complexity	(2) Economic Complexity	(3) Economic Complexity	(4) Economic Complexity
Economic Complexity (lagged)	0.506*	0.530*	0.503*	0.237
	(0.182)	(0.189)	(0.173)	(0.435
Terms of Trade	-0.001	-0.001*	-0.000	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Investment	0.028	-0.008	0.062	0.109
	(0.126)	(0.141)	(0.114)	(0.201)
Natural Resource Rent	-0.058*	-0.055*	-0.057*	-0.118*
	(0.025)	(0.027)	(0.024)	(0.064)
GDP Per Capita	0.000*	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
FDI	-0.014	-0.024	-0.006	0.005
	(0.017)	(0.021)	(0.015)	(0.026)
Average Years of Schooling (total)	0.134			
	(0.055)			
Average Years of Schooling (Primary)		0.313*		
		(0.132)		
Average Years of Schooling (Secondary)			0.243*	
			(0.097)	
Average Years of Schooling (Tertiary)				3.763
				(3.085)
Constant	-0.900*	-1.065*	-0.759*	-1.239*
	(0.363)	(0.412)	(0.329)	(0.725)
Number of Observations	60	60	60	60
Number of Countries	12	12	12	12
Number of Instruments	10	10	10	10
Sargan p. value	0.60	0.74	0.41	0.86
1st Order Serial Correlation (p-value)	0.93	0.98	0.95	0.17
2nd Order Serial Correlation (p-value)	0.41	0.35	0.46	0.84

Notes: (i) Regressions are estimated by using the system GMM estimator. (ii) The standard errors are reported in parantheses. (***), (**), (*) indicate significance at the 1, 5, 10 per cent level respectively.

Table 4: *The effects government spending on education on economic complexity*

VARIABLES	(1) Economic Complexity	(2) Economic Complexity
Economic Complexity (lagged)	0.340*	0.341*
	(0.191)	(0.286)
Terms of Trade	-0.001*	-0.001
	(0.001)	(0.001)
Investment	-0.209	-0.050
	(0.146)	(0.087)
Natural Resource Rent	-0.052***	-0.042*
	(0.011)	(0.024)
GDP Per Capita	0.000***	0.000*
	(0.000)	(0.000)
FDI	-0.015	-0.005
	(0.010)	(0.012)
Government Spending on Primary Education		0.026*
		(0.09)
Government Spending on Secondary Education	0.018**	
	(0.005)	
Constant	-0.777*	-2.601*
	(0.325)	(1.070)
Number of Observations	61	61
Number of Countries	14	14
Number of Instruments	10	10
Sargan p. value	0.004	0.320
1st Order Serial Correlation (p-value)	0.78	0.92
2nd Order Serial Correlation (p-value)	0.58	0.51

Notes: (i) Regressions are estimated by using the system GMM estimator. (ii) The standard errors are reported in parantheses. (***), (**), (*) indicate significance at the 1, 5, 10 per cent level respectively.

Table 5: *The effects of human capital and democracy on economic complexity*

VARIABLES	(1) Economic Complexity	(2) Economic Complexity	(3) Economic Complexity
Economic Complexity (lagged)	0.574***	0.731***	0.717***
	(0.149)	(0.187)	(0.189)
Total Schooling Years	-0.049	0.076	0.102*
	(0.075)	(0.062)	(0.060)
Terms of Trade	-0.002*	0.000	0.000
	(0.001)	(0.001)	(0.001)
Investment	0.138	-0.019	-0.081
	(0.112)	(0.090)	(0.092)
Natural Resource Rent	-0.050*	-0.047*	-0.012*
	(0.024)	(0.022)	(0.007)
GDP per capita	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)
FDI	-0.002	-0.015	-0.033*
	(0.015)	(0.021)	(0.019)
Democracy		0.006	-0.004
		(0.072)	(0.086)
FDI*Democracy		0.011*	
		(0.006)	
Natural Resource rent*total years of schooling	0.006*		
	(0.004)		
Natural resource rent*democracy			0.010
			(0.007)
Constant	-0.147	-0.485	-0.422
	(0.185)	(0.355)	(0.388)
Number of Observations	60	55	55
Number of Countries	12	11	11
Sargan p-value	0.17	0.74	0.29
1st Order Serial Correlation (p-value)	0.30	0.99	0.21
2nd Order Serial Correlation (p-value)	0.88	0.35	0.61

Notes: (i) Regressions are estimated by using the system GMM estimator. (ii) The standard errors are reported in parantheses. (***), (**), (*) indicate significance at the 1, 5, 10 per cent level respectively.

6. Conclusion

We explore the determinants of economic complexity by adopting a dynamic panel data methodology using data on 12 MENA countries for the period between 1970-2015.

We find robust evidence across various specifications indicating that primary and secondary education enhance economic complexity, while tertiary education does not seem to play a significant role. An important result found in all specifications is the negative effect of natural resources rent on economic complexity. The existence of a high natural resource rent seems to prevent MENA countries from exploring the possible product diversification opportunities. The results also show that FDI and terms of trade do not contribute to economic complexity, although the former seems to foster economic complexity in relatively more democratic regimes.

The evidence obtained in this study has significant implications for improving productive capabilities and product diversification in the MENA region. First, the findings reveal that human capital is positively associated with economic complexity indicating that the governments should provide adequate funding for education. Given that countries make use of tertiary education to produce higher level technology products, tertiary education must also be encouraged and supported. This in turn may help countries move from producing primary products to higher technology products. It should be noted that in this study education is measured by the average years of schooling or government expenditure on education. Although these measures may not be able to capture the differences in the quality of education across countries, they are used due to data limitations. As a result, it is important that the national statistical agencies of MENA countries initiate efforts to form broader data sets. For example, data on standardized test scores which is readily available for OECD countries would be useful to asess the impact of education in a more comprehensive manner.

Regarding foreign direct investment, our regression estimates do not show a direct significant relation with economic complexity. However, this result can be due to the fact that FDI inflows in this region are directed towards the energy sector. If the MENA countries, especially those exporting oil and natural gas, encourage FDI inflows by

removing the restrictions on these flows and provide incentives to direct FDI inflows towards tradables goods sector, there is a chance that FDI may positively influence complexity.

Last but not least, the findings of the study confirm the “resource curse” hypothesis. This points out that it is crucial for the oil exporting countries in this region to implement policies towards better managing the natural resources. In particular, they should especially concentrate efforts on how to tax these rents and better use revenues generated from natural resources. It is also seen that the marginal effect of natural resource rents depends on the accumulation of human capital. As a result, improving the education system can also help alleviate the negative effects of natural resources. Finally, the results present that FDI has a positive effect on economic complexity in democratic regimes. Thus, MENA countries should also take steps towards a more pluralistic society while also strengthening their institutional capacity, which is conducive for both private and public sector development.

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APPENDIX

Table 1: *Country List*

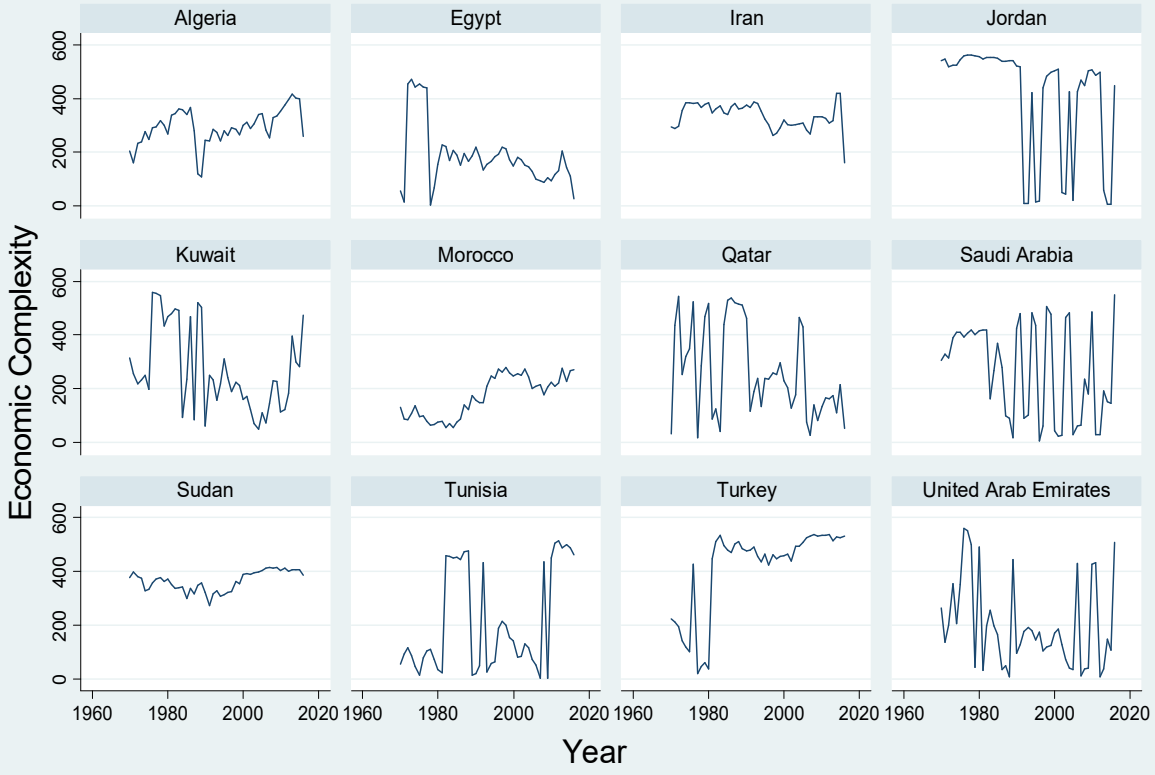
Algeria	Sudan
Egypt	Tunisia
Jordan	Turkey
Kuwait	United Arab Emirates
Saudi Arabia	Qatar
Morocco	Iran

Table 2: *Description of Variables and Data Sources*

Variable	Description	Source
Economic Complexity	Economic Complexity Index (ECI) ranks how diversified and complex a country's export basket is. ECI is a scale that uses the theory of and calculations for economic complexity to rank countries according to their level of complexity.	Observatory of Economic Complexity, AJG Simoes, CA Hidalgo. The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. (2011)
Per Capita GDP	GDP per capita based on purchasing power parity (PPP). Data are in constant 2011 international dollars.	World Development Indicators, 2018.
Investment	The total of public and private investment.	The data is obtained from International Monetary Fund, Investment and Capital Stock Dataset, 1960-2015.
Human Capital	Average years of schooling in the population over 15 years. This data is broken into primary, secondary and tertiary education.	Barro, Robert and Jong-Wha Lee, 2013, "A New Data Set of Educational Attainment in the World, 1950-2010." Journal of Development Economics, vol 104, pp.184-198.
Government Expenditure on Education	General government expenditure on education is expressed as a percentage of total general government expenditure on all sectors (including health, education, social services, etc.).	World Development Indicators, 2018.
Terms of Trade	Net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000.	World Development Indicators, 2018.
Natural Resource Rent	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.	World Development Indicators, 2018.
Foreign Direct	Foreign direct investment are the net	World Development Indicators,

Investment	inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor.	2018.
Democracy	This indicator considers different dimensions of institutionalized democracy such as the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive	Marshall, Monty, and Keith Jaggers (2007). POLITY IV PROJECT, Data Set Users Manual, Center for Systemic Peace.

Figure 1: The Trends in the Economic Complexity



Source: The Observatory of Economic Complexity