3 | The Impact of Petroleum Exports on the Saudi Arabian Economy

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Introduction

Fluctuations in petroleum exports dominate the activity of most of the major economic variables in a petroleum-based economy.[1] In Saudi Arabia's case, the quadrupling of crude oil prices in late 1973 led to a rapid improvement in the country's terms of trade. This resulted in an immediate increase in the proportion of oil receipts in national income, in the balance of payments receipts, and in the fiscal budget. The short-run effect of these developments was the rapid improvement in all segments of the economy.[2]

The series of shock waves that resulted from the crude oil price rise was transmitted into the system through the huge increase in public spending and in imports. The full impact of these developments may not have been completely felt yet. In fact, many of the trends set in motion in the mid-1970s were reinforced with oil price increases in 1978–79.

Keeping in mind that Saudi Arabia has not felt the full impact of oil revenues on the economy, this paper will examine the impact of the petroleum industry on the Saudi Arabian economy between 1960 and 1978. Particular attention is focused on: (1) the manner in which the country's oil exports can be viewed as an engine of growth (or leading sector) during this period, and (2) a determination of the overall impact of the 1973–74 export stimulation on the economy.

The Oil Sector

As shown in Table 3.1, Saudi Arabia's oil sector dominates the economy in terms of: (1) gross domestic product (where it has consistently accounted for over half of GDP); (2) government revenues (where it consistently finances well over 90 percent of the government's expenditures); and (3) exports (for all practical purposes the kingdom has no non-oil exports).

Until the last several years, these patterns were reinforced by the post-1973 oil boom. It is significant in this regard that the 1974 income ($22.6 billion) was greater than the sum of all previous annual revenues ($19.2 billion).

Production for export results from complex policy decisions that involve technical, domestic, and international factors. A convenient approximation of changes in supply over time is the relationship between the extraction rate and the number of years of crude supply corresponding to this extraction rate. Production increases or declines with rises or declines in the reserve production ratio. This relationship is therefore a first approximation in determining the normal extraction rate.[3]

In practice, the normal extraction rate has been modified by two major factors, the absorptive capacity of the economy and the kingdom's preference for moderate price increases over time. Given the government's prime objective of recycling as much revenue as possible within the economy, an ongoing effort has been made to increase the economy's absorptive capabilities. However, with the inflationary pressures resulting from massive increases in investment, the government has on occasion reduced the rate of increase in its domestic expenditures. If, during these stabilization periods, the financial reserves become too large compared to the gross national product, the absorption multiple may decrease below one and crude oil production may be reduced. (*Absorption multiple* measures the responsiveness of domestic expenditures to changes in oil revenues. Thus, a multiple less than one reflects a situation in which a one-dollar increase in oil revenues is associated with an increase of less than one dollar in domestic [government plus private] consumption and investment expenditures.)

Pricing policy is the second factor affecting the supply of Saudi Arabian oil. Since the escalation of the price of crude oil, Saudi Arabia has become of critical significance in OPEC and the world oil market because of its power to affect petroleum prices. This relates to its ability and willingness to produce at a rate far higher than its development requirements. Recent OPEC meetings held since those in Doha in 1975 have unquestionably confirmed this fact. Consequently, the current price of oil is related to the rate at which the Saudi Arabian government feels it must produce oil to make marginal alterations in the price.

Table 3.1

SAUDI ARABIA: MACROECONOMIC TRENDS, 1960–1978
(constant 1970 prices)

Aggregate	*1960*	*1970*	*1973*	*1974*	*1975*	*1978*	Average Annual Growth *1960–1970*	*1970–1973*	*1973–1978*	*1975–1978*
Government expenditure	768.2	4635.0	5763.8	8567.7	11017.7	34729.4	19.7	7.5	43.2	46.6
Government investment	30.6	1214.0	1562.9	2203.9	1925.7	16065.1	44.5	8.8	59.4	102.8
Government consumption	737.6	3421.0	4200.8	6363.9	9092.0	18664.3	16.6	7.1	34.8	27.1
Private expenditure	3715.3	7242.0	9137.8	9556.1	18496.0	32148.4	6.9	8.1	28.6	20.2
Private consumption	2929.4	5859.0	6217.3	6340.6	10308.0	21669.4	7.2	2.0	28.4	28.1
Private investment	785.9	1383.0	2920.5	3215.5	8188.0	10479.0	5.8	28.3	29.1	8.6
Total Investment	816.5	2597.0	4483.5	5419.4	10113.7	26544.1	12.3	20.0	42.7	37.9
Imports (World price deflator)	105.7	4990.0	5951.1	8839.9	14196.4	38938.3	47.0	6.0	45.6	40.0
Government revenues	2051.8	5668.0	12066.9	26906.5	47201.7	51848.8	10.7	28.6	33.9	−1.9
Oil revenue	1321.8	5463.0	9679.9	22708.1	49052.1	48528.5	15.2	21.0	38.0	−0.4
Non-oil GDP	3226.2	8253.0	11181.2	12611.2	15119.2	22691.9	9.8	10.7	15.2	14.5

SOURCE: Computed from data in Saudi Arabian Monetary Agency, *Annual Report*, 1967, 1975, 1981.

Petroleum exports affect the economy both directly and indirectly. The retained value of oil exports reflects the direct link to the economy. It is equal to the value of oil exports minus net factor payments abroad (which consist of ARAMCO's shares in profits and the company's imports of material and equipment).[4] The retained value of oil exports is divided into two parts: (1) oil taxes, royalties, and other fees, which are paid to the host governments in foreign currencies (mostly U.S. dollars); and (2) payments to the employed factors of production, which consist mainly of wages and salaries, as well as for the value of goods and services purchased domestically by the operating oil companies.[5]

Although the oil industry is well insulated from the rest of the economy, it has all the characteristics to play the role of a leading sector. Its productivity is much higher than other sectors of the economy, and until the last several years its share in gross domestic product was increasing steadily. Clearly, oil exports have the potential of leading to growth in other sectors, along with a continuous rise in domestic per capita income, which would be determined by the composition of oil-financed expenditures.

Impact of Petroleum Exports

The manner in which exports act as a leading sector and the effect of exports on national economies have been discussed in the literature for some time. The consensus among economists is that exports can contribute to economic growth through their direct contribution to gross domestic product. This is because they are included as part of GDP, and indirectly through linkages created with non-oil sectors in a sequence of multiplier-accelerator mechanisms. (*Multiplier-accelerator mechanisms* refer to the impact of expenditures on the overall level of income of the country—i.e., government expenditures increase income, which in turn stimulate higher levels of investment. This leads to a larger increase in income than would have occurred in the absence of the private sector's responsiveness [investment] to increased sales.) Theoretically, these indirect contributions to the economy can operate long after a particular change in exports has occurred.

In sum, the overall impact of a change in exports will depend on: (1) resulting changes in technology, (2) the propensity to import, (3) the extent to which investment opportunities are generated, (4) the ability to attract foreign investment, and (5) other nonquantitative effects. Since at least five somewhat unrelated factors determine the overall impact of exports on the economy, there is no reason to believe that the multiplier as measured here will remain constant in future time periods. Clearly, if the opportunities generated by the growth of the export sector are exploited, this will result in a pattern of

economic growth, characterized as a process of diversification about an export base.

More formally, there are several ways the oil industry can promote broadly based development in the country (or at least provide the means for such development if appropriate domestic policies are followed):[6]

1. direct payments to the productive factors that provide a source of noninflationary demand for domestic output
2. purchases of domestic goods and nonwage services to stimulate domestic output
3. payments to government to be used directly or indirectly for capital investment or for social programs in education and health that constitute productive investment in human resources
4. the promotion of investment through sale of petroleum products to other domestic industries, and purchases of goods and services by the petroleum sector from domestic firms (forward and backward linkages, respectively)
5. a supply of foreign exchange, so that the country is not faced with a short-term foreign exchange constraint on its development program and can thereby achieve a more rapid increase in investment

Most studies of the impact of primary products on the indigenous economies of developing countries have largely been documentations of the direct effects of the sector (items 1, 2, 3, and 5 above).[7] These studies have involved the government's retained earnings from export of the primary product, as well as the direct contribution of the sector to exports, government finances, employment, and so on. Though valuable, these studies are always somewhat unsatisfactory, since they merely confirm the sector's contribution to government revenues and foreign exchange earnings. Most studies ignore the other direct effects or linkages. These studies usually conclude that the oil sector is not a leading sector in the true historical sense, unlike many of the dynamic sectors of the past, such as Canadian wheat, Swedish timber, British textiles, and American railroads. If true, the implications of these results are somewhat unclear.

From a policy perspective, a more productive approach would be one that acknowledges the isolation of the oil industry from other sectors of the economy. Such an approach should recognize that by inducing private sector investment and an efficient pattern of government investment, the oil sector could still have an overall impact on the economy, similar in many regards to classic export-based leading sectors. The petroleum sector does not participate directly in the buying and selling of goods in the domestic Saudi market,

as have the leading export growth sectors. However, much the same effect may result from increases in petroleum revenues and the demand responses they produce as they interact with the rest of the economy.

In short, there is no a priori reason why the petroleum sector could not act as a leading sector in providing an engine of growth. The issue is ultimately an empirical one that can only be resolved through regression-based impact analysis.

The sections that follow examine whether (from a statistical standpoint) the demand-increasing effect of the continued growth of petroleum exports from Saudi Arabia has induced a steady expansion in the country's indigenous income.

Pattern of Development

The proceeds from oil exports increased markedly from 1965 to 1975, and especially sharply after the oil embargo in 1973 (Table 3.1), with accompanying huge rises in oil prices. The substantial increases in the value of oil exports had a noticeable effect on the performance of the economy. All of the major macroeconomic indicators increased rapidly. Real government investment averaged a 59.4 percent annual rate of increase over the 1973–1978 period and 102.8 percent between 1975 and 1978.

Real non-oil GDP increased at 15.2 and 14.5 percent per annum for the 1973–1978 and 1975–1978 subperiods, respectively. Real imports, however, expanded at 45.6 and 40.0 percent per annum, respectively, during the same period. One of the striking patterns during the 1970s is the fall in the percentage of GDP contributing to consumption and the expansion of investment as a proportion of GDP.

The only structural changes in the sectoral composition of output, however, included a decline in the relative contribution of agriculture and a rise (1973, 1975) and then decline (1979) in the share of crude petroleum (Table 3.2). (The sectoral composition of output refers to the components of gross domestic product, such as agriculture and industrial services.) Construction and the wholesale retail trade were the only sectors to show sustained increases in their share of GDP.

These patterns of development differ somewhat from those of the older industrialized countries, where historically the shift has been from the primary to the secondary and then to the tertiary sectors of the economy. (The *primary activities* include agriculture, mining, and crude oil and gas production; *secondary activities* include industry, construction, water, and power; and *tertiary activities* include banking, insurance, and other private and public services.) The pattern observed in Saudi Arabia also suggests the country is increasingly reliant on its only asset (oil) to provide increases in gross

Table 3.2

SAUDI ARABIA: SECTORAL COMPOSITION OF OUTPUT, 1967–1979
(constant 1970 prices)

Sector	1967	1970	1973	1975	1979
Agriculture	6.5	5.7	4.0	3.7	3.2
Crude petroleum and natural gas	45.5	46.6	56.6	54.6	45.4
Mining	0.3	0.3	0.3	0.3	0.3
Manufacturing					
Petroleum refining	5.8	7.1	5.0	4.1	3.7
Other	2.3	2.5	2.2	2.3	2.8
Electricity, gas, water	1.5	1.6	1.4	1.0	1.6
Construction	6.2	5.4	5.1	7.8	11.1
Wholesale, retail trade	5.6	5.8	5.0	6.0	9.4
Transportation, communication	6.8	7.1	6.7	4.1	6.1
Finance, services	6.0	5.8	4.4	7.0	8.3
Social and personal services	1.3	1.4	1.0	1.0	1.2
Government services	10.9	9.6	7.2	7.7	6.8
Other	1.3	1.1	1.1	0.4	0.1
Total	100.0	100.0	100.0	100.0	100.0

SOURCE: Ministry of Finance and National Economy, Central Department of Statistics, *National Accounts of Saudi Arabia*, 1967, 1975, 1981.

domestic product, with no significant signs of diversification. The data indicate that the manufacturing sector is actually declining in relative terms.

Sectoral contributions to employment show one basic change: a reduction of the labor force in the agricultural sector, accompanied by an increase in the labor force in the service sector.[8] This does not, however, necessarily reflect the same sort of structural change that resulted from the development process in the developed countries. In Saudi Arabia's case, there have been no significant increases in the Saudi labor force of the secondary sectors. Also there is no evidence that the expansion of the labor force in the service sector was in response to increasing productivity in the secondary or tertiary sectors. Actually, it has been suggested that the service sector has acted merely as a residual for employment—that is, a sector capable of absorbing workers unable to find jobs in agriculture or industry.[9] As such, its expanded employment should not be viewed as an indication of development.

On face value, the statistics show that despite the reduction of employment in the agricultural sector of the Saudi economy, this is still the largest employment sector. The economy appears to be increasingly reliant on oil. More troublesome, perhaps, is the fact that there are no real signs of diversification about an export base.

Although the relationship between the growth of oil exports and the growth of GDP over time is central to an export base model of growth, the literature has never been specific about the operational nature of this relationship—i.e., exactly what effect the time pattern changes in exports should have on income. The problem of determining the time lag between oil export growth and economic growth in Saudi Arabia must therefore be central to any econometric investigation regarding the export base.

Mechanisms of Oil-Based Growth

Given Saudi Arabia's low level of development after 1973, if oil revenues were completely utilized through government expenditures, growth in output and employment in the nonpetroleum sector would be largely a function of the trend in petroleum exports. In this situation, a Keynesian multiplier model would provide a fairly accurate depiction of the impact of oil revenues on the non-oil sectors of the domestic economy.

If the link between oil production, exports, revenues, and government expenditures is as precise as that outlined above, the economy might be conveniently described by the set of relationships:[10]

$$NOY=f(EXP)$$
$$EXP=S+Z$$
$$\Delta Z=z\Delta NOY$$
$$\Delta S=s\Delta NOY$$
$$\Delta EXP=s\Delta NOY=z\Delta NOY$$
$$\Delta NOY/\Delta EXP=1/(s+z)$$

where EXP=total value of oil revenues; NOY=non-oil gross domestic product; Z=total imports; S=total savings; z=the marginal propensity to import; and s=the marginal propensity to save.

In this depiction of the economy, government spending is totally induced by oil export receipts. Similarly, income generated in the non-oil sector is wholly induced by oil export expansion. The value of the oil export multiplier is determined by the reciprocal of $(z+s)$. Given these assumptions, income induced by the oil boom will continue to rise until the leakages (imports and savings) become equal to the initial increase in public spending. If government expenditures continue to rise from the steady expansion in oil export receipts, income generated in the non-oil sector should also continue to grow.

Preliminary regressions of oil revenues and exports on sectoral output and macroeconomic expenditures indicate that the value of the oil revenue coefficient (and exports) is very small (see Tables 3.3–3.10). This indicates that the direct effects between oil revenues and the economy are not very high. The lack of any real correlation between current revenues and these variables may, however, give a biased picture of the impact of oil revenues on the economy. For one thing, several of the more important ministries in Riyadh were incapable of adjusting their budgets to the rapidly rising revenues after 1973, thus producing a growing government surplus. Actual spending has also fluctuated from year to year and has not systematically followed fluctuations of actual expenditures from actual revenues (particularly reduced real oil revenues). These fluctuations were partially responsible for the small degree of association between expenditure (or sectoral output) and exports.[11]

Though the Keynesian model outlined above provides insights into the dynamics of Saudi Arabia's growth process, it is only a rough approximation of the forces at work. The links between oil exports, revenues, and government expenditures are not precise, nor have oil revenues risen steadily over time.

Alternative Estimation Procedures

Fortunately, econometric estimation makes possible a number of procedures that facilitate a direct determination of the impact of oil revenues over time.[12] Thus, one is not confined to a standard linear regression model that specifies a causal relationship between the dependent and independent variables. Use of that model implies that a unit change of one of the independent variables causes a change in the dependent variable only during that particular time period. Clearly, this type of specification is too restrictive for examining the impact of the oil industry on the Saudi Arabian economy. For example, oil revenues accrued and spent by the government may influence investment in various sectors of the economy over certain periods, exerting some influence today, some next year, some the year after that, and so on. Such a causal spread over a period of time is often discussed in terms of distributed lags.[13] The linear regression estimation procedure may be tailored to incorporate such effects.

For example, it can be demonstrated that an equation of the Koyck form:[14]

$$y=ax+byL+z \qquad \text{(a)}$$

implies an exponential decay scheme whereby the effect of a permanent

increase in government revenues (ax) would influence government expenditures not only during that period, but would also have (in declining terms) an impact on their level in future years. It can be shown that this result stems directly from the inclusion of national income lagged one year (byL) on the right-hand side of the equation.[15]

Saudi Arabia exhibits impact patterns along these lines, since oil-supported government expenditures (such as consumption) are especially heavy during the first few time periods, decaying gradually thereafter. Patterns of this type may modify equation (a), above.

Though this is a distinct improvement over the one-period (year) impact formulation, this specification may be too restrictive in analyzing the impact on the economy of both the oil sector and government expenditures. In actuality, delays in planning, implementing, and so on may mean that oil exports will have no appreciable effect on national income or sectoral output for some time. In this situation, the initial impact on the economy is at a maximum, exhibiting a gradual decaying pattern over time. This pattern would most likely occur in areas of new investment. Given the low base from which the economy began expanding in 1960, the distributed lag would be negligible until the plant was completed. Thereafter, its effect on production would likely make a significant increase in overall production for some time.

This type of situation can be approximated by adding another lagged term for the oil (or expenditure) variable, as in

$$y=ax+byL+cxL+z \qquad \text{(b)}$$

thus postponing the starting point for the exponential decay for one time period (year). By including further lagged values of the independent variable, x, or oil exports, expenditures, and so on, the starting point of the exponential decay could be shifted to any value (year) in the future.

Finally, if the oil impact equation had been estimated as

$$y=byL+cxL+z \qquad \text{(c)}$$

a special case of equation (b) occurs, where exponential decay would begin only after a further delay.

In short, formulations with one lagged dependent (impact) variable are capable of generating a variety of oil-related distributed lag schemes that can be easily estimated using standard econometric techniques. All these schemes are similar in that they exhibit exponential decay over some time range. More importantly, given Saudi Arabia's narrow development base, these formulations have the added advantage of generating impacts that make a priori

sense—that is, time profiles beginning with an outburst followed by a gradual decay.

Though the above formulations (equations a, b, c) are clearly significant improvements over the one-period impact formulation, government expenditure impacts can occur gradually, peak after several years, and then decay. Such a scheme can be estimated by lagging the impact variable more than once:

$$y=byL+cxL+dyL2+z. \qquad \text{(d)}$$

The time profile of the impact generated by oil-related effects through this formulation are determined by the two parameters, c and d. That is, a change in the values of c and d will affect the shape of the resulting unimodal time profile curve. As noted, all curves of this type have the property of gradually increasing their decaying after a peak year impact has been reached.

Each of the four basic formulations (a, b, c, d) above makes logical sense. Since none is superior in identifying a particular oil-related impact on the economy, all four were estimated.

Before the impact estimates were made, however, patterns of oil receipts, expenditures, and sectoral growth were examined to see if the 1973–74 oil price increases caused a fundamental structural break in past economic patterns, significantly modifying the economy's absorptive capacity.

Absorptive Capacity of the Economy

Absorptive capacity is an important factor in determining the impact of oil revenues on the economy. It facilitates estimates of the optimal rate of investment, as well as identifying the role of capital in expanding the productive capacity of the economy.[16] In Saudi Arabia's case, emphasis should be placed on the relationship between capital accumulation and capital formation. This concept challenges the notion that Arabia's economic growth is principally constrained by capital shortage to one more realistic for the post-1973 period. That is, the economy is likely to encounter a number of constraints in productively utilizing a substantially higher volume of capital.

Using this approach, absorptive capacity can be defined in terms of the optimal adjustment of the growth rates of all factors of production. Stress here is given to the importance of adjusting factor proportions to the new conditions produced by the oil boom. In this environment, labor, managerial skills, and other noncapital factors of production have been the binding constraints on real economic expansion. The country's main economic problems are best perceived in terms of capital adjustment theory. Given Saudi Arabia's historical factor price ratios (i.e., the relative price of capital and labor), producers

became accustomed to certain techniques of production. After 1973, the relative cheapening of capital and the growing cost of labor dictated a greater amount of capital per unit of labor. Clearly, the transition to this new productive structure could not be instantaneous. It requires considerable time to adjust prevailing production techniques to the new factor price ratio, even in highly industrialized economies with well-functioning capital markets.

The importance of learning effects associated with the investment process are becoming apparent. Clearly, the kingdom's current difficulties in absorbing greater amounts of capital must be partially attributed to the relatively low rate of past (pre-1973) investment. Higher historical rates would have most likely provided not only greater familiarity and practice in the investment process, but perhaps more importantly, a larger economic system capable of providing a greater volume of productive investment opportunities than currently exists.

Based on Saudi Arabia's rudimentary financial institutions, the relative inexperience of most indigenous entrepreneurs with capital-intensive techniques, and the historic isolation of the kingdom from the sources of technology, the process of adjustment will take a long time to complete.

To a certain extent, many of the bottlenecks associated with the kingdom's current economic expansion have been alleviated through the government's judicious use of foreign workers and managers. Still, it is unlikely that the fundamental problem of capital absorption will be resolved until well into the fourth plan period (1985–1990).

Despite the country's limited absorptive capacity, higher oil revenues have exerted considerable political pressures on the respective ministries to increase their investment expenditures.

To test for any possible structural shifts in government expenditures stemming from the 1973 oil price increases, several dummy variables were included in the regressions of oil revenues on government investment and total government allocations. Four dummies were constructed:

1. *DUM*1, with values of 0 for 1960–1972, and 1 for 1973–1979
2. *DUM*2, with values of 0 for 1960–1973, and 1 for 1974–1979
3. *DUM*3, with values of 0 for 1960–1974, and 1 for 1975–1979
4. *DUM*4, with values of 0 for 1960–1975, and 1 for 1976–1979

The dummy variables were then introduced, one by one, into the general equation:[17]

$$GEXP = z + (b1)OILREV + (b2)DUM$$

where $DUM = (Dn)(OILREV)$, with $GEXP$ = government expenditures in constant 1970 prices (investment total): $OILREV$ = government oil revenues (deflated with world prices of industrial goods, 1970 = 1.0), and DUM = the dummy variables with $n = 1-4$.

The results (Table 3.3) for each of the class of government expenditures show a similar and striking pattern—dummies 1, 2, and 3 resulted in identical nonsignificant results (therefore only *DUM*4 is significant in most cases).[18]

One might have expected the government to have adjusted its expenditures earlier to the oil price increases of late 1973. However, 1975–76 is misleading, since the figures used were based on the Saudi calendar year ending June 30. Presumably if the data were based on the Gregorian calendar year, a greater increase in government expenditures would have been recorded in 1974, 1975, and 1976.

Oil Revenue Impact on Macroeconomic Variables

Regressions (Table 3.3) of oil revenues on real government investment, government consumption, and total government expenditures (consumption plus investment) show, in fact, that current period revenues have only a minor impact on government expenditure patterns. The best results were obtained using a Koyck distributed lag scheme (equations 3, 12, and 21) with a dummy variable (*DUM*4 values of zero for 1960–1975, one for 1976–1978).

As with government expenditures, current period oil revenues have only a minor impact on each of the major macroeconomic aggregates (Tables 3.4–3.7). In terms of real non-oil GDP, a Koyck lag pattern (equation 7) provides the best results, although the coefficient for oil revenues (0.04) is quite small (as was the case in the other regressions). The impact of oil revenues on real private consumption was best estimated with a two-period lag scheme (Table 3.5, equation 8), indicating a considerable period of adjustment of consumption patterns to increased exports. In contrast to the other macroeconomic aggregates, imports are significantly affected by current period oil revenues (Table 3.6, equation 1), although a two-period oil revenue lag scheme (equation 8) seems to give the best statistical results.

Private investment is also fairly responsive to current period oil revenues (Table 3.7, equation 1). However, a Koyck distributed lag scheme provides better results (Table 3.7, equation 3). Though sometimes positive, the tendency for lagged private investment to assume a negative sign in a number of regressions may indicate an inability of private investors to keep up with the expansion in exports.

Though current period oil revenues affect the determinants of investment, the lagged versions provide better results. This implies that expansion of current exports is not necessary for the growth of capital. It also indicates that

Table 3.3

SAUDI ARABIA: DETERMINANTS OF GOVERNMENT EXPENDITURE, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Government Expenditure*	*Oil Revenue*	*Lagged Oil Revenue*	*Expenditure Lagged Twice*	*DUM4*	*RHO*[a]	Intercept	r^{2} [b]	*F*[c]	DW[d]
Total Government Expenditure	(1)		0.20			0.27	0.18	2599.80			
			(2.85)			(2.88)	(0.77)	(2.20)	0.873	49.73	1.25
	(2)		0.03				0.97	63699.9			
			(0.24)				(16.52)	(2.46)	0.004	0.06	0.45
	(3)	0.84		0.21			−0.67	146.03			
		(21.32)		(14.84)			(−3.67)	(1.37)	0.999	7385.08	2.07
	(4)	1.12	0.10				−0.60	−417.89			
		(18.45)	(5.23)				(−3.05)	(−1.80)	0.995	1277.43	1.89
	(5)	0.85	0.01	0.19			−0.72	102.85			
		(20.66)	(0.89)	(7.91)			(−4.35)	(0.89)	0.999	4719.13	2.08
	(6)	0.90	0.07	0.04		0.06	–	2460.2			
		(22.15)	(2.52)	(0.58)		(2.17)		(2.12)	0.999	5498.13	1.80
Government investment	(7)		0.06				0.97	41505.1			
			(0.90)				(18.02)	(2.28)	0.048	0.807	0.45
	(8)		0.03			0.17	−0.06	700.66			
			(0.91)			(4.60)	(−0.25)	(1.33)	0.866	45.44	1.43
	(9)	0.97		0.09			−0.63	−267.79			
		(10.85)		(7.43)			(−3.32)	(−2.36)	0.992	817.99	1.76
	(10)	0.87		0.003		0.006	–	87.68			
		(26.98)		(4.54)		(9.65)		(1.72)	0.999	1460.98	1.71
	(11)	1.28	0.04				0.57	−320.69			
		(11.14)	(3.03)				(−2.83)	(−1.55)	0.974	262.56	2.10
	(12)	0.88	0.01			0.08	–	141.08			
		(25.80)	(3.87)			(16.31)		(2.83)	0.999	3479.45	1.81
	(13)	0.81	−0.06	0.17			−0.68	−119.53			
		(18.56)	(−7.68)	(14.10)			(−3.86)	(−2.30)	0.998	2732.54	1.81
	(14)	0.85	−0.03	0.01		0.04	–	−1.57			
		(21.69)	(−1.85)	(2.76)		(2.33)		(−0.03)	0.999	3299.86	1.55
	(15)	1.73	0.05		−1.04		–	−37.24			
		(8.10)	(4.32)		(−2.44)			(−0.18)	0.984	257.59	2.50
	(16)	0.42	−0.01		0.88	0.11		88.65			
		(7.21)	(−1.36)		(13.28)	(17.50)	–	(0.53)	0.995	417.19	1.64
Government consumption	(17)		0.08				0.97	28006.9			
			(1.87)				(16.38)	(2.72)	0.180	3.50	0.52
	(18)		0.16				0.43	2088.93			
			(4.78)				(2.04)	(2.87)	0.868	40.07	1.09
	(19)	0.85		0.09			0.04	453.89			
		(5.68)		(2.78)			(0.17)	(1.52)	0.987	3479.45	1.81
	(20)	0.75		0.19		−0.07	−0.78	169.85			
		(8.56)		(7.02)		(−4.51)	(−5.21)	(1.07)	0.997	1454.14	2.68

Table 3.3 (cont.)

SAUDI ARABIA: DETERMINANTS OF GOVERNMENT EXPENDITURE, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Government Expenditure*	*Oil Revenue*	*Lagged Oil Revenue*	*Expenditure Lagged Twice*	*DUM4*	*RHO*[a]	Intercept	r^{2} [b]	*F*[c]	DW[d]
Government investment	(21)	0.92	0.07				−0.71	132.38			
		(32.87)	(13.96)				(−4.19)	(2.14)	0.999	7787.77	2.41
	(22)	0.89	0.07	0.01			−0.69	173.79			
		(18.22)	(9.58)	(0.67)			(−3.99)	(1.95)	0.999	4515.14	2.48
	(23)	0.94	0.09	−0.05		0.02	−0.84	191.35			
		(16.70)	(5.74)	(−1.07)		(1.32)	(−6.40)	(2.29)	0.999	4319.27	2.36
	(24)	0.64	0.08		0.25		−0.64	243.08			
		(2.67)	(9.26)		(1.02)		(−3.32)	(2.34)	0.999	2384.11	2.19

NOTE: Equations were estimated in linear form, $Y=a+b1X1+b2X2$, where Y=dependent variable, X refers to the independent variables, a is the intercept, and b is the independent variable coefficient. Figures within the parentheses contain the t statistic.

a. *RHO* is a term created by the Cochrane-Orcutt estimation procedure to eliminate first-order serial correlation in the estimated variables.

b. r^2 is a measure of the goodness-of-fit.

c. F is a statistic measuring the significance of the regression equation.

d. DW is the Durban-Watson statistic (see Hall and Hall, "Time Series Processor," pp. 22–24.

Table 3.4

SAUDI ARABIA: IMPACT OF OIL REVENUES ON NON-OIL GROSS DOMESTIC PRODUCT, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Non-oil GDP*	*Oil Revenues*	*Lagged Oil Revenues*	*Non-oil GDP Lagged Twice*	*DUM4*	*RHO*	Intercept	r^{2}	*F*	DW
Non-oil gross domestic product	(1)		0.05			0.04	0.96	3119.86			
			(1.68)			(1.86)	(14.58)	(4.70)	0.320	3.29	0.51
	(2)		0.02								
			(1.43)						0.114	2.06	1.23
	(3)	1.12		0.01			0.17	−130.52			
		(19.64)		(0.83)			(0.74)	(−0.37)	0.996	1656.49	1.85
	(4)	1.01		0.09			−0.85	123.88			
		(29.64)		(5.22)			(−6.58)	(0.73)	0.999	5632.50	1.97
	(5)	1.06	0.04	−0.02			0.56	84.14			
		(44.99)	(6.15)	(−2.21)			(−2.77)	(0.64)	0.999	7617.40	2.30
	(6)	1.04	0.03	0.02		−0.02	−0.46	127.34			
		(37.56)	(3.09)	(0.79)		(−1.56)	(−2.13)	(0.93)	0.999	6052.32	2.20
	(7)	1.05	0.04			−0.01	−0.51	93.65			
		(49.13)	(6.91)			(−2.60)	(−2.42)	(0.76)	0.999	8142.97	2.29
	(8)	0.75	0.04		0.31		−0.20	230.97			
		(2.78)	(4.25)		(1.06)		(−0.83)	(1.32)	0.999	4054.05	2.04
	(9)	1.24	0.03		−0.03	−0.01	−0.55	87.08			
		(3.48)	(3.65)		(−0.55)	(−2.20)	(−2.62)	(0.58)	0.999	4076.76	2.45

Table 3.5

SAUDI ARABIA: IMPACT OF OIL REVENUES ON PRIVATE CONSUMPTION, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Private Consumption*	*Oil Revenues*	*Lagged Oil Revenues*	*Private Consumption Lagged Twice*	*DUM4*	*RHO*	*Intercept*	r^2	*F*	*DW*
Private consumption	(1)		0.14			0.07	0.10	3808.02			
			(2.58)			(1.31)	(0.45)	(4.36)	0.7265	18.60	1.33
	(2)	1.11		0.06			−0.41	−454.81			
		(3.86)		(1.35)			(−1.83)	(−0.41)	0.944	118.30	2.05
	(3)	0.99		0.26		−0.17	0.34	−900.73			
		(2.15)		(2.56)		(−3.07)	(1.51)	(−0.49)	0.892	33.10	1.81
	(4)	1.34	0.02				−0.26	−1328.71			
		(5.62)	(0.67)				(−1.12)	(−1.40)	0.930	793.29	1.77
	(5)	2.17	0.14			−0.16	0.85	−7289.45			
		(6.69)	(3.42)			(−4.61)	(6.73)	(−2.01)	0.794	15.41	1.46
	(6)	1.21	0.02		0.21		−0.24	1634.30			
		(2.52)	(0.57)		(0.38)		(−0.85)	(−1.36)	0.924	48.79	1.71
	(7)	2.28	0.13		0.77	−0.18	0.93	−1759.66			
		(7.40)	(3.25)		(2.70)	(−6.02)	(10.17)	(−2.57)	0.851	11.37	1.33
	(8)	1.10	−0.02	0.08			−0.43	−408.84			
		(3.81)	(−0.36)	(1.17)			(−1.96)	(−0.36)	0.946	69.96	2.16
	(9)	0.78	−0.13	0.43		−0.18	−0.49	118.75			
		(2.28)	(−2.05)	(2.64)		(−2.29)	(−2.36)	(0.12)	0.953	81.80	2.30

Table 3.6

SAUDI ARABIA: IMPACT OF OIL REVENUES ON IMPORTS, 1960–1978
(constant 1970 prices)

	Equation	Independent Variables: *Lagged Imports*	*Oil Revenues*	*Lagged Oil Revenues*	*Imports Lagged Twice*	*DUM4*	*RHO*	Intercept	r^2	*F*	DW
Imports	(1)		0.36			0.23	0.45	–			
			(4.55)			(2.82)	(2.24)	–	0.856	95.15	1.03
	(2)	1.12	0.11				−0.07	−471.96			
		(23.03)	(5.92)				(−0.31)	(−1.88)	0.996	1590.13	2.00
	(3)	1.03	0.11			0.04	−0.23	−158.85			
		(17.41)	(6.32)			(1.79)	(−0.95)	(−0.60)	0.997	1352.49	1.89
	(4)	0.91		0.20			0.01	73.69			
		(10.94)		(5.69)			(0.05)	(0.26)	0.995	1449.53	1.95
	(5)	0.88		0.26		−0.05	−0.13	−170.28			
		(11.94)		(6.20)		(−1.92)	(−0.56)	(−0.63)	0.997	1282.11	2.06
	(6)	1.53	0.10		−0.60		−0.79	−60.20			
		(13.28)	(8.47)		(−4.04)		(−5.21)	(−0.37)	0.999	3435.21	1.95
	(7)	1.59	0.10		−0.67	−0.008	−0.80	−89.81			
		(6.75)	(7.81)		(−2.65)	(−0.32)	(−5.27)	(−0.46)	0.999	1739.97	1.98
	(8)	0.95	0.05	0.15		−0.02	0.01	−241.36			
		(13.15)	(2.14)	(2.46)		(−0.73)	(0.05)	(−0.91)	0.997	1064.37	1.99

Table 3.7

SAUDI ARABIA: IMPACT OF OIL REVENUES ON PRIVATE INVESTMENT, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Private Investment*	*Oil Revenues*	*Lagged Oil Revenues*	*Private Investment Lagged Twice*	*DUM4*	*RHO*	Intercept	r^2	*F*	DW
Private investment	(1)		0.18				0.44	–			
			(13.53)				(2.14)		0.915	183.23	1.62
	(2)		0.18			−0.009	0.46	–			
			(9.38)			(−0.45)	(2.23)		0.911	164.58	1.56
	(3)	0.39	0.10				−0.66	482.52			
		(2.74)	(6.03)				(−3.59)	(3.02)	0.984	451.15	2.28
	(4)	0.84	0.08			−1.35	−0.74	−18.16			
		(2.33)	(3.42)			(−1.35)	(−4.50)	(−0.05)	0.988	317.97	2.35
	(5)	−0.04	0.10	0.06							
		(−0.07)	(5.22)	(0.79)							
	(6)	−0.95	0.07	0.30		−0.07	0.33	1295.20			
		(−3.05)	(3.35)	(4.61)		(−3.40)	(1.45)	(3.31)	0.965	81.78	1.58
	(7)	−0.07	0.12		0.39		−0.86	508.89			
		(−0.28)	(6.92)		(2.12)		(−6.85)	(3.55)	0.990	404.96	2.37
	(8)	0.61	0.09		0.51	−0.06	−0.59	−419.42			
		(2.29)	(4.98)		(3.22)	(−2.75)	(−2.93)	(−1.22)	0.992	253.69	2.19
	(9)	−1.62		0.38			0.28	2487.42			
		(−3.44)		(5.56)			(1.19)	(4.64)	0.885	53.96	1.74
	(10)	−1.24		0.44		−0.10	−0.04	1546.16			
		(−2.89)		(6.81)		(−0.26)	(−0.16)	(3.56)	0.965	110.16	2.01

the country may have enough reserves to finance its current investment needs. Thus, short-run fluctuations in export earnings need not impair the country's development plans.

The coefficients for oil revenues are quite small in all of the macroeconomic regressions. They are considerably smaller, however, in the sectoral regressions. Construction is the only sector where current period oil revenues have a possibility of affecting production, but even here the result is not very significant (Table 3.8, equation 5).

Oil Revenue Impact on Sectoral Output

The responsiveness of the economy's seven major sectors to changes in oil revenues was examined. (The results of this study are available from the author on request.) It is expected that the growth in oil revenues would stimulate the output of these sectors, through backward, forward, and final demand linkages, as well as through the less direct spread effects.[19]

In general, sectoral output is best estimated with a lagged sector/lagged oil revenue equation—agriculture, manufacturing, trade, and electricity. Koyck distributed lag schemes were best in estimating construction, transport and communications, and public administration and defense. The results imply a positive but weak spread effect, with construction clearly the sector most affected by the oil boom.

Several factors are undoubtedly responsible for the lack of a strong direct association between expenditure and sectoral output and exports. The steady upward rise in exports has forced ARAMCO and other oil-related companies to pay continually higher wages. As a result, other government and many larger private sector companies have come under constant pressure to raise wages and reduce the pay differentials between themselves and the petroleum sector. Therefore, domestic labor costs have recently tended to be quite high by international standards. In addition, the country's abundant foreign exchange (dollar) supplies, combined with domestic inflationary pressures, have resulted in an overvalued Saudi rial. Imports are thus cheap, whereas exports other than oil are difficult to develop. Manufacturing has, therefore, expanded relatively slowly around a small base of import-substitution industries, local industries producing goods domestically that were formerly imported—e.g., many of the local industries springing up in the Eastern Province to supply ARAMCO.

The Saudi government has exercised considerable discretion in the timing of its expenditures and has assembled a large foreign financial portfolio in recent years. One would thus expect the relationship between sectoral output and government expenditures (in terms of total government expenditures and government investment) to be stronger than for oil revenues. However, this

Table 3.8

SAUDI ARABIA: IMPACT OF OIL REVENUES ON SECTORAL OUTPUT, 1960–1978

(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: *Lagged Sector Value*	*Oil Revenues*	*Oil Revenues Lagged*	*DUM4*	*RHO*	Intercept	r^2	*F*	DW
Agriculture	(1)		0.0008			0.96	1622.46			
			(0.68)			(14.26)	(7.05)	0.028	0.461	0.77
Agriculture	(2)	0.87		0.0014		0.47	137.93			
		(4.67)		(1.33)		(2.22)	(0.77)	0.901	64.05	1.60
Manufacturing	(3)		0.0005		0.0039	0.96	4266.91			
			(0.24)		(1.98)	(14.13)	(6.98)	0.209	1.85	1.03
Manufacturing	(4)	0.98		0.0037		0.11	20.69			
		(18.63)		(2.10)		(0.46)	(1.91)	0.982	646.81	2.02
Construction	(5)		0.014		0.012	0.96	4981.97			
			(1.81)		(2.38)	(15.39)	(2.72)	0.385	4.40	0.80
Construction	(6)	0.91	0.015			0.054	80.71			
		(10.82)	(4.02)			(−0.23)	(1.29)	0.987	538.11	2.05
Construction	(7)	0.86		0.019		−0.14	139.74			
		(6.24)		(2.76)		(−0.61)	(1.56)	0.983	429.51	1.85
Transportation, communication	(8)		0.0088		0.0094	0.97	7487.34			
			(0.86)		(1.45)	(15.70)	(3.15)	0.166	1.40	0.37

Table 3.8 (cont.)

SAUDI ARABIA: IMPACT OF OIL REVENUES ON SECTORAL OUTPUT, 1960–1978
(constant 1970 prices)

Dependent Variable	Equation	Independent Variables: Lagged Sector Value	Oil Revenues	Oil Revenues Lagged	DUM4	RHO	Intercept	r^2	F	DW
Transportation, communication	(9)	1.15 (41.45)	0.0046 (3.40)		0.00018 (1.88)	−0.44 (2.01)	−45.13 (−1.90)	0.999	6634.02	2.22
Transportation, communication	(10)	1.13 (34.81)	0.0036 (2.23)	0.0039 (1.85)		−0.39 (−1.75)	−41.91 (−1.64)	0.999	6272.63	2.27
Trade	(11)	1.17 (14.92)		0.0044 (1.25)		0.40 (1.83)	−68.69 (−0.83)	0.991	771.12	1.85
Public administration, defense	(12)		0.0041 (1.36)		0.0031 (1.64)	—	—	0.222	4.57	1.72
Public administration, defense	(13)	0.91 (18.01)	0.0064 (3.49)			−0.12 (−0.53)	200.99 (3.31)	0.992	862.80	2.04
Electricity, gas, water	(14)	1.44 (13.14)	−0.0011 (−1.26)			0.59 (3.02)	−60.30 (−2.02)	0.959	162.72	2.26
Electricity, gas, water	(15)	1.10 (9.77)		0.0021 (1.12)		0.26 (1.12)	−7.66 (−0.35)	0.982	217.96	1.59

does not appear to be the case. In nearly all cases (Table 3.8), regressions using government expenditures gave poorer statistical results (in terms of r^2 and F) than comparable tests using oil revenues. (These results are available from the author on request.) In no case was there any significant improvement using government expenditures. The same is true for the major macroeconomic variables including non-oil GDP (see Table 3.9).

One explanation for the observed results involves the compositional pattern of government expenditures. Although the government has proceeded with a series of massive infrastructural projects, a larger increase has taken place in its expenditures on social, military, and administrative services. Like most governments, the authorities in Riyadh have been tempted to spend their revenues on projects that produce immediate results—that is, on public building projects and housing projects, rather than on infrastructure directly supporting final producing units or indirectly productive investments in factories.

The pattern of government spending leads to rapid expansion of imports and service activities, with little impact either on the sectoral output or the productive capacity of the economy. Given the country's limited range of advantages, this strategy may have been the best of the options open to the government. This also explains the positive but low spread effects associated with the sectoral patterns of growth.

In general, these results indicate that current exports are not important in determining output, but do create positive (albeit small) spread effects. In short, there is considerable evidence that spread effects are important and that the investment opportunities generated by the oil revenues are being exploited to advantage.

The regressions also indicate weak direct linkages, meaning that most of the sectoral output will grow independently of the expansion of exports. In the case of manufacturing, this indicates that output largely involves import substitution and responds to the general level of domestic demand. It may also indicate that the expansion in oil exports is not fully exploited in stimulating manufacturing output. In other words, the country is having difficulty maximizing the rate of growth of its only logical alternative (if it is to lessen its dependence on oil). The problem here may be simply one of insufficient market size.

Conclusion

We may ask whether the conclusions prove that Saudi Arabia's oil revenues have created numerous incentives for the non-oil sector, and whether that sector has generated spread and linkage effects through the economy. As is well known, statistical analysis can only prove hypotheses incorrect; analysis

Table 3.9

SAUDI ARABIA: IMPACT OF GOVERNMENT EXPENDITURE ON MAJOR ECONOMIC AGGREGATES, 1960–1978
(constant 1970 prices)

	Independent Variables										
Dependent Variable	*Lagged Aggregate Value*	*Total Government Expenditure*	*Government Investment*	*Total Government Expenditure Lagged*	*DUM4*	*Aggregate Value Lagged Twice*	*RHO*	Intercept	r^2	*F*	DW
Imports	0.55	1.16			−0.67		−0.23	−363.78			
	(2.86)	(11.56)			(−4.03)		(−0.95)	(−2.40)	0.999	2877.05	1.99
Private	0.61	0.09			−0.06	0.51	−0.59	−419.42			
investment	(2.29)	(4.98)			(−2.75)	(3.22)	(−2.94)	(−1.22)	0.992	253.70	2.19
Private	0.45			0.63	−0.06		−0.24	684.62			
consumption	(2.68)			(7.40)	(−3.19)		(−1.04)	(1.16)	0.985	280.87	2.18
Total private	1.22		0.84		−0.14		−0.62	1368.45			
expenditure	(5.99)		(3.47)		(−2.51)		(−3.25)	(−1.23)	0.977	173.19	2.09
Non-oil gross											
domestic				0.30			0.95	18198.7			
product				(7.34)			(12.94)	(5.45)	0.783	53.99	1.90
Non-oil GDP			0.42				0.96	25378.7			
			(4.67)				(13.76)	(5.52)	0.593	21.87	1.44
Non-oil GDP				0.30	0.024		0.95	19861.9			
				(5.31)	(1.94)		(12.13)	(5.49)	0.744	17.48	1.01

of the sort presented here can never prove a hypothesis correct. As such, these results do not support the idea that the Saudi Arabian petroleum sector has had only a short-run, transitory impact in stimulating the domestic economy. The results also show that the country's entrepreneurs have not taken advantage of some of the investment possibilities made available by the revenues generated by the petroleum sector. In general, changes in the level of exports impact the non-oil sector of the economy, but take time to produce their full effect. The precise nature of these mechanisms varies from sector to sector and by the type of expenditure. No doubt, further testing is needed before a definitive statement can be made.

It is clear, however, that the principal characteristics of Saudi Arabian development are not simply a consequence of the petroleum industry. Rather, they result from the economic policies pursued by the government in an environment heavily influenced by the existence of the petroleum industry. In other words, the current and future role of the petroleum industry in Saudi development is in large measure a consequence of government policies and sociocultural conditions.

The results also suggest that the investment is made primarily in industries whose output does not depend on a steady infusion of oil revenues to sustain demand (e.g., investment to build the infrastructure and to produce import substitutes for which demand is readily available). Moreover, some of the country's investments may require a long development period, such as those projects undertaken at Jubail in petrochemicals, steel, and other heavy industries. There is also the possibility that some imported capital goods may not be fully utilized due to domestic market limitations. The expansion in exports neither provides adequate sales volume nor creates enough demand to justify the economic establishment of many manufacturing industries.

Notes

1. An excellent formal model of these relationships is given in E. E. Hagen, "Economic Growth with Unlimited Foreign Exchange and No Technical Progress," in Jagdish Bhaghwati and Richard Eckaus, eds., *Development and Planning* (London: George Allen & Unwin, 1972), pp. 69–78.

2. Unless otherwise specified, all data on the economy are from Saudi Arabian Monetary Agency, *Annual Report*, various issues.

3. Jean Paul Cleron, *Saudi Arabia 2000* (New York: St. Martin's Press, 1978), p. 24.

4. Cf. Donald Wells, "Aramco: The Evolution of an Oil Concession," in Raymond F. Mikesell, ed., *Foreign Investment in the Petroleum and Mineral Industries* (Baltimore: Johns Hopkins Press, 1971), pp. 216–36.

5. Ahmad Kader, "The Contribution of Oil Exports to Economic Development: A Study of the Major Oil Exporting Countries," *The American Economist*, Spring 1980, p. 46.

6. William Harris, "The Impact of the Petroleum Export Industries on the Pattern of Venezuelan Economic Development," in Mikesell, *Foreign Investment*, p. 130.

7. As an example of this approach, see William Bartsch, "The Impact of the Oil Industry on the Economy of Iran," in Mikesell, *Foreign Investment*, pp. 237–63.

8. Not shown here, but found in Ministry of Planning, *The Second Development Plan, 1975–1980* (Riyadh: Ministry of Planning, 1976) and *Third Development Plan, 1400–1405 A.H.* (Riyadh: Ministry of Planning, 1980).

9. John S. Birks and Charles A. Sinclair, *Arab Manpower* (London: Croom Helm, 1980), p. 107.

10. Cf. the Hagen and Kader articles cited in notes 1 and 5 for approaches along these lines.

11. See Robert Looney, *Saudi Arabia's Development Potential* (Lexington, Mass.: Lexington Books, 1982), chaps. 6 and 12, for an elaboration of these points.

12. In particular, see Robert S. Pindyck and Daniel Robinfeld, *Econometric Models and Economic Forecasts*, 2nd ed. (New York: McGraw-Hill, 1981), chap. 9.

13. For a detailed explanation of the theory of distributed lags, together with an outline of operational estimating procedures, see Ziv Griliches, "Distributed Lags: A Survey," *Econometrica*, January 1967, pp. 15–49.

14. Cf. Leon M. Koyck, *Distributed Lags and Investment Analysis* (Amsterdam: North Holland, 1954).

15. Potluri Rao and Rodger Miller, *Applied Econometrics* (Belmont, Calif.: Wadsworth, 1971), chap. 7.

16. See, for example, Brunko Horvat, "The Optimum Rate of Investment," *The Economic Journal*, December 1958; Raymond F. Mikesell, ed., *U.S. Private and Government Investment Abroad* (Eugene, Ore.: University of Oregon Books, 1962); and John Adler, *Absorptive Capacity: The Concept and Its Determinants* (Washington, D.C.: The Brookings Institution, 1965).

17. Formulations along these lines have also been attempted by Ragaei El Mallakh and Mihssen Kadhim, "Absorptive Capacity, Surplus Finds, and Regional Capital Mobility in the Middle East," *Rivista Internazionale di Scienze Economiche e Commerciali*, April 1977, pp. 308–25. Because the time period for their study ends in 1974, their results are not nearly as striking as the ones presented below.

18. All of the empirical results that follow were obtained through ordinary least squares regression estimates using the TSP statistical program. First-order serial correlation was corrected for by using a two-stage iteration Cochrane-Orcutt technique. The method estimates *ROW* from ordinary least squares residuals, transforms the dependent and independent variables so that the residuals from the transformed equation will be roughly serially uncorrelated, and then runs a regression using the transformed variables. Cf. Bronwyn Hall and Robert Hall, "Time Series Processor, Version 3.5 User's Manual," mimeographed (Stanford, Calif., April 6, 1980), pp. 22–23.

19. A discussion of these points is given in Michael Metwally and Hans V. Tamaschke, "Oil Exports and Growth in the Middle East," *Kyklos*, 1980, pp. 499–522.