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Bahrain Aggregate Production Function, Determinants and Impacts

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Abstract— **In this paper an attempt is made to examine and analyses the determinants of the level of output of Kingdom of Bahrain RGDP using the Aggregate Production Function Model, the Cobb-Douglas Function. The impact of factor of production on the level output is being examined, using time series data RGDP as an aggregate level of output and the inputs of labor, capital accumulation, in addition to two other factors that's believed to have an essential impact on the level of output, (expenditure on educating and life expectancy). Time series have been tested for stationary using Augmented Dickey-Fuller test of unit root, and cointegration test. At the level the test suggests that some variables are nonstationary at first difference the null hypothesis of unit root is rejected and we conclude that the data are stationary at first difference. Cointegration test indicate that the analysis so far only suggests the long-run associations amongst the variables in the analysis. VAR technique was used to examine the variability of the GDP of Bahrain. Important finding of this analysis is that Life expectation, Labor force, EDUR have a significant impact on the level of GDP, and less contribution is found by GCF. The elasticity of output with respect to inputs suggests that the inputs of labour force and capital formation have essential impact on the level of Real GDP, in addition to the life expectancy. Moreover, increasing return to scale is indicated. The more powerful input is the labour force.**

Keywords: Kingdon of Bahrain, Reale Gross domestic of bhrain (RGDP), labor force of bahrain(LF), Fixed Gross Capital Formation (GCF), Education(EDUR), Life expectation(LIFEXP).

I. INTRODUCTION

The estimation and use of aggregate production function has become a wide spread and important practice in economic analysis.

Cobb-Douglas functions are frequently used in economics to show the relationship between input factors and the level of production. This form of functions is two factors of production to influence the level of output; they are labor (L) and capital (K). In the economics of joint production one often distinguishes between the two cases: the one in which a firm produces multiple products each produced under separate function process, and the other "true joint production" where a number of outputs are produced from a single production process, where each product shares common inputs. In the econometric practice the first case has often been dealt with by aggregation of individual production function into a macro production function. The second case has often called for estimation of an implicit aggregate production function.

The concern of this research is about the aggregate (Macro) production function, so it is important to understand what aggregate production function is one must understand what the aggregation problem involve.

II. PRODUCTION FUNCTION

The aggregate production function is the maximum output that can be produced given the quantities of the factors of production. The starting point for analysis of the Classical engine is the production function:

$$Y = f(K^*, L) \qquad (1)$$

The Classical production function shows different levels of output (y) assuming fixed technology and varying amounts of factors of production (K = capital in the form of plant and equipment; L = labor measured in homogeneous units). In the short-run it is assumed that the amount of capital is fixed (indicated by the symbol over K, but in the long run capital is varied too) and varying quantities of labor but assuming a fixed population (otherwise additional labor would become available simply through natural growth). This function displays the following three properties: the function (1) is increasing (possibly weakly), (2) displays constant returns to scale, (3) and displays diminishing returns.

Returns to scale are technical properties of the production function, $y = f(x_1, x_2, ..., x_n)$. If we increase the quantity of *all* factors employed by the same (proportional) amount, output will increase. The question of interest is whether the resulting output will increase by the same proportion, more than proportionally, or less than proportionally. In other words, when we double *all* inputs, does output double, more than double or less than double? These three basic outcomes can be identified respectively as *increasing returns to scale* (doubling inputs more than doubles output), *constant returns to scale* (doubling inputs doubles output) and *decreasing returns to scale* (doubling inputs less than doubles output).

The concept of return to scale has been discussed extensively over a log time and examined by many economists. Alfred Marshall (1890) used the concept of returns to scale to capture the idea that firms may alternatively face "economies of scale" (i.e. advantages to size) or "diseconomies of scale" (i.e. disadvantages to size).

Knut Wicksell (1900, 1901, 1902), P.H. Wiicksteed (1910), Piero Sraffa (1926), Austin Robinson (1932) and John Hicks (1932, 1936), has discussed the concept of definition of return to scale in a technological sense.

In the macroeconomic environment, the theoretical analysis of economic growth is the nature of the relationship between an economy's factors of production and its output. Assuming homogeneity of the aggregate production function, an important element of this relationship is the degree of returns to scale. In neoclassical growth models, constant returns to scale is usually assumed to prevail due to perfect competition. In contrast, endogenous growth models typically assume increasing returns to scale as a result of technological progress that is usually modeled as arising from the accumulation of physical or human capital (e.g., Romer (1987) and Lucas (1988). For production, the function is

$$Y = AL^{\alpha} K^{\beta}$$

Where:

Y = total production (the monetary value of all goods produced in a year)

L = labor input

K = capital input

A = total factor productivity

α and β are the output elasticities of labor and capital, respectively. These values are constants determined by available technology.

It is a mathematical mistake to assume that just because the Cobb–Douglas function applies at the micro-level, **it also applies at the macro-level**. Similarly, there is no reason that a macro Cobb–Douglas applies at the disaggregated level. The Cobb–Douglas function form can be estimated as a linear relationship using the following expression:

$$\log_e(Y) = a_0 + \sum a_i \log_e(I_i)$$

Where:

Y = Output

I_i = Inputs

a_i = model coefficients

We take our inputs to be physical capital, labor, and human capital. We model output as a function of inputs and technologies using the following aggregate production function:

$$Y = AK^{\alpha} L^{\beta} e^{\Phi_1 + \Phi_2 lifexp + \Phi_3 edur}$$

Where Y is output or real gross domestic product (GDP); A represents Total Factor Productivity TFP; K is physical capital (Gross Capital Formation); L is the labor force; and human capital consists of two components, health (which we proxy with life expectancy) LIFEXP, and public expenditure of education EDUR. We assume that the effect of health and education on output depends only on the average level of health and education in the economy and not on its distribution. For policy purposes, we estimate the effect of increasing health on average; particular health interventions that affect different sections of society in different ways may have a greater or lesser effect than this. Taking logs of the aggregate production function, we derive an equation for the log of Output in time t:

$$\ln GDP = \beta_1 + \beta_2 \ln GCF + \beta_3 \ln LF + \beta_4 \ln EDUR + \beta_5 \ln LIFEXP \qquad (7)$$

Where:

GDP is the real GDP

GCF is the real Capital Formation

LF is the total number of labor force

EDUR is the real expenditure on education

LIFEXP is the life expectation

The regression coefficients of Cobb Douglas type of such model indicate the elasticities of production inputs, especially for capital (GCF) and labor (LF), and sum of these elasticities indicate the nature of return to scale. These elasticities indicate the change in output if input is increased by one percent. The above model will be estimated for the purpose of the study.

III. EDUCATION

Education is well known to have a direct and positive effect on economic development, economic growth and productivity. For examples: Denison (1967, 1979), found that the growth in the real national income of the United States can be attributed to education. Same finding was found by Jamison and Lau (1982),.Lau and Yotopoulos (1989), and Hayami and Ruttan (1985)when examine the relationship between agricultural output and education There have also been numerous studies in which the economic benefit of education is measured in terms of its effect on the lifetime earnings of individual workers. The implied rate of return to the education is then estimated. This is the so-called 'Human Capital' approach, pioneered by Schultz (1961), and Psacharopoulos (1985) have summarized the many rate of return to education studies around the world. The found that the estimated rates of return to education are typically above, and sometimes considerably above, ten percent per annum in real terms. Some of the channels through which education affects economic growth, are productivity and development in general

Moreover, there is evidence from the experience of many countries that education, by enabling the acquisition of the necessary skills by the workers, is in fact a complementary input to physical capital and technology. Having physical and financial capital as well as access to technology is not enough: there must be the skilled manpower to make use of these resources. For example, the successes of South Korea and Taiwan in developing their respective economies and the failure of Thailand, until recently, to develop hers, may be partially attributed to the relatively lower level of educational development in Thailand in the 1960's and 1970's. By the late 1980's, however, Thailand has finally caught up with the level of educational development achieved by South Korea and Taiwan in the early 1960's and is now well on her way to becoming the fifth "Newly Industrialized Economy' (NIE). Lawrence J. Lau et al, 1991.

IV. HEALTH

Although labor quality, in the form of human capital, clearly contributes significantly to economic growth, most empirical studies identify human capital narrowly with education. Health has been ignored as a crucial aspect of human capital, and therefore a critical ingredient of economic growth. Healthier workers are physically and mentally more energetic and robust. They are more productive and earn higher wages. A substantial body of microeconomic evidence documents many of these effects (see Strauss & Thomas, 1998). Therefore this factor is included in the model to examine whether this micro evidence can be corroborated by macro evidence of an effect of population health on economic growth. Health, in the form of life expectancy, has appeared in many cross-country growth regressions, and investigators generally find that it has a significant positive effect on the rate of economic growth (see Bloom & Canning, 2000, 2003).

V. DATA AND METHODOLOGY

Data for all the variables used in this paper is from the Word Development Indicators WID for the period 1985-2005 and Statistical Abstract of Kingdom of Bahrain 1999. Data used in any econometric model have to be tested. Why do we need to test for Non-Stationarity? Often, ordinary least squares (OLS) is used to estimate the slope coefficients of the autoregressive model. Use of OLS relies on the stochastic process being stationary. When the stochastic process is non-stationary, the use of OLS can produce invalid estimates. Granger and Newbold (1974) called such estimates 'spurious regression' results: high R^2 values and high t-ratios yielding results with no economic meaning.

In statistics, a **unit root test** tests whether a time series variable is non-stationary using an autoregressive model. The most famous test is the augmented Dickey–Fuller test. Another test is the Phillips–Perron test. Both these tests use the existence of a unit root as the null hypothesis. To estimate the slope coefficients, we can

- assume the process is stationary (has no unit roots) and use OLS, or
- Assume that the process has a unit root, and apply the difference operator to the series. OLS can then be applied to the resulting (stationary) series to estimate the remaining slope coefficients.

When data are non-stationary undesired outcomes can be deducted:

- The stationarity or otherwise of a series can strongly influence its behavior and properties e.g. persistence of shocks will be infinite for nonstationary series
- Spurious regressions. If two variables are trending over time, a regression of one on the other could have a high *R*2even if the two are totally unrelated
- If the variables in the regression model are not stationary, then it can be proved that the standard assumptions for asymptotic analysis will not be valid. In other words, the usual "*t*-ratios" will not follow a *t*-distribution, so we cannot validly undertake hypothesis tests about the regression parameters.

However, non-stationary variables may be used in the regression if they prove to be cointegrated. There are three approaches to the problem of spurious regression. The first approach is to difference the data before estimating. The second approach is to add the lags of the dependent variable. Finally, one may consider using the co-integration technique. In statistics and econometrics, an **augmented Dickey–Fuller test (ADF)** is a test for a unit root in a time series sample. It is an augmented version of the Dickey–Fuller test for a larger and more complicated set of time series models. The augmented Dickey–Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit roots at some level of confidence.

The testing procedure for the ADF test is the same as for the Dickey–Fuller test but it is applied to the model:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_p \Delta y_{t-p} + \varepsilon_t$$

Where α is a constant, β the coefficient on a time trend and *p* the lag order of the autoregressive process. Imposing the constraints α = 0 and β = 0 corresponds to modeling a random walk and using the constraint β = 0 corresponds to modeling a random walk with a drift. Consequently, there are three main versions of the test, analogous to the ones discussed on the Wikipedia page for the Dickey-Fuller test. See that page for a discussion on dealing with uncertainty about including the intercept and deterministic time trend terms in the test equation.

By including lags of the order *p* (Greek for 'rho') the ADF formulation allows for higher-order autoregressive processes. This means that the lag length *p* has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannan-Quinn information criterion.

The unit root test is then carried out under the null hypothesis γ = 0 against the alternative hypothesis of γ < 0. Once a value for the test statistic $DF_\tau = \hat{\gamma}/SE(\hat{\gamma})$ is computed it can be compared to the relevant critical value for the Dickey–Fuller Test. If the test statistic is less (this test is non symmetrical so we do not consider an absolute value) than (a larger negative) the critical value, then the null hypothesis of γ equals 0 is rejected and no unit root is present. Data of the model have been tested for the presence of unit root. The order of integration for each variable is determined using Augmented Dickey and Fuller (ADF).

TABLE 1. Augmented Dickey and Fuller (ADF) results

Variable	Constant	Constant and Trend	No Constant & No Trend
Log Level			
GDP	1.512438*	-4.187269**	4.210184

GCF	-2.847097***	-2.795717	0.010574
EDU	-0.907019	-0.684128	-2.272120**
Life-Exp.	-4.377699*	-2.241464	7.135603
LF	-3.945703*	-2.762839	1.125484
Log First Difference			
GDP	-4.102311*	-4.34970**	-2.399985*
GCF	-5.797241*	-5.791444*	-5.929008*
EDU	-7.392807*	-7.331152*	-2.366345**
Life-Exp.	-3.753402*	-4.975804*	-2.030484**
LF	-1.691456	-3.841241**	-2.478209**

*Reject Null Hypothesis (unit root) at 1%

**Reject Null Hypothesis (unit root) at 5%

Tables.1 shows the empirical and stationarity tests results which indicate that the variables are non stationary in levels, however, with first difference they become stationary, thus they are I(1). Co-integration test are necessary to be examined to reflect the long run and stable relationship between the variable exist. The results of the unit root and test are reported in table 1 suggest that all the variables contain a unit root. Since the five variables are noted to be I(1), there exist the possibility that they share a long run equilibrium using cointegration test as stated by Engle and Granger (1987).

VI. COINTEGRATION TEST

Empirical research in macroeconomics as well as in financial economics is largely based on time series. Ever since Economics Laureate Trygve Haavelmo's work it has been standard to view economic time series as realizations of stochastic processes. This approach allows the model builder to use statistical inference in constructing and testing equations that characterize relationships between economic variables.

Some applied studies including a study of (Nelson and Plosser (1982) and study of Phillips (1987) stated that much of the time series are unstable because they contain a unit root, where the presence of unit root in any series time to the lack of independence of the average and the variability of the variable for time. The procedure results in a relationship downward time series, which already contain the root of unity in the standard models, a correlation false, including problems in the analysis and reasoning Standard (Granger and Newbold), and (Rao). Therefore, the will be time series analysis of the variables under study to test the stability of time series over time and determine the degree of integration by testing the relationship equilibrium, and test the causal relationship in the short and long-terms. Before testing the existence of the relationship between long-term real GDP (RGDP), and other variable in the model, and the analyze of the behavior of the relationship in the short term, time series should be test to confirm their stability over time and determine the degree of integration. If an OLS regression is estimated with non-stationary data and residuals, then the regression is spurious.

Cointegration is a statistical property possessed by some time series data that is defined by the concepts of stationarity and the order of integration of the series. A stationary series is one with a mean value which will not vary with the sampling period. For instance, the mean of a subset of a series does not differ significantly from the mean of any other subset of the same series. Further, the series will constantly return to its mean value as fluctuations occur. In contrast, a non-stationary series will exhibit a time varying mean. The order of integration of a series is given by the number of times the series must be differenced in order to produce a stationary series. A series generated by the first difference is integrated of order 1 denoted as I(1). Thus, if a time series, is I(0), it is stationary, if it is I(1) then its change is stationary and its level is non-stationary. To overcome this problem the data has to be tested for a unit roots (i.e. whether it is stationary.

Cointegration is said to exist between two or more non-stationary time series if they possess the same order of integration and a linear combination (weighted average) of these series is stationary. Thus, if x_t and y_t are non-stationary and are of the same order, there may exist a number b such that, the residual series, g_t, $(= y_t - bx_t)$ is stationary. In this case x_t and y_t are said to be cointegrated with a cointegrating factor of b.

The significance of cointegration analysis is its intuitive appeal for dealing with difficulties that arise when using non-stationary series, particularly those that are assumed to have a long-run equilibrium relationship. For instance, when non-stationary series are used in regression analysis, one as a dependent variable and the other as an independent variable, statistical inference becomes problematic [Granger and Newbold, 1974]. Cointegration analysis has also become important for the estimation of error correction models (ECM). The concept of error correction refers to the adjustment process between short-run disequilibrium and a desired long run position. As Engle and Granger (1987) have shown, if two variables are cointegrated, then there exists an error correction data generating mechanism, and vice versa. Since, two variables that are cointegrated, would on average, not drift apart over time, this concept provides insight into the long-run relationship between the two variables and testing for the cointegration between two variables such as RGDP and labor force would also be a test of the validity of an error correction specification involving these variables. With regard to testing procedures for the error correction model, once cointegration is ascertained, then the residuals from the cointegrating test, lagged one period, are used in a vector autoregression involving the appropriate differencing of the series (to ensure stationarity) forming the hypothesized relationship. The empirical results of these relationships are presented in the following tables.

The trace and Max eigenvalue statistic for testing the rank of cointegration are shown in Tables 2 and 3, respectivaly. The results of both tests deny the absence of cointegrating relation between petroleum and cereals prices series. Furthermore, both tests suggest the presence of one cointegrating equation at 5% level.

TABLE 2. Co integration results

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value 0.05	Prob.**
None *	0.890024	137.791	88.8038	0.0000
At most 1 *	0.780627	84.8109	63.8761	0.0003
At most 2 *	0.659501	48.4034	42.9153	0.0129
At most 3	0.436358	22.5472	25.8721	0.1228
At most 4	0.306586	8.7871	12.5179	0.1939

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

TABLE 3. Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.890024	52.97991	38.331	0.0006
At most 1 *	0.780627	36.40752	32.118	0.0140
At most 2 *	0.659501	25.85624	25.823	0.0495
At most 3	0.436358	13.76008	19.387	0.2706
At most 4	0.306586	8.787088	12.518	0.1939

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Co-integration tests are presented in Tables 4 and 5, respectively. These results suggest that a long run and stable relationship between the variables exists. Further, the results indicate that real gross domestic product (GDP) has a long run significant impact on gross capital formation (GCF).

TABLE 4. Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I)

LGDPF1	LGCF	LEDUR	LLF	LLIFEXP	@TREND(81)
-13.92	-0.42	-0.735	-24	188.78	0.959888
40.973	-1.6	0.0228	138	-628.3	-3.880617
-2.012	-0.98	17.98	-121	327.89	2.198285
4.2204	5.45	-7.127	112	-258.5	-2.683937
-5.406	0.88	-5.57	-78	445.11	1.400675

TABLE 5. Unrestricted Adjustment Coefficients (alpha)

D(LGDPF1)	0.0319	-0.0095	0.0086	0.0023	-0.0102
D(LGCF)	0.1086	0.0418	-0.0567	-0.1769	-0.0139
D(LEDUR)	0.012	-0.0416	-0.0501	-0.0125	0.0121
D(LLF)	-0.005	-0.001	-0.0001	-0.0008	-0.0003
D(LLIFEXP)	-0.0012	-1.87E-05	-0.00052	0.00019	-0.000929

VII. ERROR CORRECTION MODEL

We have rejected the null hypothesis of no cointegration. The Error Correction model ECM is then formed using the residual lagged one time period as the error correction term. The ECM models the short-run dynamics of the model. As with short-run models including lags, it can be used for forecasting. The coefficient on the error correction term can be used as a further test for cointegration.

The error correction term tells us the speed with which our model returns to equilibrium following an exogenous shock. It should be negatively signed, indicating a move back towards equilibrium; a positive sign indicates movement away from equilibrium. The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment The following ECM was formed and the following results were found:

$$\Delta GDP = 0.119 - 1.944\Delta LF - 0.814 LIFEXP + 0.0405 GCF - 0.152 EDUR - 0.457 ECT(-1)$$
$$(0.03038)\ (1.0209)\ \ (3.2395)\ \ (0.0239)\ \ (0.0900)\ \ (0.1317)$$
$$R^2 = 0.54 \qquad DW = 1.94$$
$$SE\ is\ in\ parentheses$$

The error correction term has a t-statistic of -3.47, which is highly significant (P=0.0026) supporting the cointegration result. The coefficient on the error correction term is negative, so the model is stable. The coefficient of -0.457, suggests 45.7% movement back towards equilibrium following a shock to the model, one time period later.

VIII. VARIEANCE DECOMPOSITIONS

The cointegration analysis so far only suggests the long-run associations amongst variables in the analysis. However, our objective is also to examine the relative strength of each variable in explaining the changes in the dependent variable. Here, we implement an unrestricted VAR model. From the model, we generate variance decompositions (VDCs) and Impulse Response functions (IRFs) to capture the relative importance of various shocks and their influences on our variable of interest. The orderings that we have chosen are: DGDP, DGCF, DLIFEXP, DLF, and DEDUR. This is based on the assumption that GDP influence DGCF, DLIFEXP, DLF, and DEDUR.

Tables .6, 7, 8, 9, and 10 show the variances decomposition of the GDP over 6 periods. The statistics indicate the percentage contribution of innovations in each of the variables in the system to the variance of the GDP. *The results show that shocks to the GDP itself*, Life Expectation LIFEXP, *the Labor Force LF, Education EDUR over all horizons*. Not much can be attributed to Gross Capital Formation GCF although over longer horizons its relative contribution increases.

More importantly, the variance decomposition of the Gross Capital Formation GCF (Tables .6 to .10) shows that apart from innovations to GCF itself, GDP contributes significantly to the variations in the GCF. *We can conclude that the basic transmission mechanism runs from base GDP to Gross Capital Formation.* Further the contribution of innovations in the Life Expectation LIFEXP suggests that much variation in LIFEXP will enhance GCF, and this supported by (Strauss & Thomas, 1998). Fewer contributions were reflected by LF and EDUR.

TABLE 6. Variance Decomposition of DGDP

Peri	S.E.	DGDP	DGCF	DLIFE	DLF	DEDU

od				XP		R
1	0.036	100.0	0.000	0.000	0.000	0.000
2	0.048	63.65	0.513	26.09	6.855	2.897
3	0.050	58.43	0.999	30.37	6.953	3.252
4	0.056	58.71	0.851	30.85	5.944	3.644
5	0.059	56.72	0.837	32.53	6.111	3.809
6	0.063	54.48	0.917	34.45	6.083	4.071

TABLE 7. Variance Decomposition of DGCF

Period	S.E.	DGDP	DGCF	DLIFEXP	DLF	DEDUR
1	0.464	8.959	91.04	0.000	0.000	0.000
2	0.541	6.640	85.52	6.498	0.634	0.711
3	0.675	12.48	81.63	4.829	0.563	0.504
4	0.739	10.93	82.68	5.317	0.483	0.592
5	0.813	10.98	82.84	5.112	0.506	0.562
6	0.878	10.65	83.06	5.229	0.488	0.573

TABLE 8. Variance Decomposition of DLIFEXP

Period	S.E.	DGDP	DGCF	DLIFEXP	DLF	DEDUR
1	0.003	11.11	0.001	88.89	0.000	0.000
2	0.003	8.820	3.004	87.81	0.293	0.073
3	0.004	11.87	2.254	85.41	0.217	0.256
4	0.004	10.24	2.853	86.21	0.454	0.226
5	0.005	9.645	2.655	86.99	0.435	0.278
6	0.005	9.228	2.754	87.31	0.437	0.274

TABLE 9. Variance Decomposition of DLF

Period	S.E.	DGDP	DGCF	DLIFEXP	DLF	DEDUR
1	0.004	4.993	4.439	33.11	57.45	0.000
2	0.005	4.398	2.390	29.19	62.18	1.837
3	0.006	4.142	1.737	23.65	69.16	1.311
4	0.007	4.456	1.493	23.86	68.79	1.396
5	0.008	3.954	1.233	23.19	70.39	1.238
6	0.009	3.831	1.097	22.69	71.19	1.194

TABLE 10. Variance Decomposition of DEDUR

Period	S.E.	DGDP	DGCF	DLIFEXP	DLF	DEDUR
1	0.104	33.42	0.124	0.815	6.019	59.62
2	0.160	37.82	13.30	7.711	11.28	29.90
3	0.191	42.75	9.487	6.623	10.64	30.51
4	0.219	43.96	10.78	6.784	10.73	27.75
5	0.241	44.74	9.588	6.812	11.02	27.84
6	0.264	45.80	9.663	6.771	11.05	26.71

The variance decomposition of the Life Expectation is shown in the table *.The figures indicate that a shock to the LIFEXP itself is highly significant.* Furthermore contribution is noted to shocks of GDP, this comes from the fact that an increase in the level national income will improve LIFEXP. But less contribution is found to the shock of GCF.

More importantly, the variance decomposition of the Labor Force LF shows that apart from innovations to the LF itself, Life Expectation contribute significantly to the variations in the Labor force, and more less to GDP.

Finally, the table shows the variance decomposition of the Education EDUR. The greater contribution of innovations in the Education suggests that much of its volatility is the result of GDP (even in the long run). One will also note the increasing contribution of the LF over time.

IX. GRANGER CASUALTY TEST

To test the existence of a long-run relationship between each two variables, we also implemented the Granger Causality test within an error-correction framework. To analyze the relationship between, causality among these variables using the method developed by Granger (1969). Granger causality test is one of the most interesting and widely used VAR applications. The intuition behind it is simple: If previous values of variable X significantly influence current values of variable Y, then one can say that X causes Y. Since this technique is used in a number of economic studies, only brief explanations of these method is provided below.

A general specification of the Granger causality test in a bivariat (X, Y) context can be expressed as follows:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \cdots + \alpha_l Y_{t-l} + \beta_1 X_{t-1} + \cdots + \beta_l X_{t-l} + \varepsilon$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \cdots + \alpha_l X_{t-l} + \beta_1 Y_{t-1} + \cdots + \beta_l Y_{t-l} + \varepsilon$$

The existence of a long-run relationship between two variables for example GDP and GCF means that both variables are causally related at least one direction. But, whether change in variable is causing change in the second variable is still unknown. In order to learn the direction, we implemented the Granger causality test. We can obtain two tests from this analysis: the first examines the null hypothesis that the GDP does not Granger-cause GCF, and the second test examines the null hypothesis that the GCF does not Granger-cause the GDP. If we fail to reject the former null hypothesis and reject the latter, then we conclude that GDP changes are Granger-caused by a change in GCF. Therefore this test involves the examination of the statistical significance of the parameters of X in Eq. (9) and those of Y in Eq. (10). To verify the existence of a long-run relationship between each two variables, F-statistics and probability values are constructed under the null hypothesis of noncausality in Table (11). It can be observed that there is a causal relationship between GDP and EDUR. However, our results show that one-way causality exists only from GDP to EDUR. The important finding is that causal relationship between GDP and LF is indicated, in one way direction from GDP to LF. Regarding GDP and LIFEXP, causality has been found in one way direction from GDP to LIFEXP. Finally, it can be seen that there a causality relationship between LIFEXP and LF in one way direction.

TABLE 11. Pairwise Granger Causality Tests Lags: 1

Probability	F-Statistic	Obs.	Null Hypothesis:
0.75195	0.10256	24	DGCF does not Granger Cause DGDPF1
0.43715	0.62744		DGDP does not Granger Cause

			DGCF
0.84381	0.03979	24	DEDUR does not Granger Cause DGDPF1
0.10106	2.94129		DGDP does not Granger Cause DEDUR
0.33901	0.95730	24	DLF does not Granger Cause DGDPF1
0.06479	3.79818		DGDP does not Granger Cause DLF
0.99847	3.8E-06	24	DLIFEXP does not Granger Cause DGDPF1
0.02912	5.48466		DGDP does not Granger Cause DLIFEXP
0.92387	0.00935	24	DEDUR does not Granger Cause DGCF
0.12791	2.51230		DGCF does not Granger Cause DEDUR
0.67846	0.17674	24	DLF does not Granger Cause DGCF
0.48309	0.50980		DGCF does not Granger Cause DLF
0.38861	0.77511	24	DLIFEXP does not Granger Cause DGCF
0.33106	0.99004		DGCF does not Granger Cause DLIFEXP
0.11365	2.72527	24	DLF does not Granger Cause DEDUR
0.71676	0.13522		DEDUR does not Granger Cause DLF
0.34556	0.93108	24	DLIFEXP does not Granger Cause DEDUR
0.99532	3.5E-05		DEDUR does not Granger Cause DLIFEXP
0.07007	3.64291	24	DLIFEXP does not Granger Cause DLF
0.23580	1.48961		DLF does not Granger Cause DLIFEXP

X. Empirical Results: Elasticities and Return to Scale

The Cobb-Douglas production function is used to test the elasticity of output GDP with respect to capital and labor. In this approach, the output elasticity with respect to each input must be estimated from production function using the share of each variable of the model. The logarithm production function stated in equation (5) is tested to include different variables starting from the full form i.e. Including all variable, eliminating some variables, and finally, to include only the two inputs Labor Force LF and Gross Capital Formation GCF as shown in table .12.

TABLE 12. The Elasticity and return to Scale Coefficients

Expl. Variable	Coefficients	Model1 OLS	Model 2 AR(2)	Model3 AR(2)	Model 4 AR(2)	Mode5 AR(2)
Cons	β_1	22.23	-10.5	-	-9.919	0.642
ln LF	β_2	2.9016***	1.338***	1.6887***	1.2338*	1.616***
lnGCF	β_3	0.120***	0.068**	0.064***	0.04907***	0.0492*
ln Lifexp	β_4	-8.59*	3.460	-	3.4884	-
ln EDUR	β_5	-0.5**	-0.13	-0.11	-	-
Adj. R^2		0.96	0.98	0.987	0.98	0.982
D-W		1.19	1.65	1.62	1.561	1.56

They indicate that the output elasticity of labor for the economy is greater than one and higher than capital elasticity, indicating that the real GDP is elastic with respect to LF. The elasticity of real GDP with respect to capital is less than one (inelastic) In other words, during the past two decades, the Bahrain economy relied more heavily on labor than capital in production processes. The important thing is that the coefficient of the inputs Labor force and Gross Capital Formation are mostly highly significant. Moreover, the adjusted R^2 is high in all models. Durbin-Watson statistics are all in line with high degree of model performance, except for model1.

The size of the return to scale in the aggregate production function has important implications for many questions in macroeconomics. Analyses of business cycle, growth rate, and the scope of government policy depend fundamentally on whether there constant return to scale (CRS), or increasing return to scale (IRS). For example, with IRS, indicates the importance of government policies (fiscal and monetary policies) to be used to improve economic welfare.

Regarding economic growth, if aggregate production function technology is CRS and depend on measured inputs of capital and labor, then log-run growth could determined by technological factors, while model which exhibit IRS can imply that economic growth is largely due to increase accumulated factors. All tested models exhibit increasing return to scale (IRS). But, the more important factor is the labor force.

XI. CONCLUSION

The main objective of this paper is to adopt an economic approach for making the most of Bahrain's factors of production, and other factors such as LIFEXP and EDUR, that will have a great impact on enhancing the level of output (Gross Domestic Product-GDP). Several approaches have been used for this purpose. VAR technique was used to examine the variability of the GDP of Bahrain. Important finding of this analysis is that Life expectation, Labor force, EDUR have a significant impact on the level of GDP, and less contribution is found by GCF. In addition, the contribution of innovations in all explanatory variables of the model comes from the variability of the GDP. This indicates the existence of mutual influence between the dependent variable (GDP) and the independent variables of the model. At a time where we see the effect of independent variables on the dependent variable, we find that this change has a positive impact on improving the independent variables later.

The Aggregate Cobb-Douglas production function is used to test the elasticity of output (GDP) with respect to labor (LF) and capital (GCF). Because of the Autoregressive problem, (AR) was added to the base model. The results indicate that the elasticity output (GDP) with respect of labor input is greater than one, indicating that the real GDP is elastic with respect to LF, and highly significant for all tested models. The elasticity of output with respect of capital GCF was found highly significant, but, it is inelastic.

More important, the Aggregate Cobb-Douglas production function indicates that the output of Bahrain experiences an increasing return to scale (IRS), which imply that economic growth is largely due to an increase in the accumulated factors of production (labor and capital). Life expectancy and real spending on education are less important due to the negative signs in the base model (OLS), but positive with other tested models. The adjusted R^2 is high in all models. Durbin-Watson statistics are all in line with high degree of model performance, except for model1.

Some interesting conclusions can be made. First, with regard to the output level GDP of Bahrain, our findings indicate that a major effect can be attributed to the Labor Force input, and it is highly significant factor. Therefore priorities should be given to enhancing the labor force in order to achieve high performance of the Bahrain economy. Second, the capital formation is less important as a factor of production, however it requires more attention to utilize this resource of production, to make essential contribution to the level of output. Hence, Bahrain economy relied more heavily on labor than capital in production processes. Thirdly, any policy adopted by Bahrain government to enhance the level of output will actually have mutual influences between dependent variable and independent variables, so it will improve the education and better life for Bahraini people.

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