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AN ECONOMETRIC STUDY OF THE EFFECT OF GROWTH IN OIL EXPORT ON THE SAUDI ARABIAN ECONOMY 1970 – 1982

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بسم الله الرحمن الرحيم

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INTRODUCTION:

In this study we investigate empirically the relationship between the economic development of the Kingdom of Saudi Arabia (K.S.A.) and the growth of its oil exports during the period 1970-1982. The choice of this particular time period was governed mainly by the availability of disaggregated sectoral time-series data suitable for intensive econometric work. The period also coincides with that of rapid growth in revenue from the export sector due to the expansions in the production of oil and the rise in its prices since late 1973.

The study is divided into six sections. Section I reviews briefly the existing economic literature on export-led growth models. Section 2 outlines the main economic characteristics of the K.S.A. Section 3 presents the models used for the empirical work and briefly describes the data used. Section 4 and 5 address themselves to the empirical analysis of the results obtained. The final section summarizes the main findings of the study.

1- Export Led Growth Models: A Theoretical Discussion :

The relationship between export performance and economic growth has been a subject of considerable interest to development economists. Experience has tended to demonstrate that developing countries with favourable exports record usually enjoy higher rates of national income growth. Obviously, since exports are a component of aggregate output, one would expect a strong positive association between the two. But several empirical studies demonstrate that exports contribute to the growth of Gross Domestic Product (GDP) more than just the change in the volume of exports. See for example Balassa[1] , Heller and Porter [6] , Metwally and Tamaschke [8], Michaely [9] and Tyler [12].

The particular mechanism by which exports could act as an 'engine of growth' or 'leading sector' and the determinants of the over-all impact of an export stimulation of the economy have been also well discussed in the literature. Baldwin [2] , Bhagwati et. al [4] , Emery [5], Metwally and Tamaschke [8] and Syron and Walsh [11] among others considered various theoretical and empirical aspects of this particular mechanism.

Exports contribute to economic growth directly through its contributions to the GDP and indirectly through its contributions per medium of spread or carry-over effects. The indirect contribution to growth embraces Hirschmann- type[1] linkages. These linkages embody various beneficial aspects of exports such as greater capacity utilization, economies of scale, incentives for technological improvements, efficient

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(1) See Hirschman [7]

management plus various other intra and intersectoral spread and spill-over effects. These linkages can broadly be considered as operating through a sequence of multiplier - accelerator mechanisms. Theoretically, indirect contributions - or spread-effects - can continue to accrue long after some export stimulus has occurred. The overall impact of an export stimulus on the economy has many determinants including technology, the propensity to import, the extent to which investment opportunities generated are accepted domestically, the ability to attract foreign factors and soon. Provided that investment opportunities generated by the export sector are exploited, the model predicts that economic growth will be a process of diversification about an export base.

2- Main Economic Characteristics of K.S.A.:

The Kingdom of Saudi Arabia (K.S.A.) is an oil-producer developing economy. She contributes over 25 percent of total OPEC oil exports and over 1/8 of world supply of this vital commodity. Unlike some other oil producers, K.S.A. has been exporting oil for quite a time. Hence it would not be unreasonable to investigate the possibility of oil exports acting as a leading sector. This is particularly so given the significance of this sector to the K.S.A. economy.

The value of crude oil production and exports in 1981 were 42 times their levels in 1970. This substantial increase in oil revenue was reflected in the standard of living in the country. Thus GDP and per capita GDP increased substantially over the period. In 1981 total GDP (in money terms) was 30 times it level in 1970. (2)

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(2) In real terms i.e. at fixed prices, the K.S.A., GDP in 1981 was over 3 times its level in 1971.

This substantial increase has resulted in a per capita income very close to that of USA. This impressive increase in GDP has taken place after the oil embargo in 1973 and the consequent export price rises. It is therefore, attributable to the performance of the export sector and especially to the increasing oil prices. The rise in export prices relative to those of imports must be regarded as a real gain to the K.S.A. economy.

The K.S.A. economy witnessed a significant change in the pattern of demand for resources since the 1973 oil boom as can be seen from the data in table (2.1) below:

Table (2.1)

Structure of K.S.A. Demand for Resources
(percentages)

Expenditure	1970	1974	1978	1982
Government consumption	19.7	9.9	20.8	19.5
Private consumption	33.7	9.9	24.2	24.1
Gross Capital Formation	16.2	9.3	33.1	24.6
Exports	59.2	86.3	62.4	67.6
Imports	28.8	15.4	40.5	35.8

Sources: IMF International Financial Statistics, 1983, Year book and January 1984.

Exports as a percentage of GDP reached its highest level in 1974. The opposite happened with respect to all other expenditures. However, the economy adjusted itself a few years after but did not follow the same path as before 1974. The share of private consumption declined while that of Gross Domestic Capital Formation (GFCF) - particularly in Building and Construction - increased sharply. Also a larger percentage of demand is met through imports. Government consumption as a percentage of GDP remained more or less the same. However, the share of exports, though declined compared to its unusually high level in 1974 remained significantly high. Exports in 1982 accounted for two thirds of the demand for resources in the K.S.A. economy. Almost 49 percent of these exports are crude oil and petroleum products.

On the production side, almost one-half of K.S.A. GDP is contributed by the oil sector.(3) This percentage reached 63 percent in 1974.

Table (4.2) gives the percentage contribution of the different sectors to GDP in K.S.A. The data in this table show that the share of the oil sector was at its lowest level in 1981/1982 due to the slump in oil exports. The only sectors whose contribution increased significantly over the period were the Building and Services Sectors. A building boom seems to have taken place since 1974-a feature shared by many oil producers whose capacity to absorb capital productively is relatively limited. Also some observers suggest that the services sector in many developing countries act merely as a "residual" and its expansion need not be a rigorous indicator of economic development.

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(3) K.S.A. Ministry of Planning; Achievements of Development Plans: Facts and Figures, 1390-1402H. (in Arabic)

Table (2.2)

Percentage Contribution of Sectoral Output in K.S.A.

Sector	1969/70	1973/74	1977/78	1981/82
1. Agriculture, Forestry	5.7	3.6	3.5	3.4
2. Mining & Quarrying	0.3	0.3	0.3	0.3
3. Manufacturing	2.4	2.1	2.8	3.7
4. Electricity, Gas & Water	1.6	1.3	1.6	2.6
5. Building & Construction	4.1	3.9	10.0	10.7
6. Transportation & Storge	7.1	7.0	6.1	6.8
7. Other services	22.4	17.1	25.9	30.7
The Oil Sector	55.0	63.4	49.1	41.3

Source: Achievements of Developments Plans; Facts and Figures 1390-1402H; K.S.A. Ministry of Planning.

The manufacturing sector is gaining ground but at a very slow rate and only since 1977. However, the percentage contribution of this sector is extremely low. Hence the only sector that could possibly act as a leading sector is the Oil sector.

The K.S.A. economy witnessed many significant developments in the areas of health, education, manpower training and in the quality of life. Thus while the structure of the economy may not have changed significantly, its performance and infrastructure have definitely improved.

3- The Model and the Data:

The postulated relationship between exports growth and GDP over time is central to the 'exports as an engine of growth' model. Theoretically exports can contribute to economic development directly and indirectly along the lines discussed in Section 1.

The first direct contribution could best be captured by a simple model which relates the GDP variable to exports. Thus

$$Y = \phi (X) \quad \ldots\ldots\ldots \quad (3.1)$$

Where Y is the GDP income variable
and X is the exports variable

Two functional forms could be used on model (3.1). If a constant response of GDP to exports variation is postulated, then a linear relationship of the form

$$Y_t = \beta_o + \beta_1 X_t \quad \text{——————} \quad (3.2)$$

would suffice. However, if a non constant response is deemed more appropriate then a logarithmic functional form of the type

$$Y_t = \beta_o X_t^{\beta_1}$$

could be suitable.

As for the second indirect contribution of exports to growth in GDP, we note that the spread and spill-over effects generally take time and may operate per medium of sequences of multiplier - accelerator mechanisms. The theory says little or nothing about the nature of these dynamic mechanisms and little or nothing about the length of the time periods which might actually be involved. The question then remains an empirical one. In an attempt to address the question, we deployed two types of lag mechanisms to model that dynamic element present in the spread models. The first type consists of using first period and second period free lags to estimating equations of the form

$$Y_t = \beta_o + \beta_1 X_t + \beta_2 X_{t-1} + \epsilon_t \quad \text——————} \quad (3.3)$$

$$Y_t = \beta_o + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 X_{t-2} + \epsilon_t \quad \text——} \quad (3.4)$$

for the constant response linear models and

$$Y_t = \beta_o X_t^{\beta_1} X_{t-1}^{\beta_2} e^{\epsilon_t} \quad \text{---------- (3.5)}$$

$$Y_t = \beta_o X_t^{\beta_1} X_{t-1}^{\beta_2} X_{t-2}^{\beta_3} e^{\epsilon_t} \quad \text{---------- (3.6)}$$

for the nonconstant nonlinear models. The second type consists of a geometrically-declining weights Koyck-type lag mechanism achieved through the imposition of a suitable partial adjustment mechanism to a relationship of the type

$$Y^* = \phi(X)$$

where now Y^* stands for optimal GDP and $\phi(.)$ may be linear or nonlinear. The rationale for this change of variable specification being that because of the presence of various institutional and sectoral bottlenecks, the K.S.A. economy is more likely to lie off its production possibility frontier leading to a discrepancy between optimal output and actual output. The response of optimal output to variations in exports would thus follow a retarded path through a partial adjustment mechanism.

This second type lag mechanism is more general than the finite length free lags since it could be shown to correspond to an infinite length free-type lag which would reflect spread effects continuing onto the infinite horizon. The partial adjustment mechanism in the linear case

$$Y_t = \beta_o + \beta_1 X_t \quad \text{---------- (3.8)}$$

assumes the linear form

$$Y_t - Y_{t-1} = \gamma (Y_t^* - Y_{t-1})$$

where $0 < \gamma < 1$ is the adjustment parameter. This would lead to an estimable relationship of the form

$$Y_t = \gamma\beta_o + \gamma\beta_1 X_t + (1 - \gamma) Y_{t-1} + \epsilon_t$$

$$\text{or } Y_t = \delta_o + \delta_1 X_t + \delta_2 Y_{t-1} + \epsilon_t \qquad \text{---------- (3.9)}$$

As for the logarithmic formulation

$$Y_t^* = \beta_o X_t^{\beta_1} \qquad \text{---------- (3.10)}$$

we stipulate a geometric partial adjustment mechanism of the form

$$\frac{Y_t}{Y_{t-1}} = \left(\frac{Y_t^*}{Y_{t-1}} \right)^{\gamma} e^{\epsilon_t}$$

which would lead to a log-linear estimating equation of the form:

$$\log Y_t = \gamma \log \beta_o + \gamma\beta_1 \log X_t + (1 - \gamma) \log Y_{t-1} + \epsilon_t$$

or $\log Y_t = \delta_o' + \delta_1' \log X_t + \delta_2 \log Y_{t-1} + \epsilon_t$ ----------(3.11) (4)

For both types of models (3.9) and (3.11) we expect a priori

$$\delta_1 > 0 \quad ; \quad \delta_1' > 0$$

and

$$0 < \delta_2 < 1$$

Similar considerations to those cited above, apply to relationships connecting the investment variable to exports variations. Indeed (5)

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(4) After simple reparameterization and change of variables, it could be seen that both equations (3.9) and (3.11) assume the form

$$Z_t = w_o + w_1 F_t + w_2 Z_{t-1} + \epsilon_t$$

which in turn could be shown to correspond to an infinite length free lag model since

$$Z_t - w_2 Z_{t-1} = w_o + w_1 F_t + \epsilon_t$$

$$Z_t = \frac{w_o}{1 - w_2} + \frac{w_1}{1 - w_2 L} F_t + \frac{1}{1 - w_2 L} \epsilon_t$$

$$= \frac{w_o}{1 - w_2} + w_1 \sum_{j=0}^{\infty} w_2^j F_{t-j} + \sum_{j=0}^{\infty} w_2^j \epsilon_{t-j}$$

$$\text{or } Z_t = w_o + \sum_{j=0}^{\infty} \Theta^j F_{t-j} + \epsilon_t^*$$

where L is the lag operator and ϵ_t^* is a new infinite length moving-average random error component.

(5) See Metwally and Tamaschke [8]

> " . . . Investment analysis is crucial to export-led growth models of development. It is essential that the investment opportunities generated by the expansion in exports be fully exploited. This requires that investment not only responds to the growth in exports but must be of the 'right' type - ie. in directions which result in expanding the output of the affected industries. If that happens, the productive capacity of the economy would expand and diversification around the export base will take place."

To test these conjectures we used four models similar to those of the GDP-export relationship. The first two rested on the - somewhat restrictive - static current period formulation with its linear and log-linear variants. Thus

$$I_t = \beta_o + \beta_1 X_t \qquad \text{(3.12)}$$

and

$$I_t = \beta_o X_t^{\beta_1}$$

with its log-linear form

$$\log I_t = \log \beta_o + \beta_1 \log X_t \qquad \text{(3.13)}$$

Investment, however, is a variable which does not respond instantaneously to its stimuli - exports included. The presence of bottlenecks, gestation periods, lags between capital appropriations and expenditures plus various other institutional lags necessitate a partial adjustment of actual investment to an optimal or desired level. Again we used discrete free lags of various lengths and superimposed a partial adjustment process on the optimal investment equation - in both cases leading to a staggered response of investment to variations in exports.

Again both linear and log-linear forms were tried. Thus in the case of free weights we used equations o the form

$$I_t = \beta_o + \beta_1 X_t + \beta_2 X_{t-1} + \epsilon_t \qquad \text{(3.14)}$$

for one-period lags, and

$$I_t = {}_o + {}_1 X_t + {}_2 X_{t-1} + {}_3 X_{t-2} + {}_t \text{ ------} \quad (3.15)$$

for two-period lags in the linear case. In the log-linear case we have

$$\log I_t = \log {}_o + {}_1 \log X_t + {}_2 \log X_{t-1} + {}_t \text{ -----} \quad (3.16)$$

for one- period lags and

$$\log I_t = \log {}_o + {}_1 \log X_t + {}_2 \log X_{t-1} + {}_3 \log X_{t-2} + t \text{--} (3.17)$$

for two-period lags. In the case of the K oyck lags the estimating equations assume the form

$$I_t = {}_o + {}_1 X_t + {}_2 Y_{t-1} + {}_t \text{ ----------} \quad (3.18)$$

for the linear case and

$$\log I_t = {}_o + {}_1 \log X_t + {}_2 \log Y_{t-1} + {}_t \text{ -----} \quad (3.19)$$

for the log-linear formulation.

Ordinary least Squares (OLS) was then employed to estimate the parameters of the above derived equations for GDP-exports and for investment-exports relationships.[6] To guage the effectiveness of the resultant estimated relationships the usual summary test statistics are deployed. Thus the adjusted R^{-2} are used to test for the adequacy of the fit, F-values to check for the significance of the whole relationship and t-statistics are reported beneath each parameter estimate to detect the significance of their attached coefficients. Other reported statistics include Durbin-Watson D.W. and Durbin's h statistics, both designed to discover autocorrelated error contaminations, the latter being used in

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(6) The short time series used necessitated the use of Ordinary Least Squares method since other estimation methods ,e.g maximum likelihood and Instrumental Variable, usually require much longer time series to achieve their optimal properties.

the case of lagged dependent explanatory variables. The importance of these statistics, however, cannot be overly stressed since values for the D.W. statistics are usually provided for samples of size 15 at least whereas our sample now is composed of 13 observations only. The h-statistic on the other hand is a large sample test an thus its validity for our small sample remains suspect. However, we chose to report these statistics since they may serve as a rough indicator of the presence and severity of autocorrelated ailments thought to plague our data.(7)

As for the data used in the study, it consisted of annual observations covering the period 1970-1982. All variables were measured at constant prices to suppress any inflationary effects. Data on GDP, Gross Fixed Capital Formation (GFCF) were obtained both at the aggregate economy level and at the disaggregated sectoral levels. Data on exports were aggregative and were deflated by the industrialized counries export unit value index. The sectoral classification used on the GDP variable included:

- The Non-oil Sector.
- Agriculture, Forestry and Fisheries
- Mining and Quarrying (excluding oil)
- Manufacturing
- Electricity, Gas and Water
- Building and Construction
- Transportation, Storage and Communications
- Other Services
- Non-oil private sector
- Non-oil Government sector.

While that on the GFCF variable included

- The Government Sector
- The Private Sector
- The Oil Sector
- The Non-oil Sector.

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(7) Due to the small numbers of observations, it is not possible to carry out transformations, that may get rid of problems of serial coorelation existing. The use of Generalised Least Squares may result in a less of data points without apparent gains in efficiency.

- Building & Construction.
- Transport Equipment.
- Other Construction.
- Machinery and Equipment.

4. Exports and the Gross Domestic Product - The Empirical Results:

The empirical analysis of the relationship connecting GDP to exports was conducted both at the aggregate level and at various levels of sectoral disaggregation. Two functional forms were used on each relationship. The linear form was firstly tried as a preliminary estimate and then a log-linear formulation was subsequently estimated - the latter form embodying a non-constant impact on the economy over-time of an export stimulus of given intnsity.

For both forms we started by the simplest relationship which ignores spread effects. These effects which include accelerator mechanisms are captured by the introduction of dynamic lags i nto the estimated relationship along the lines discussed before.

The results of the application of OLS to the GDP-Exports model are listed in tables (4-1) to (4-22).

The aggregate results are provided in tables (4-1) and (4-2)[8] The first table contains results on the linear model while the second table contains results on the log-linear model. The static model for both forms provides a good fit with $\bar{R}^2$ being respectively 0.755 and 0.776 for the linear and log-linear forms. The response of GDP to variations in current period exports is both positive and significant as judged by the magnitudes, signs and the t-values of the parameter estimates.

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(8) GDP here includes that from the Oil Sector.

Table (4.1)

Exports and Gross Deomestic Product
1970 - 82.

The Linear Models

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	Y_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.1.1)	Y_t	20.119 (5.385)	0.086 (5.635)				0.755	31.76	1.470	
(4.1.2)	Y_t	19.161 (7.101)	0.048 (2.906)	0.047 (3.080)			0.874	35.6	1.213	
(4.1.3)	Y_t	18.600 (8.255)	0.046 (3.372)	0.020 (1.102)	0.039 (2.152)		0.913	36.0	1.398	
(4.1.4)	Y_t	5.583 (3.271)	0.016 (2.015)			0.835 (10.623)	0.982	269.62		0.569

values in parenthesis are t statistics.

Table (4.2)

Exports and Gross Domestic Product
1970 - 82

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	In X_t	In X_{t-1}	In X_{t-2}	In Y_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.2.1)	In Y_t	1.435 (3.864)	0.418 (5.962)				0.776	35.5	1.324	
(4.2.2)	In Y_t	1.428 (4.744)	0.226 (2.298)	0.199 (2.385)			0.852	29.9	0.971	
(4.2.3)	In Y_t	1.521 (5.462)	0.180 (1.922)	0.091 (0.917)	0.144 (1.657)		0.879	25.2	0.887	
(4.2.4)	In Y_t	0.536 (3.228)	0.042 (0.814)			0.813 (8.333)	0.974	187.7		0.343

values in parenthesis are t statistics.

The introduction of lagged terms improves the fit markedly and in the case of first period lags the coefficients remain statistically significant in both linear and log-linear forms with the pattern of the lag coefficients declining by a small amount through time. However with the addition of second period lags as in equations (4-1-3) and (4-2-3) this pattern is no longer maintained. The coefficient of X_{t-1} becomes insignificant at 5% level in the linear model whereas all the coefficients apart from the constant term are insignificant at 5% level in the log-linear form. The results on the Koyck-type lags given in equations (4-1-4) and (4-2-4) provide the best fit. The linear model proves to be a superior model as compared to the log-linear form with this particular sample since the coefficient of current exports proves to be statistically insignificant at 5% level in the log-linear form - a somewhat implausible result. Thus among the eight equations in table (4-1) (4-2), equations (4-1-2), (4-2-2) and (4-1-4) could be judged as adequate to base inferences upon. Spread effects are positive, significant and decline through time through the response of GDP to exports. Equation (4-4-4) provides an estimate of the magnitude of the adjustment coefficient $\hat{\gamma}$, since

$$0.835 = 1 - \hat{\gamma}$$
$$\hat{\gamma} = 0.165$$

which is a low adjustment level pointing to the presence of possible bottlenecks hampering the quick adjustment of GDP to its optimal level in response to variations in exports - a result confirmed by an expected lag length of approximately 5 years to completion.(9)

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(9) The expected or mean log is computed as $\frac{1-\hat{\gamma}}{\hat{\gamma}}$

The significance of the coefficients of the export variable X may be a reflection of the simple fact that exports are a component of GDP. In order to suppress this component effect we excluded the contribution of the oil sector from GDP. The results for the linear form are given in table (4-3) whereas those for the log-linear form are given in table (4-4). The linear form does marginally better than its log-linear counterpart in terms of the number of statistically significant coefficients. X_t is a significant variable in the static model (4-3-1) but the exclusion of spread effects may have resulted in a somewhat depressed $\bar{R}^2$. Indeed upon inclusion of first period lags, (4-3-2) shows a somewhat improved fit of 0.848 level but the response pattern now increases from X_t to X_{t-1} which may point to the fact that first period lagged exports may be a more important determinant than current period exports. This would happen in the presence of severe bottlenecks affecting the Non-Oil sectors. We turn to the Koyck-type equations (4-3-4) and (4-4-4) for support of this hypothesis. The coefficient of Y in (4-3-4) is greater than one, contrary to our a prior restriction and in general the equation is rather poor as judged by the insignificance of the intercept and the current period export variable. These poor results may be attributable to the presence of a problem of multicollinearity between the explanatory variables since the F-value points to the significance of the whole relationship whereas the t-values indicate the insignificance of two of its constituent explanatories. Equation (4-4-4) of the log-linear Koyck type specification is statistically more plausible to base inferences concerning the adjustment coefficients upon. Indeed, $\hat{\gamma}$ gives 0.062 which is an extremely low value supporting the presence of bottlenecked sectors in the economy. The response of Non-oil GDP to the export variable is slower than that of total GDP which may point to the fact that GDP of the oil sector responds more fully than that of the Non-oil sector.

The analysis was carried to a further level of disaggregation to investigate the relationship between sectoral outputs and exports. We examined the responsiveness of five main sectors to changes in exports. A priori it is expected that the growth in exports revenues

Table (4.3)

Exports and GDP of the Non-oil Sector

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	Y_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.3.1)	Y_t	5.053 (1.547)	0.060 (4.511)				0.659	202	1.388	
(4.3.2)	Y_t	4.169 (1.901)	0.025 (1.870)	0.043 (3.495)			0.848	290	1.242	
(4.3.3)	Y_t	3.682 (2.110)	0.024 (2.224)	0.020 (1.419)	0.034 (2.419)		0.906	33.0	0.960	
(4.3.4)	Y_t	0.355 (1.038)	0.003 (1.176)			1.074 (31.638)	0.997			1.540

values in parenthesis are t statistics.

Table (4.4)

Exports and GDP of the Non-oil Sector
1970 - 82

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	In X_t	In X_{t-1}	In X_{t-2}	In Y_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.4.1)	In Y_t	-0.495 (-0.718)	0.631 (4.843)				0.692	23.5	1.190	
(4.4.2)	In Y_t	-0.509 (-0.971)	0.245 (1.430)	0.401 (2.761)			0.923	24.2	0.893	
(4.4.3)	In Y_t	-0.324 (-0.712)	0.153 (0.999)	0.188 (1.151)	0.285 (2.009)		0.871	23.6	0.571	
(4.4.4.)	In-Y_t	0.013 (0.169)	0.053 (2.132)			0.938 (28.000)	0.997	1421.8		0.885

values in parenthesis are t statistics.

would stimulate the output of these sectors by differing degrees through backward, forward and final demand linkages as well as through less direct spread and transmission effects.

The first sector to be treated was the Agriculture, Forestry and Fisheries sector. The importance of this sector stems from the fact that it provides the means of livelihood for the majority of the population. Private investment is small in this sector. Most of the investments remain public in nature and are directed towards the provision of the necessary infrastructures - dams, canals etc... - for a later takeoff.

Thus results for the Agriculture, Forestry and Fisheries sector are provided in table (4-5) with the linear forms and in table (4-6) with the log-linear forms. Similar patterns to those of the Non-oil sector are discernable. The current period formulation provides a good relationship in terms of the individual coefficients. However, the fit is somewhat inadequate due possibly to the neglect of spread and carry-over effects. The introduction of these factors through first and second period lags significantly increased the fit as judged by the now higher $\bar{R}^2$ but adversely affected the significance of the individual coefficients possibly due to the presence of a multicollinearity problem between the successive lagged terms of the export variable. Further support of the possibility of a multicollinearity problem is detected in the Koyck-type equation where the individual coefficients, except that of Y_{t-1}, proved insignificant. The coefficient of Y_{t-1} itself exceeds 1 in value which is contrary to our a priori expectations. Thus as far as the Agriculture, Forestry and Fisheries sector is concerned the static formulation is adequate but first period lagged spread effects may be present.

Results for the Mining and Quarrying sector - excluding oil - are given in table (4-7) for the linear form and in table (4-8) for the log-linear form. Current period exports play a significant role in the determination of GDP of this sector. However, unexplained variation

Table (4.5)

Exports and Sectoral GDP

1- Agriculture, Forestry & Fisheries

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	G_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.5.1)	G_t	0.913 (7.453)	0.0021 (4.201)				0.625	17.6	1.401	
(4.5.2)	G_t	0.883 (9.617)	0.001 (1.595)	0.002 (2.873)			0.792	20.1	1.110	
(4.5.3)	G_t	0.866 (10.496)	0.001 (1.681)	0.001 (1.042)	0.001 (1.741)		0.834	17.8	0.889	
(4.5.4)	G_t	-0.065 (-0.545)	0.0001 (0.198)			1. 092 (8.766)	0.960	121.6		0.044

values in parenthesis are t statistics.

Table (4.6)

Exports and Sectoral GDP

1- Agriculture, Forestry and Fisheries 1970-82.

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	In X_t	In X_{t-1}	In X_{t-2}	In G_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.6.1)	In G_t	-1.083 (-3.004)	0.264 (3.872)				0.583	15.0	1.023	
(4.6.2)	In G_t	-1.089 (-3.532)	0.093 (0.920)	0.177 (2.075)			0.695	12.4	0.690	
(4.6.3)	In G_t	-1.014 (-3.314)	0.056 (0.539)	0.091 (0.832)	0.115 (1.206)		0.712	9.2	0.481	
(4.6.4)	In G_t	0.053 (0.376)	-0.002 (-0.075)			1.049 (10.938)	0.971	166.1		-0.316

values in parenthesis are t statistics.

due to the omission of the carryover effects resulted in a low R^2. Introduction of first and second period lags accounting for the spread effects, increased the $\bar{R}^2$ but introduced a multicollinearity problem resulting in insignificant coefficients related to the X variable and its lagged terms. The log-linear Koyck model did better than its linear counterpart but X_t was again insignificant. The adjustment coefficient was 0.44 which reflects a relatively speedy adjustment of this sector to variations in the export variable with a mean lag of estimated length 1.3 years - a result which we alluded to as a possibility earlier on.

The Manufacturing sector in K.S.A. is still in its infancy. It contributes a small proportion to the total GDP. Heavy industry is absent and the major source of finance and capital remains the private investors though the government has recently begun to invest in directly producing activities such as petrochemical industries. Thus, results for the effect of exports on GDP originating in the Manufacturing sector are given in tables (4-9) and (4-10). The best equation could be cited as (4-10-2) where first period carry over effects are present whereas the current period exports variable is statistically insignificant. Again, the Koyck-type equations (4-9-4) and (4-10-4) show evidence of multicollinearity with high F-values coupled with insigniciant - and often showing the wrong negative sign - individual coefficients. To worsen things the adjustment coefficients lie outside the premissible range of 0 to 1.

Similar considerations apply to the services sector of Electricity, Gas and water, where only the static formulation could be considered adequate - reference to tables (4-11) and (4-12). The logarithmic formulation is superior in terms of fit and the significance of the intercept term to the linear case.

The construction sector in K.S.A. includes public and private projects for both commercial and residential purposes. The results on the empirical models for this sector are shown in table (4-13) and (4-14).

Table (4. 7)

Exports and Sectoral GDP

2- Mining and Quarrying 1970 - 82.

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	q_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.7.1)	q_t	60.663 (3.517)	0.250 (3.545)				0.536	12.6	1.239	
(4.7.2)	q_t	56.692 (4.104)	0.092 (1.090)	0.195 (2.493)			0.707	13.0	1.573	
((4.7.3)	q_t	53.434 (5.147)	0.082 (1.299)	0.037 (0.442)	0.225 (2.713)		0.837	18.1	1.572	
(4.7.4)	q_t	23.670 (1.512)	0.088 (1.331)			0.693 (3.490)	0.793	20.2		0.173

values in parenthesis are t statistics.

Table (4.8)

Exports and Sectoral GDP

2. Mining and Quarrying 1970-82

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	In X_t	In X_{t-1}	In X_{t-2}	In q_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.8.1)	In q_t	2.142 (4.074)	0.487 (4.907)				0.700	24.1	1.47	
(4.8.2)	In q_t	2.134 (4.531)	0.262 (1.699)	0.234 (1.793)			0.757	16.6	1.793	
(4.8.3)	In q_t	2.338 (6.809)	0.160 (1.383)	-0.002 (-0.016)	0.316 (2.947)		0.876	24.6	1.963	
(4.8.4)	In q_t	1.168 (2.096)	0.184 (1.310)			0.560 (2.591)	0.815	23.0		- 0.196

values in parenthesis are t statistics.

Table (4.9)

Exports and Sectoral GDP

3. Manufacturing 1970 -82.

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	M_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.9.1)	M_t	270.2 (1.279)	3.645 (4.215)				0.626	17.8	1.321	
(4.9.2)	M_t	213.0 (1.502)	1.369 (1.575)	2.808 (3.499)			0.834	26.1	1.203	
(4.9.3)	M_t	187.6 (1.465)	1.291 (1.653)	1.572 (1.543)	1.756 (1.715)		0.866	22.6	0.693	
(4.9.4)	M_t	- 38.918 (-3.582)	0.006 (0.0798)			1.185 (64.837)	0.099	6259.3		0.719

values in parenthesis are t statistics.

Table (4.10)

Exports and Sectoral GDP

3. Manufacturer 1970 - 82.

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	$\ln X_t$	$\ln X_{t-1}$	$\ln X_{t-2}$	$\ln M_{t-1}$	$\bar{R}^2$	F.	D.W.	h
(4.10.1)	$\ln M_t$	3.721 (5.029)	0.603 (4.316)				0.638	18.6	1.018	
(4.10.2)	$\ln M_t$	3.708 (6.093)	0.229 (1.149)	0.389 (2.303)			0.755	16.4	0.710	
(4.10.3)	$\ln M_t$	3.868 (6.526	0.149 (0.747	0.204 (0.959)	0.247 (1.339)		0.777	12.6	0.429	
(4.10.4)	$\ln M_t$	-0.170 (-1.689)	-0.003 (-0.174)			1.046 (44.435)	0.998	3038.7	0.486	

values in parenthsis are t statistics.

Table (4.11)

Exports and Sectoral GDP

4. Electricity, Gas & Water 1970-82

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	E_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.11.1)	E_t	69.815 (0.379)	2.494 (3.303)				0.498	10.9	1.005	
(4.11.2)	E_t	28.013 (10.187)	0.831 (0.907)	2.053 (2.426)			0.674	11.4	0.904	
(4.11.3)	E_t	13.884 (0.090)	0.787 (0.837)	1.366 (1.114)	0.977 (0.792)		0.658	7.428	0.558	
(4.11.4)	E_t	-82.839 (-1.611)	0.070 (0.232)			1.320 (10.830)	0.964	134.6		0.810

values in parenthesis are t statistics.

Table (4.12)

Exports and Sectoral GDP

4. Electricity, Gas and Water
1970-82.

The Logarithmic Models:

Eq. No.	Dep. vb.	Constant Term	In X_t	In X_{t-1}	In X_{t-2}	In E_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.12.1)	In E_t	3.098 (2.816)	0.609 (2.929)				0.431	8.581	8.580	
(4.21.2)	In E_t	3.088 (2.794)	0.326 (0.901)	0.294 (0.959)			0.426	4.712	0.516	
(4.12.3)	In E_t	3.237 (2.758)	0.251 (0.637)	0.122 (0.290)	0.230 (0.628)		0.379	3.035	0.401	
(4.12.4)	In E_t	-0.640 (-0.919)	0.008 (0.067)			1.120 (6.928)	0.909	50.700		0.842

values in parenthesis are t statistics.

The non-linear equation (4-14-1) reflects better results on fit and statistical significance of the individual coefficients than the linear model given by (4-13-1). There is also same evidence of first and second period lagged spread effects in this sector and the adjustment of GDP emanating in this sector to its optimal level in response to variations in exports earnings is somewhat retarded as reflected by the low adjustment coefficients of 0.045 for the linear model and 0.215 for the log-linear model.

The transportation, storage and communications sector is defined in the National Accounts to include:

1- Oil pipelines
ii- Postal, Telephone and Telegraph.
iii- Airline, Railway and Ports.
iv- Mechanized Road Transport which started to grow since 1960 with the construction of major roads to link the Kingdom's cities and coasts. The first three items are government owned.

The best equation for this sector is the static linear formulation (4-15-1) where current exports plays a somewhat statistically significant role - but with a low magnitude for the coefficient - in the determination of sectoral GDP. There is no evidence as to the presence of spread over effects in this sector as judged by our empirics which may seem a somewhat surprising result since most mechanized equipment must be imported and arranging for the delivery and construction of such items usually involves lengthy time periods.

The other services sector is classified to include the following components of the national GDP statistics:

i - Banking, Insurance and Real Estate.
ii - Public Administration and Defence.
iii- Education and Health.
iv - Other services - mainly Religious and Ministry of Information activities.

Table (4.13)

Exports and Sectoral GDP

5. Building and Construction
1970-82.

The Linear Models:

Eq. No.	Dep. vb.	Constant Term	X_t	X_{t-1}	X_{t-2}	B_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.13.1)	B_t	3.776 (0.459)	0.133 (3.949)				0.593	15.6	1.271	
(4.13.2)	B_t	1.653 (0.280)	0.049 (1.341)	0.104 (3.125)			0.794	20.3	0.910	
(4.13.3)	B_t	0.210 (0.050)	0.044 (1.699)	0.034 (1.009)	0.099 (2.935)		0.894	29.2	1.253	
(4.13.4)	B_t	3.464 (1.411)	0.011 (0.685)			0.955 (9.644)	0.964	134		1.803

values in parenthesis are t statistics.

Table (4.14)

Exports and Sectoral GDP
5- Building & Construction
1970-82.

The Logarithmic Models:

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In B_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.14.1)	In B_t	-2.190 (-1.952)	1.044 (4.929)				0.708	24.3	1.475	
(4.14.2)	In B_t	-2.216 (-3.262)	0.306 (1.379)	0.766 (4.068)			0.890	41.4	1.091	
(4.14.3)	In B_t	-1.893 (-4.422)	0.145 (1.006)	0.392 (2.561)	0.499 (3.741)		0.958	77.1	1.180	
(4.14.4)	In B_t	-0.177 (-0.388)	0.197 (1.572)			0.785 (8.271)	0.965	137.3		1.360

values in parenthesis are t statistics.

The sector contributes about 15% of the total GDP in the economy.(10)

The results for this sector are provided in tables (4-17) and (4-18). They indicate some evidence of the presence of carryover effects upto the second period in the linear model (4-17-3) where X_{t-1} is statistically significant at 10% level. This equation possess a relatively high $\bar{R}^2$ of magnitude 0.918 and hence could be accepted as the best equation for this sector.

As for the Non-oil private sector the linear model performs better than the log-linear variant since it possess more statistically significant coefficient compared to the latter. There is evidence of current period and second period lagged spread effects as judged by (4-19-3) whereas X_{t-1} proves insignificant at 5% level.

For the Non-oil government sector similar conclusion could be drawn but in addition, the non-linear static form (4-22-1) and the non-linear Koyck-type equation (4-22-4) are also statistically significant, the latter showing an adjustment parameter for this sector of magnitude 0.128.

Thus to summarize, we have attempted to study aggregate and sectoral output determination via the introduction and use of exports earnings variables. Static formulations were tried and spread effects both at the economy and the intra-sectoral levels were then imposed in the form of lags.

At the aggregate level a log-linear formulation proved adequate and pointed to the possibility of bottlenecks operating in the economy and hampering its adjustment to its optimal level. There was some evidence that the GDP of the oil sector may respond more fully than that of the Non-Oil sector.

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(10) See F. Bashir [3] pp. 46.

Table (4.15)

Exports and Sectoral GDP

6- Transporation, Storage and Communications
1970-82.

The Linear Mod els:

Eq.No.	Dep. vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	T_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.15.1)	T_t	1.042 (2.763)	0.006 (3.784)				0.571	14.3	0.998	
(4.15.2)	T_t	0.995 (2.644)	0.004 (1.727)	0.002 (1.076)			0.579	7.86	1.063	
(4.15.3)	T_t	0.951 (2.513)	0.004 (1.666)	0.0001 (0.048)	0.008 (1.009)		0.579	5.592	0.781	
(4.15.4)	T_t	0.255 (0.624)	0.002 (1.187)			0.753 (2.723)	0.750	16.0		0.270

values in parenthesis are t statistics.

Table (4.16)

Exports and Sectoral GDP

6- Transportation, Storage and Communications
1970-82.

The Logarithmic Models:

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In T_t	$\bar{R}^2$	F.	D.W.	h
(4.16.1)	In T_t	-1.289 (-1.729)	0.396 (2.811)				0.408	7.903	0.700	
(4.16.2)	In T_t	-1.289 (1.631)	0.384 (1.486)	0.012 (0.054)			0.335	0.708	0.708	
(4.16.3)	In T_t	-1.396 (-1.396)	0.307 (1.125)	-0.167 (-0.573)	0.239 (0.942)		0.325	2.606	0.594	
(4.16.4)	In T_t	-0.504 (-0.702)	0.158 (0.990)			0.657 (2.207)	0.586	8.087		0.406

values in parenthesis are t statistics.

Table (4.17)

Exports and Sectoral GDP

7- Other Services

1970-82.

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	S_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.17.1)	S_t	2.330 (1.339)	0.033 (4.581)				0.700	21.0	1.470	
(4.17.2)	S_t	1.840 (1.688)	0.013 (1.962)	0.024 (3.906)			0.871	37.7	1.270	
(4.17.3)	S_t	1.601 (1.828)	0.012 (2.317)	0.013 (1.800)	0.017 (2.359)		0.918	38.2	0.988	
(4.17.4)	S_t	0.179 (0.835)	0.002 (1.278)			1.067 (26.242)	0.996	1156.5		-0.107

values in parenthesis are t statistics.

Table (4.18)

Exports and Sectoral GDP

7- Other Services
1970-82

The Logarithmic Models:

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In S_{t-1}	$\bar{R}^2$	F.	D.W.	h
(4.18.1)	In S_t	-1.305 (-1.807)	0.659 (4.833)				0.691	23.4	1.346	
(4.18.2)	In S_t	-1.320 (-2.651)	0.220 (1.348)	0.456 (3.305)			0.853	30.0	0.889	
(4.18.3)	In S_t	-1.149 (-2.622)	0.134 (0.908)	0.258 (1.643)	0.226 (1.943)		0.891	28.2	0.535	
(4.18.4)	In S_t	-0.050 (-0.371)	0.060 (1.533)			0.933 (18.539)	0.992	628.2		-.786

values in parenthesis are t statistics.

Table (4.19)

Exports and GDP

8- Non-oil Private Sector
1970-82

The Linear Models:

Eq.No.	Dep. vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$(NOPS)_{t-1}$	$\bar{R}^2$	F.	D.W.	h
(4.19.1)	($NOPS_t$	3.719 (1.713)	0.039 (4.415)				0.649	19.5	1.363	
(4.19.2)	$NOPS_t$	3.139 (2.111)	0.016 (1.774)	0.029 (3.383)			0.838	26.8	1.230	
(4.19.3)	$NOPS_t$	2.827 (2.292)	0.015 (2.022)	0.013 (1.354)	0.022 (2.190)		0.890	27.9	0.922	
(4.19.4)	$NOPS_t$	0.053 (0.182)	0.001 (0.580)			1.102 (25.388)	0.995	1028.9		0.712

values in parenthesis are t statistics.

Table (4.20)

Exports and GDP

8- Non-oil private sector

1970 - 82.

The Logarithmic Models:

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In$(NOPS)_{t-1}$	$\bar{R}^2$	F.	D.W.	h
(4.20.1)	In$(NOPS)_t$	0.688 (-1.018)	0.594 (4.657)				0.674	21.7	1.107	
(4.20.2)	In$(NOPS)_t$	-0.700 (-1.298)	0.238 (1.348)	0.370 (2.376)			0.792	20.1	0.835	
(4.20.3)	In$(NOPS)_t$	-0.526 (-1.075)	0.150 (0.915)	0.168 (0.960)	0.270 (1.770)		0.836	18.0	0.564	
(4.20.4)	In$(NOPS)_t$	-0.007 (-0.074)	0.040 (1.258)			0.945 (21.376)	0.994	788.6		0.402

values in parenthesis are t statistics.

Table (4.21)

Exports and Sectoral GDP

9- Non-oil Government Sector

1970-82

The Linear Models:

Eq.No.	Dep. vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$(NOGS)_{t-1}$	$\bar{R}^2$	F.	D.W.	h
(4.21.1)	$NOGS_t$	1.350 (1.239)	0.021 (4.711)				0.679	22.2	1.438	
(4.21.2)	$NOGS_t$	1.050 (1.471)	0.009 (2.078)	0.015 (3.636)			0.864	32.8	1.266	
(4.21.3)	$NOGS_t$	0.877 (1.688)	0.009 (2.701)	0.006 (1.515)	0.012 (2.884)		0.929	44.6	1.079	
(4.21.4)	$NOGS_t$	0.280 (1.812)	0.002 (1.775)			1.005 (22.093)	0.994	855.6		0.570

values in parenthesis are t statistics.

Table (4.22)

Exports and Sectoral GDP

4- Electricity, Gas and Water
1970-82.

The Linear Models:

Eq.No.	Dep. vb.	Const.Term	$\ln X_t$	$\ln X_{t-1}$	$\ln X_{t-2}$	$\ln(NOGS)_t$	$\bar{R}^2$	F.	D.W.	h
(4.22.1)	$\ln(NOGS)_t$	-2.052 (-2.831)	0.711 (5.194)				0.722	27.0	1.366	
(4.22.2)	$\ln(NOGS)_t$	-2.068 (-4.186)	0.266 (1.646)	0.462 (3.375)			0.871	34.7	1.051	
(4.22.3)	$\ln(NOGS)_t$	-1.866 (-4.854)	0.165 (1.278)	0.229 (1.663)	0.312 (2.600)		0.925	42.1	0.623	
(4.22.4)	$\ln(NOGS)_t$	-0.172 (-1.200)	0.096 (2.612)			0.872 (19.969)	0.994	809.0		0.307

values in parenthesis are t statistics.

As for the sectoral results, there was no uniform and consistent set of empirics, but in general it was found that the introduction of lags to account for spread effects usually increased the fit and generally pointed to the possibility of bottlenecks resulting in spread effects acting through time.

5. Exports and Investment: The Empirical Results:

The models developed in section 3 for the analysis of the impact of export growth on investment were tested with the data. The results for the various specifications tried are listed in table (5-1) to (5-18) below.

The empirical analysis was conducted at both the economy-wide aggregate level and at various levels of sectoral disaggregation.

As for the aggregate level, the results are provided in table (5-1) and (5-2) for the linear and log-linear forms respectively. The degree of explained variation in the GFCF variable is high and increases substantially with the introduction and use of varying lag lengths. The logarithmic form does marginally better-despite a consistent negative intercept term - as compared to the linear form. Evidence of spread-over effects is more apparent for the investment variable - as compared to the previous income variable and as suggested by the significance of the coefficients of the lagged variables. The importance of spread-over effects is further manifested by the estimates of the adjustment coefficients j obtained as 0.156 in (5-14) and as 0.282 in (5-2-4) suggesting the presence of lagged effects in the response of actual investments to their desired levels.

The results for the Building and Construction sector are shown in table (5-3) and (5-4). The log-linear form proved better than the linear form in terms of the incidence of individually significant coefficients. Hence inference could be based upon it. The static form

Table (5.1)

Exports and Aggregate Investment
1970-82

The Linear Models:

Eq.No.	Dep. vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	I_{t-1}	$\bar{R}^2$	F.	D.W.	h
(5.1.1)	I_t	1.390 (0.469)	0.048 (3.973)				0.600	15.8	1.342	
(5.1.2)	I_t	0.517 (0.307)	0.014 (1.303)	0.043 (4.490)			0.871	34.8	1.469	
(5.1.3)	I_t	0.135 (0.103)	0.012 (1.528)	0.024 (2.315)	0.026 (2.503)		0.922	40.5	1.590	
(5.1.4)	I_t	0.186 (0.129)	0.015 (1.748)			0.844 (5.527)	0.906	49.1		0.003

values in parenthesis are t statistics.

Table (5.2)

Exports and Aggregate Investment
1970-82.

The Logarithmic Models:

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In I_{t-1}	$\bar{R}^2$	F.	D.W.	h
(5.2.1)	In I_t	-2.642 (-2.941)	0.944 (5.566)				0.750	31.0	1.493	
(5.2.2)	In I_t	-2.661 (-4.31)	0.378 (1.968)	0.588 (3.612)			0.893	42.7	1.500	
(5.2.3)	In I_t	-2.412 (-5.504)	0.253 (1.717)	0.299 (1.908)	0.386 (2.825)		0.943	56.0	1.707	
(5.2.4)	In I_t	-0.472 (-0.889)	0.242 (1.770)			0.718 (6.163)	0.951	98.1		-0.183

values in parenthesis are t statistics.

(5-4-1) gives a statistically significant X_t variable, but the relatively low $\bar{R}^2$ may suggest that there is still some room for improving the fit by the inclusion of other - possibly lagged - varaibles. This was accomplished and there was some evidence of the presence of lagged effects upto X_{t-2} The adjustment parameter gives an estimate of 0.107 magnitude which may reflect a slow adjustment of investment in this sector to appropriations stimuli spilling from the exports sector. Bottlenecks could develop in the delivery of material or in the execution of projects specially since a major proportion of materials used in construction are imports and that may lead to the occurence of substantial delivery lags.

Results on the other consturction sector are shown in tables (5-5) and (5-6). The log-linear form again does better than the linear form. The static form (5-6-1) provides a good fit explaining around 72% of the variations in sectoral investment. The introduction of first period lag in fact reduces $\bar{R}^2$ to 0.692 and the use of Koyck-type geometrically declining weights lag also does not improve the fit beyond that attained for the static case. This may point to the fact that spread effects are not predominant in this sector. The sector adjusts quickly to its desired investment levels as witnessed by the - somewhat high - adjustment coefficient of 0.645 attained in (5-6-4) which in turn would suggest a mean lag of 0.55 years governing the investments of this sector.

As for investments in the Transport equipment sector, results are provided in tables (5-7) and (5-8) - the log-linear form again proving to be superior compared to its linear counterpart in terms of the significant coefficients and the plausibility of its coefficients magnitudes. The response of this sector to exports stimuli is again retarded and may cover periods of 2.8 years in mean length as judged by its coefficient of adjustment estimate = 0.262.

Table (5.3)

Exports and Sectoral Investment

1- Building and Construction
1970-82.

The Linear Models:

Eq.No.	Dep. vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{b,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.3.1)	$I_{b,t}$	0.539 (0.723)	0.012 (3.788)				0.572	14.4	1.530	
(5.3.2)	$I_{b,t}$	0.333 (0.686)	1.135 (1.135)	0.010 (3.674)			0.821	23.9	1.528	
(5.3.3)	$I_{b,t}$	0.205 (0.657)	0.003 (1.553)	0.0038 (3.567)	0.0089 (3.567)		0.927	43.5	1.571	
(5.3.4)	$I_{b,t}$	0.315 (0.885)	0.001 (0.202)			1.004 (5.659)	0.904	27.92	2.813	

values in parenthesi are t statistics.

Table (5.4)

Exports and Sectoral Investments
1- Building and Construction
1970-82

The Logarithmic Models :

Eq.No.	Dep. vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{b,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.4.1)	In $I_{b,t}$	-3.488 (3.420)	0.849 (4.409)				0.648	19.4	1.773	
(5.4.2)	In $I_{b,t}$	-3.511 (-5.734)	0.176 (0.877)	0.699 (4.120)			0.873	35.5	1.639	
(5.4.3)	In $I_{b,t}$	-3.214 (-8.697)	0.027 (0.217)	0.336 (2.688)	0.459 (3.986)		0.956	72.9	1.352	
(5.4.4)	In $I_{b,t}$	0.129 (0.150)	0.025 (0.133)			0.893 (5.217)	0.910	51.5		-1.706

values in parenthesis are t statistics.

Table (5.5)

Exports and Sectoral Investments

2- Other Construction

1970-82

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{c,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.5.1)	$I_{c,t}$	1.174 (2.171)	0.011 (4.766)				0.685	22.7	1.896	
(5.5.2)	$I_{c,t}$	1.110 (2.033)	0.0081 (2.459)	0.003 (0.975)			0.683	11.8	1.935	
(5.5.3)	$I_{c.t}$	1.010 (2.061)	0.008 (2.654)	-0.0018 (-0.476)	0.0068 (1.749)		0.748	10.9	2.045	
(5.5.4)	$I_{c,t}$	0.883 (1.516)	0.0052 (1.041)			0.471 (1.192)	0.699	12.6		-0.741

values in parenthesis are t statistics.

Table (5.6)

Exports and Sectoral Investments

2- Other Construction
1970-82

The Logarithmic Models:

Eq.No.	Dep.vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{c,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.6.1)	In $I_{c,t}$	-2.036 (-3.241)	0.611 (5.152)				0.719	26.5	1.673	
(5.6.2)	In $I_{c,t}$	-2.042 (-3.107)	0.529 (2.496)	0.086 (0.479)			0.692	12.2	1.681	
(5.6.3)	In $I_{c,t}$	-1.831 (-3.084)	0.425 (2.161)	-0.165 (-0.778)	0.332 (1.791)		0.759	11.5	1.640	
(5.6.4)	In $I_{c,t}$	-1.045 (-0.881)	0.353 (1.223)			0.355 (0.982)	0.718	13.7		-0.763

values in parenthesis are t statistics.

Table (5.7)

Exports and Sectoral Investment

3- Transport Equipment

1970-82

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{T,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.7.1)	$I_{T,t}$	0.349 (0.536)	0.0082 (3.095)				0.462	9.580	0.900	
(5.7.2)	$I_{T,t}$	0.237 (0.392)	0.0038 (1.021)	0.0055 (1.614)			0.543	6.9	0.518	
(5.7.3)	$I_{T,t}$	0.134 (0.241)	0.0035 (1.020)	0.0005 (0.117)	0.0071 (1.597)		0.618	6.4	1.017	
(5.7.4)	$I_{T,t}$	0.430 (1.429)	0.0003 (0.141)			0.874 (0.874)	0.885	39.6		1.768

values in parenthesis are t statistics.

Table (5.8)

Exports and Sectoral Investments

3- Transport Equipment
1970-82.

The Logarithmic Models:

Eq.No.	Dep.vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{T,t-1}$	$\bar{R}^2$	F.	D.W.	
(5.8.1)	In $I_{T,t}$	-6.164 (-4.083)	1.266 (4.442)				0.652	19.7	1.396	
(5.8.2)	In $I_{T,t}$	-6.195 (-5.885)	0.355 (1.031)	0.946 (3.242)			0.831	25.5	0.642	
(5.8.3)	In $I_{T,t}$	-5.825 (-6.366)	0.170 (0.552)	0.517 (1.579)	0.574 (2. 010)		0.877	24.8	0.783	
(5.8.4)	In $I_{T,t}$	-1.051 (-0.854)	0.254 (1.060)			0.738 (5.264)	0.912	53.0		1.555

values in parenthesis are t statistics.

The Machinery and Equipment (other than Transport) sector provides some support for the existence of sectoral spread and carry-over effects especially in its log-linear form whose results are listed in table (5-10). Equation (5-10-2) points to the presence of first order logs in X_t with a high degree of fit - R^2 being 0.91. The Koyck formulation (5-10-4) supports this conjecture since all of its coefficients are significant and of the right sign and magnitude. The adjustment parameter in the Koyck accelerator mechanism is estimated at 0.394 which gives adjustments occuring over an expected period of 1.5 years - again in conformity with these use of the first period lag with the static form.

Results on the Oil sector as given by tables (5-11) and (5-12) may suggest that the response of investments in this sector to export stimuli may almost be instantaneous. Thus the static form - especially in its log-linear form - is adequate. Addition of lagged terms doesnot improve the fit and in some cases worsens the situation leading to the rejection of the presence of lagged effects in this sector. Exports are mainly oil. Proceeds from exports are ploughed back into investments in this same sector because of its importance as the leading sector and because of the comparative sectoral advantage it enjoys. Sectoral transmissions then operate leading to spillover and carryover effects from this sector into other sectors and this may take sometime to occur.

The Non-Oil sector shows an all together different pattern as compared to the Oil sector - evidence of tables (5-13) and (5-14). Adjustments are slow and transmissions and carry over effects are operative with expected lags of length 4 years for the Non-linear pattern.

Tables (5-15) to (5-18) give the results of investments carried by the Government sector and those carried by the private sector. The patterns are rather similar and suggest spread effects occuring over approximately 3.6 years in time.

Table (5.9)

Exports and Sectoral Investments

4- Machinery and Equipment *

1970-82

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{m,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.9.1)	$I_{m,t}$	-1.263 (-1.006)	0.020 (3.897)				0.587	15.2	1.276	
(5.9.2)	$I_{m,t}$	-1.633 (-2.280)	0.005 (1.214)	0.018 (4.479)			0.867	33.7	1.433	
(5.9.3)	$I_{m,t}$	-1.698 (-2.290)	0.005 (1.134)	0.015 (2.545)	0.005 (0.754)		0.860	21.5	1.374	
(5.9.4)	$I_{m,t}$	-0.913 (-1.292)	0.0091 (2.433)			0.843 (4.561)	0.871	34.7		-0.431

values in parenthesis are t statistics.

* Other than Transport.

Table (5.10)

Exports and Sectoral Investments

4- Machinery and Equipments*
1970-82.

The Logarithmic Models:

Eq.No.	Dep.v.b.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{m,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.10.1)	In $I_{m,t}$	-7.398 (-5.102)	1.546 (5.645)				0.755	31.9	1.328	
(5.10.2)	In $I_{m,t}$	-7.429 (-7.718)	0.640 (2.033)	0.940 (3.524)			0.914	42.4	1.336	
(5.10.3)	In $I_{m,t}$	-7.191 (-7.567)	0.520 (1.630)	0.664 (1.951)	0.370 (1.248)		0.899	30.723	1.675	
(5.10.4)	In $I_{m,t}$	-3.520 (-3.148)	0.756 (3.434)			0.606 (4.825)	0.930	67.0		-0.987

values in parenthesis are t statistics.

* Other than Transport

Thus to conclude this section, we notice that, over all, the statistical results on investment may suggest firstly that it responds nonlinearly to exports variations. Secondly, aggregate and sectoral results may point to the presence of lags and gestation periods of varying lengths in the different sectors - the arguement being that expansions in exports earnings stimulates investments, both at the aggregate and sectoral levels, by providing the necessary foreign exchanges to order and import different capital goods. Thirdly, the Oil sector proves to be the fastest to respond but the other sectors are affected after a period through spill-over mechanisms due to various delivery, behavioural, psychological and institutional lags.

Table (5.11)

Exports and Sectoral Investments

5- Oil Sector
1970-82

The Linear Models:

Eq.No.	Dep.v b.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{0,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.11.1)	$I_{o,t}$	0.509 (0.974)	0.008 (3.520)				0.533	12.4	1.480	
(5.11.2)	$I_{o,t}$	0.392 (0.894)	0.0031 (1.175)	0.006 (2.226)			0.675	11.4	1.777	
(5.11.3)	$I_{o,t}$	0.372 (0.796)	0.003 (1.087)	0.005 (1.218)	0.001 (0.364)		0.636	6.818	1.607	
(5.11.4)	$I_{o,t}$	0.156 (0.312)	0.004 (1.206)			0.687 (1.851)	0.632	9.582		-0.065

values in parenthesi are t statistics.

Table (5.12)

Exports and Sectoral Investments

5- Oil Sector
1970-82

The Logarithmic Models:

Eq.No.	Dep.v.b.	Const.Term	X_t	X_{t-1}	X_{t-2}	In $I_{o,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.12.1)	In $I_{o,t}$	-3.044 (-3.510)	0.705 (4.305)				0.637	18.53	1.843	
(5.12.2)	In $I_{o,t}$	-3.056 (-3.419)	0.543 (1.884)	0.169 (0.691)			0.614	8.97	1.749	
(5.12.3)	In $I_{o,t}$	-3.020 (-3.105)	0.525 (1.632)	0.126 (0.364)	0.056 (0.186)		0.693	5.27	1.696	
(5.12.4)	In $I_{o,t}$	-2.166 (-1.237)	0.518 (1.427)			0.227 (0.584)	0.608	8.76		0.080

values in parenthesis are t statistics.

Table (5.13)

Exports and Sectoral Investments

6- Non-oil Sector
1970-82.

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{no,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.13.1)	$I_{no,t}$	0.366 (0.148)	0.043 (4.207)				0.625	17.7	1.273	
(5.13.2)	$I_{no,t}$	-0.311 (-0.181)	0.017 (1.631)	0.0317 (3.294)			0.821	24.0	0.913	
(5.13.3)	$I_{no,t}$	-0.693 (-0.504)	0.016 (1.916)	0.013 (1.217)	0.0262 (2.387)		0.887	27.3	1.244	
(5.13.4)	$I_{no,t}$	0.498 (0.699)	0.0069 (1.498)			0.929 (10. 020)	0.969	156.8		1.047

values in parenthesis are t statistics.

(Table 5.14)

Exports and Sectoral Investments

6- Non-oil Sector
1970-82

The Logarithmic Models:

Eq.No.	Dep.vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{no,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.14.1)	In $I_{no,t}$	-3.385 (-3.015)	1.038 (4.896)				0.697	24.0	1.319	
(5.14.2)	In $I_{no,t}$	0.346 (-4.658)	0.724 (1.453)	(3.587)			0.869	34.2	0.989	
(5.14.3)	In $I_{no,t}$	-3.118 (-5.877)	0.189 (1.073)	0.347 (1.833)	0.499 (3.017)		0.935	48.9	1.210	
(5.14.4)	In $I_{no,t}$	-0.551 (-1.385)	0.211 (2.230)			0.903 (10.866)	0.978	226.9		1.412

values in parenthesis are t statistics.

Table (5.15)

Exports and Sectoral Investment

7- Government Sector
1970-82

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{g,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.15.1)	$I_{g,t}$	-0.322 (-0.217)	0.027 (4.433)				0.651	19.652	1.229	
(5.15.2)	$I_{g,t}$	-0..689 (0.602)	0.013 (1.865)	0.017 (2.688)			0.794	20.2	0.896	
(5.15.3)	$I_{g,t}$	-0.918 (-0.932)	0.012 (2.069)	0.006 (0.793)	0.016 (1.995)		0.850	19.8	1.144	
(5.15.4)	$I_{g,t}$	0.258 (0.541)	0.005 (1.440)			0.912 (8.964)	0.964	136.6		0.918

values in parenthesis are t statistics.

Table (5.16)

Exports and Sectoral Investments

7- Government Sector
1970-82.

The Logarithmic Models:

Eq.No.	Dep.vb.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{g,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.16.1)	In $I_{g,t}$	-4.405 (-3.700)	1.120 (4.983)				0.704	24.8	1.136	
(5.16.2)	In $I_{g,t}$	-4.453 (-4.886)	0.473 (1.608)	0.677 (2.714)			0.827	24.9	0.927	
(5.16.3)	In $I_{g,t}$	-4.087 (-5.756)	0.292 (1.242)	0.243 (0.961)	0.574 (2.593)		0.900	30.7	1.043	
(5.16.4)	In $I_{g,t}$	-0.784 (-1.630)	0.236 (2.251)			0.795 (10.389)	0.977	213.9		1.412

values in parenthesis are t statistics.

Table (5.17)

Exports and Sectoral Investments

8- Private Sector
1970-82.

The Linear Models:

Eq.No.	Dep.vb.	Const.Term	X_t	X_{t-1}	X_{t-2}	$I_{p,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.17.1)	$I_{p.t}$	0.688 (0.663)	0.015 (3.707)				0.560	13.7	1.301	
(5.17.2)	$I_{p,t}$	0.378 (0.606)	0.004 (1.074)	0.015 (4.148)			0.843	27.9	0.943	
(5.17.3)	$I_{p,t}$	0.225 (0.499)	0.004 (1.331)	0.007 (1.983)	0.011 (2.931)		0.919	39.0	1.395	
(5.17.4)	$I_{p,t}$	0.237 (0.588)	0.003 (1.236)			0.914 (7.303)	0.936	73.5		-733

values in parenthesis are t statistics.

Table (5.18)

Exports and Sectoral Investment

8- Private Sector
1970-82

The Logarithmic Models:

Eq.No.	Dep.v b.	Const.Term	In X_t	In X_{t-1}	In X_{t-2}	In $I_{p,t-1}$	$\bar{R}^2$	F.	D.W.	h
(5.18.1)	In $I_{p,t}$	-3.646	0.932				0.662	20.5	1.519	
		(-3.349)	(4.533)							
(5.18.2)	In $I_{p,t}$	-3.701	0.190	0.776			0.906	49.4	1.139	
		(-6.461)	(1.025)	(4.953)						
(5.18.3)	In $I_{p,t}$	-3. 430	0. 056	0. 456	0.424		0.966	94.3	1.497	
		(-9.668)	(0.475)	(3.601)	(3.836)					
(5.18.4)	In $I_{p,t}$	-0.682	0.207			0.784	0.943	84.4		0.026
		(-1.092)	(1.524)			(6.770)				

values in parenthesis are t statistics.

6. Conclusions

In this study we have investigated empirically the effect of growth in exports' earnings on the Saudi Arabian economy during the period 1970-1982. We focused our attention on the income variable and the investment variable. Certain hypotheses were advanced as to the presence and occurence of spread and carry-over effects both at the aggregate economy and the disaggregated sectoral levels. The hypotheses were incorporated in the models via the use of various forms and lengths of lags. They were then tested on aggregate and sectoral data using two functional forms.

Thus for the aggregate output equations we obtained spread effects which were positive, significant and declining in importance through time. Adjustment patterns were low at the economy-wide level pointing to the presence of bottlenecks hampering the quick adjustment of GDP to its optimal level in response to variations in exports' earnings.

The response of Non-Oil GDP to the exports' variable was found to be slower than that of total GDP which may point to the fact that GDP of the oil sector responds more fully than that of the Non-Oil sector.

At the disaggregated sectoral levels we obtained conflicting results on the presence of spread-over effects. In the Agriculture, Mining and Transportation sectors, spread-over effects were more or less absent. The Manufacturing sector, on the other hand, was governed by first period spread over effects whereas in construction and Non-oil Private and Government sectors lagged spread effects up to second periods were operative.

As for the investment variable, we did find that evidence of spread-over effects is more apparent and consistent as compared to the GDP variable. Adjustments were slow as in the cases of construction,

Transport equipment, Machinery and Equipment, Non-oil, private and Government sectors , thus supporting the spread and carry-over hypothesis. Bottlenecks of various forms and duration lengths are operative on the investments of the above mentioned sectors. The Oil sector and the other consutrction sector were an exception. Adjustments in both were almost instataneous and in general there was no evidence on carry-over effects.

In the light of the above conclusions, we may be able to forward the following recommendations. Firstly, effective measures need to be taken to remove the bottlenecks which seem to hinder the exploitation of the investment opportunities generated by the growth in oil exports. Secondly, expansions in K.S.A. absorptive capacity is vital if other sectors were to fully respond to the growth in oil exports. In particular, it is recommended that measures be taken to train skilled labour and to establish ancillary industries which serve the construction of a solid and varied industrial base. Thirdly, a policy of import substitution to expand the manufacturing sector could be followed. Also integration with other Gulf states may help overcoming the market limitations facing the growth of the secondary sector which may, in the long run, prove to be most beneficial in lessening the dependence on the Oil sector.

The above research could be complemented by others directed towards the study of the transmission mechanisms connecting the various sectors of the K.S.A. economy and leading to intersectoral spill overs in addition to the above studied intrasectoral spread and carryover effects ; the study of growth through import substitution; the study of K.S.A. capacity to absorb capital of large quantities and modern vintages and the study of the various inducement to investment in K.S.A. projects.

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