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Technological Capability: Does it Matter for Bahrain?

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Abstract: The study aims at determining the impact of the technological capability on the economic growth of Kingdom of Bahrain during the period (2005-2014). The study methodology is based on the econometric analytical approach to estimate the parameters' values and the trends of the economic relationship between the study variables by employing the cointegration and Granger causality techniques. The study found that there is a positive long run relationship between the technological capability and economic growth. Granger causality test reveals that the technological capability Granger causes the economic growth in Bahrain. This means the technological capability could accelerate the economic growth in the long run. The study result is consistent with the new growth theory and various empirical studies in different countries. The study recommends that government and policy makers in Bahrain should pay careful attention to all of the factors that provide incentives for technological creation such as R&D, the education system, entrepreneurship and the tolerance for diversity, macroeconomic expectations and openness to trade.
Keywords: Technology, Cointegration, Causality, Economic Growth, Bahrain

INTRODUCTION

Can Bahrain economy grow faster by raising its technological capability? Since the early of 1980s growth theory and development theory view technological progress as a product of economic activity, and it is almost certainly the key driver of long run economic growth. Romer emphasized that the ability to grow the economy by increasing technology rather than labor or capital creates opportunities for nearly boundless growth. An economy without technological innovation, even if it has extremely high national savings rate will not able to avoid stagnation unless it continually advances its technological capability. To do so systematically, the country needs to aware about the process of developing and applying new ideas in production [1].

The theoretical models of new growth theory stress that there are two basic modes of advancing technology. One is innovation (developing one's own new technologies) and the other one is adoption (introducing technologies that have been devised elsewhere). Adoption of technology from abroad is sufficient to raise standards of living substantially, and even to achieve long run growth based on the continuing technological innovation achieved abroad, while technology adoption has its limitations as well.

There are several attempts by governmental and nongovernmental institutions and international organizations that tried to measure the technological capability at the country level. One of these measures is ArCo technological capability index, which is created by Archibugi and CoCo in 2004. They measured the technological capability by taking into account three main dimensions of technological capabilities, which are: technology creation, technology diffusion and human resources development. They choose theses three dimensions of technological capabilities assuming that they play comparable role in making of the country's technological capability. The three dimensions include eight indicators which are: patents, scientific articles, internet penetration, telephone penetration, electricity consumption, tertiary science and engineering enrolment, many years of schooling and literacy rate. They measure the technological capability by summing of the simple mean of eight indicators of technology, where each indicator has the same weight [2].

The main goal of the current study is to determine the impact of technological capability on the economic growth and the standards of living in Bahrain during the period (2005-2014). The study mainly depends on the database published by Central Bank of Bahrain, in addition to international institutions such as the World Bank (WB), International Telecommunication Union (ITU), and United Nations Development Program (UNDP).

The rest of paper is organized as follows: Section two illustrates the profile of technological

capability of Bahrain during the study period. Section three, shows the tudy hypotheses and mythology. Section four presents the study empirical results. And finally conclusion and recommendations.

Bahrain's technological capability: an overview

Kingdom of Bahrain have tried to shift from a resources-based economy to a knowledge- based economy Since 1940, because the government of Bahrain have believed that the economic processes which create and diffuse new technology are critical to shaping the growth at a country level, communities and individual firms. Bahrain Petroleum Company "BAPCO" was the first company in the region that implemented automated machines for its oil operation in 1940. Bahrain took another step forward in the late 1970s when the Bahrain Airport implemented a system called LOPAC for passenger check-in and it was connected to other GCC countries. The technological revolution in the kingdom gathered pace when Bahrain became the first country in region that implemented touch-screens in offshore banks within their dealing rooms. The banking sector continued to lead the way to technological progression when computer networks started to appear when Central Informatics Organization and banks connected branches together. Recently the Information and communications technology (ICT) sector is booming where Bahrain succeeded in being up-to-date in many technological fields. Now telecommunications companies are providing services to the population of Bahrain. Moreover mobile computing became very well established in the country, and not only for commercial purposes, but also to conduct governmental services and transactions on mobiles. [3]. In order to evaluate the development of Bahrain's technological capability during the period (2005-2014; the study will illustrate the development of eight indicators of technological capability that adopted by ArCo.

- Internet penetration: Internet plays an important role in kingdom of Bahrain for variety of reasons, as well as it affects and facilitates nearly every aspect of modern life of Bahrainis. The Internet becomes extremely important in many fields, education, healthcare, business and government. Bahrain is a progressive Gulf state, with an increasingly liberalized telecommunications sector as part of the Kingdom's wider VISION 2030 strategy. Telecommunications infrastructure in Bahrain is among the most basic infrastructure progress in the region, due to multi-modernization of the Internet network. Recent statistics of ITU shows Internet use has grown considerably in the last decade, where there number of Internet users increases from approximately 182,000 in 2005 – which represents 21.3% of the population- to 634,000 and 1240,000 which represent 53% and 91% of the population in years 2009 and 2014 respectively. The percentage of Bahrainis using internet is very high compared with the average rate of internet users either in developed (79.5%) or developing (32.4%) countries. Due to the increase the number of internet users the internet service in the Kingdom has received big boost after completing the process of comprehensive modernization of the power bandwidth of the network in year 2015, where telecommunication companies doubling the capacity to link its network to reach more than 400 MB per second. This update enhanced network performance to a great extent and provides the ability faster browsing on the internet for all internet users.[4]

  Recent survey about "Internet use amongst young people in Bahrain" finds out that Bahraini young people use the Internet an average of 2.5 – 3.5 hours every day. They use the Internet for a number of different reasons; mainly for homework purposes, to play games or to interact with other people via instant messaging, chat rooms, games, blogging and Social Networking Sites (SNS). [5] . It is obvious that the growth in ICT plays both an essential role in the economic development of Bahrain heading towards 2030, and in equipping young people with essential skills.

- **Telephone penetration:** mobile-cellular and fixed telephone lines subscription penetration are the broadest and most common measurement of the degree of telecommunication development in Bahrain. There are three telecommunication companies in Bahrain: Batelco, VIVA and Zain. According to the database of ITU the fixed telephone penetration rates declined from 40% in year 2005 to 37% in year 2009 and to 36% in year 2014, on the contrary Mobile-cellular penetration rates exceeds 173% in year 2014 compared with 87% in year 2005.Recent ITU reports show that the fixed telephone penetration rates in Bahrain is less than the fixed telephone penetration rates in developed world (39.9%) while it is higher than the fixed telephone penetration rates in developing world (10%), as well as GCC countries; {Qatar (18.41%),Kuwait (14.2%), UAE (22.26%), KSA (13.36%), Oman (9.56%), and Yemen (4.68%)}. On the contrary the mobile-cellular penetration rates in Bahrain is higher than the average Mobile-cellular subscription in year 2014 in both developed and developing world as well as Qatar, Oman, and Yemen, where the Mobile-cellular penetration rates are 119.9%, 91.1%, 145.75%, 157.75% and 68.49%, respectively, while it is less than the average number of subscriptions in KSA

(179.56%), UAE (178.06%) and Kuwait (218.43%) [4].

- **Electricity consumption:** the World Bank database of electric power consumption illustrates that Bahrain was one on the biggest countries in the consumption of electricity during the period (2005-2014), this might be to meet energy demand related to high economic growth in Bahrain during the study period. In 2005 the electricity consumption in Bahrain was 20212.7 (kWh per capita) while the average world electricity consumption was 2496.1 (kWh per capita). Despite of the electricity consumption per capita in Bahrain began to decline during the next years but Bahrain is still higher than the average world in addition to Gulf countries. In 2014 the electricity consumption per capita in Bahrain was 17395.3 (kWh). The average world electricity consumption is 3064.5 (kWh per capita), while the electricity consumption per capita in Qatar, Kuwait, UAE, KSA, Oman, and Yemen were {161831, 15721.8, 10465.6, 8303.5, 6094.7, 170.1} respectively.

- **Patents:** U.S. Patent and Trademark Office report shows that the number of patents granted in Bahrain before 2001 was five patents, while in the period (2005-2009) the number of patents granted was only one patent. During the period (2010-2014) the number of patents granted increased to six patents. It is obvious, the number of patents granted in Bahrain is very low, and this might be due to decreasing the spending on research and development (R&D) as a percentage of Bahrain's GDP which does not exceed 0.2% of GDP during the study period. This rate is less than the average spending on R&D in both developed and developing worlds, where it was 2.4% and 1.1% respectively. The report illustrates also the number of patents granted in other Gulf countries is higher than Bahrain's patents during the study period [6].

- **Scientific articles:** During the study period, Bahrain's scientific and technical journal articles that published and indexed were not stable, where the average number of journal articles was 24.8 articles, and raised to 38.2 articles in 2006, and it decreased to 33.3 articles. During the period(2010-2014) the average number of journal articles increased and the average number of journal articles reached its maximum in year 2011, (48.4 articles). Despite of the number of published scientific articles increases during the study period but it is still less than the average number of published scientific articles in other GCC countries (except Yemen). Where the average number of published scientific articles in KSA, Kuwait, UAE, Qatar, Oman, and Yemen are {7232.6, 2282, 2344.6, 551, 1717.7, 134.2} respectively during the study period [7].

- **Literacy rate:** The WB database shows that the Literacy rate in Bahrain raised from 95.1% for the period (2005-2009) to 98.2% for the period (2010-2014). The literacy rate rising during the study period due to adopting the Bahrain Economic Vision 2030, which aims to take progressive action for sustainability and competitiveness of future generations in terms of social and economic development of Bahrain. In order to achieve the goals the ministry of education put a plan for illiteracy eradication targeting the over 10 years of age. The purpose, in addition to eradicating illiteracy, is to provide them with the skills necessary for personal and professional development, including human and citizenship rights education. Moreover they put incentives system and rewards whereby no government jobs can be obtained without a certificate proving the completion of this course, or a signed agreement to enroll in it. Additionally, part of the plan's orientation is the development of an integrated educational system for adults that combines formal and non-formal educational curricula. This measure is aimed at enhancing the quality and relevance of adult education programmes and more closely linking them to social and economic development needs. The Government of Bahrain, through the Ministry of Education, is also directing its efforts towards women by facilitating their enrolment in flexible programmes offered in the afternoons and evenings for those who cannot attend daytime classes. [8]. The World Bank statistics show that the literacy rate in Bahrain is above the world literacy rate which is 90.6%, while it equals to the literacy rate in most of the Gulf countries, this could be because most of gulf countries are adopting the same educational policies [7].

- **Mean years of schooling:** The mean years of schooling in Bahrain is 12 where the Pre-university educational system in Bahrain consists of four phases: a primary level that includes six years, but the system allows moving after the end of the third year of education to religious institute, to complete primary school, and then studying in middle school for two years, followed by high school in the same Institute for Three years. Intermediate level that includes three years. Secondary level which includes three years and also branched to Secondary General (scientific, Arts), industrial secondary and commercial secondary in order to get an industrial or commercial diploma.

- **Tertiary science & engineering enrolment** : Recent reports of UNDP illustrate that the enrolment in science and engineering colleges (% of 20-24 age group) declined sharply from 23% for the period (2005-2009) to 13% for the period (2010-2014) compared to the average world which equals to 22.8%.The main reason behind the reduction in enrolment in Science and Engineering Colleges and increasing the enrolment in Business, Arts and Teachers Collages due to changing in demand of the labor market in Bahrain over the past decade. Where there is increasing in demand for graduates of Colleges of Business and Teachers while there is a lack of demand for Scientific College's graduates. On the other hand, Most of Bahraini students prefer Business, Art and Teachers colleges rather than scientific colleges cause these colleges are easy than the other [9].

It clear from the above, there is significant development in several technological capability indicators of Bahrain particularly the technology diffusion indicators and literacy rate indicator , while technology creation indicators are less than the world standard even though it increased during the study period.

Study hypotheses and mythology study hypotheses

The purpose of this study is to investigate the direction of causality runs from technological capability to economic growth during the study period. Thus the study tests the following hypotheses:

H0: Technological capability does not Granger cause economic growth in Bahrain

H1 Technological capability does Granger cause economic growth in Bahrain

Study methodology

Testing the relationship between the technological capability and economic growth requires three steps: First, the time series would be analyzed to determine the order of integration. Second, investigating the long run relationship between the technological capability and economic growth. Third, the existence of cointegration between the two time series indicates the existence of a causality relationship at least in one direction in short run as well as the long run.

The unit root test is employed to detect the stationarity of the two variables under study. The test is undertaken for two reasons. First, avoiding the spurious regression problem. Second, a basic assumption underlying the application of causality test is that the time series in question should be stationary. Hence, in order to detect the stationarity of the two variables, the study employs the ADF test (Dickey and Fuller, 1981) [10], and the (PP) test (Phillips and Perron, 1988) [11], with intercept and trend. Individual economic time series may not be stationary, but there may be cases of linear combination among them. This means that nonstationary economic time series may produce stationary relationships if they are cointegrated. This is a reason why we subjected the two variables series individually to unit root analysis. If both time series are integrated of the same order, I(d) for d=0,1,2,…, then the two series are said to be cointegrated and the regression on the same levels of the two variables is meaningful, in addition to the possibility to proceed with the estimation of the following cointegration regression:

$$Ecog_t = \alpha + \beta\, TC_t + \varepsilon t \qquad (1)$$

Where $Ecog_t$: economic growth rate, TC_t : technological capability at time t, and ε_t : random error term (residual). Residuals ε_t measures the extent to which $Ecog_t$ and TC_t are out of equilibrium.

If the residual of the two variables do not contain unit roots, the econometric relationship among the variables could be cointegrating. The Johansen (1988) cointegration test is adopted to analyze the long run relationship between the two variables in Bahrain [12]. The Granger causality test is also applied in order to determine the direction of Granger causality [13]. If the technological capability helps to forecast economic growth, then we say that the technological capability Granger causes the economic growth. Furthermore, if economic growth also Granger causes the technological capability, there is bilateral causality between technological capability and economic growth. However, if both variables do not cause each other, it means that these two variables are statistically independent. On the other hand, if the technological capability causes the economic growth but the economic growth does not cause the technological capability, then a unidirectional causality from technological capability to economic growth exists. If there is no cointegration among the variables, the VAR procedure will be used. However, if a unique cointegrating vector for the variables used in the cointegration analysis, the Granger causality procedure based on VECM is used. This procedure is particularly favorable compared to the standard VAR as it permits temporary causality to emerge from the sum of the lagged coefficients of the explanatory differenced variables and the coefficient of the error correction term (ECT). Besides indicating the direction of causality among variables, the VECM framework could also distinguish between short run and long run causality. The significance of the F-test and Wald χ 2 test helps to indicate any short run causality between the independent variable and dependent variable. The long run causality is identified through ECT where a

significant t-statistic shows the existence of long run causality running from the independent variable to the dependent variable.

Table (1) shows the results of the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) unit root tests for levels and first differences of economic growth and technological capability series. The results show that at the level, both variables are non-stationary but both of them are stationary at the first difference. Accordingly, bath variables are integrated of the same order of one I (1), which means that the cointegration test could be applied.

Empirical results

Unit root test

Table-1: ADF and PP Stationarity tests

Variables	Level		First differences	
	ADF	PP	ADF	PP
$Ecog_t$	-2.56(2)	-2.64(3)	-3.19(1)	-3.61(3)
TC_t	-2.43(4)	-2.54(3)	-4.25(2)	-4.25(2)

Sources: Researcher's estimation

ADF and PP critical values at level are: -4.38 at 1% of probability, -3.65 at 5% and -3.24 at 10%.

ADF and PP critical values at first differences are: -2.727 at 1%, -1.964 at 5% and -1.627 at 10%.

The numbers in parentheses are the lag length, which are augmented up to a maximum of 4 lags ,the optimal lag length is determined based on Schwarz Information Criterion (SIC).

Cointegartion test

Having established that two variables are integrated of same order, we proceed to test for presence of cointegration between the two variables. We employ Johansen cointegration test. It may be noted here that we are interested to check for the presence of cointegrating relationship between the variables, however, number of cointegrating vectors is not of our interest. Table (2) presents the results of the null hypothesis that there is no cointegration against the alternative that there exists cointegration. Starting with the null hypothesis that cointegration does not exist among the two variables; the trace statistic value is shown to be greater than the critical values at both 5% and 1% levels. Hence, we reject the null hypothesis of no cointegration in favor of existence of cointegration for all the series at both 5% and 1% levels. Moreover, the maximum Eigen statistic value indicates that 2 cointegration equation at 5% and 1% levels of significance. Accordingly, both the trace and maximum Eigen value test statistics indicate that there is a long run equilibrium relationship between technological capability and economic growth in Bahrain.

Table-2: Johansen Panel cointegration (Trace and Maximum Eigen Value Test)

Hypothesized No. of CE(s)	Trace Statistic	Eigen value	1% critical value	5% critical value
None	17.245	0.766237	10.310	15.197
At most one	12.971	0.294521	6.936	3.962

Hypothesized No. of CE(s)	Max-Eigen Statistic	Eigen value	1% critical value	5% critical value
None	18.436	0.766237	17.936	14.036
At most one	12.971	0.294521	6.936	3.962

Sources: Researcher's estimation

The critical values in the table are copied from Walter Enders, Applied Economic Time Series, Wiley Series in Probability and Statistics, 1995, p.420.

Hence, the study can analyze the long run cointegration equation of economic growth with its independent variable of technological capability with VECM. The equation can be written as follows: (the numbers in ( ) are T-statistics)

$$Ecog_t = 2.015 + 0.365\ TC_t \qquad (2)$$

(1.783) (2.528)*

The above equation illustrates that the technological capability has positive significant at 5% on the economic growth in Bahrain effect during the study period.

Granger causality test

The existence of cointegrating relationship between technological capability and economic growth for Bahrain suggests that there must be long run Granger causality in at least one direction. The Granger causality test based on VECM is applied to the variables after first differencing, with the purpose of testing whether the technological capability causes the economic growth or not. The results presented in Table-3.

Table-3: Granger causality tests

Null hypothesis	Obs.	F-stat	Short run results	ECT (-1) t-stat	Long run results
TC_t does not cause $Ecog_t$	10	1.123	.	-2.201*	$TC_t \Rightarrow Ecog_t$
$Ecog_t$ does not cause TC_t		3.67*	$TC_t \Leftarrow Ecog_t$	-1.31	

Source: Researcher's estimation using SPSS
* Significance at 5%. & " ⇒ " indicates the direction of Granger causality

From Table (3), the result is different for the short-run and long-run. In the short-run, the technological capability does not Granger causes the economic growth, while in the long run there is unidirectional causality from technological capability to economic growth; this means that the technological capability Granger causes the economic growth. This result indicates the technological capability could accelerate the economic growth only in the long run which is consistent with new growth theory.

CONCLUSION

Measuring the technological capability of Bahrain during the period (2005-2014) shows that Bahrain has achieved improvement in technology diffusion in addition to literacy rate , while the technology creation indicators are still less than the required standard. Even though the improvement in final technological capability index affects significantly on the economic growth in Bahrain in the long run. In order to improve the technology creation indicators which creates the differences among the industrial countries in growth and trade on the one hand and the gap between the developed and developing countries on the other hand. Government of Bahrain should review and upgrade their existing science, technology and innovation (STI) policies, where Bahrain needs to be capable of evaluating impacts of their exiting STI policies. Bahrain also needs potential to assess the level of its STI capacities to order to develop new policies and to benchmark these capacities with more successful countries in order to catch up.

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REFERENCES

1. Romer P; Endogenous Technological Change, Journal of Political Economy.The University of Chicago. USA. 1990, 98(5): 71-102.
2. Archibugi D, Coco A, A New Indicator of Technological Capabilities for Developed and Developing Countries (ArCo), Science and Technology Policy Research (SPRU), University of Sussex, UK, 2004; 111.
3. Telecommunications Regulatory Authority, Annual Report, 2015.
4. International Telecommunications Union (ITU), Measuring the Information Society Report, Geneva, Switzerland, 2014.
5. Davidson J, Martellozzo E; Kingdom of Bahrain State of the Nation Review of Internet Safety, the Telecommunications Regulatory Authority (TRA), 2010.
6. U.S. Patent and Trademark Office, Patent Counts by Country, State, and Year: All Patent Types, Patent Technology Monitoring Team (PTMT), 2014.
7. World Bank, World Development Indicators, WB Publications, 2005 & 2014
8. Ministry of Education of Bahrain, Annual Report, 2013.
9. UNDP, Human Development Reports, different issues.
10. Dickey DA, Fuller WA; Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica, 1981, 49.
11. Phillips PCB, Perron P; Testing for Unit Roots in Time Series Regression, Biometrika, 1988, 75: 335-346.
12. Johansen S; Statistical Analysis of Cointegration Vectors, Journal of Economic Dynamics and Control, North-Holland, 1988, 12: 231-254.
13. Granger CW; Investigating causal relations by econometric models and cross-spectral methods. Econometrica: Journal of the Econometric Society, 1969; 424-438.