

SOCIO-ECONOMIC TRADEOFFS IN SAUDI ARABIA'S THIRD FIVE YEAR PLAN (1980-1985)

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Abstract—Using an optimal control macroeconomic model of the Saudi Arabian economy, the Saudi Arabian Third Five Year Plan (1980-1985) is examined for goal feasibility and possible tradeoffs among the plan's major goals.

The main conclusions reached by the analysis are that: (1) some inflationary pressures can be reduced with a greater than planned infusion and/or retention of foreign workers; (2) with the labor force increasing in the 4-5% range, a rate of around 6% real growth might be achieved with inflation held around 8%, together with a gradual increase in the relative share of private sector participation.

INTRODUCTION

Over 10 yr ago the presentation of the eleventh annual report of the Saudi Arabian Monetary Agency included this quotation from the Koran: "Verily, never will God change the condition of a people until they change it themselves." Throughout the third plan, more than in any of its precursors, it is this theme of change and responsive participation in change which is dominant as exemplified in the introductory statement of development philosophy: "strategic priority to structural change rather than to growth" and "the spontaneous response from society... to the opportunities offered by development [1].

Although the weakening of oil markets in 1982 and the lowering of oil prices beginning in 1983 meant that Saudi Arabia's oil revenues have declined considerably through the third plan the country's relatively small population (about 7 million) together with its vast foreign portfolio (at least \$200 billion) have allowed the country to maintain its planned level of expenditures.

It will be some time before a complete *ex post* assessment of the plan's performance can be made. Preliminary to this assessment, this paper comments on and assesses the third five year development plan (1980-1985) from a macroeconomic point of view—in terms of the plan's feasibility of attainment and consistency with regard to the macro investments used and the plan's ultimate objectives.

OVERVIEW OF THE THIRD PLAN

The third plan departs from its predecessors [2] in several areas. Both the first and second plans targeted high growth rates in all sectors; this carried with it a policy of allowing relatively free importation of foreign labor to satisfy demand. The third plan is much more selective, opting for high growth in those areas Saudi planners feel have proven potential. Clearly

implied in the plan is the country's major long term objective, that of containing and eventually reducing the size of the foreign labor force. In contrast to the second plan's emphasis on infrastructure development designed to increase the absorptive capacity of the economy, the emphasis of the new plan is largely on raising the efficient utilization of the labor force—domestic and foreign alike—in hydrocarbons (usually high capital intensive) and other manufacturing industries (especially in the agricultural and mining sectors). As in the past the overall goal is to diversify the economic bases of the nation.

While the third five year plan is undoubtedly a more sophisticated document than either the first or second, nevertheless it does retain much of character of a project's list, with its financial implications not completely [3] worked out. Moreover, the plan seems to suffer from a weakness noted in the previous ones, namely that although manpower, infrastructure and other obstacles to economic development are acknowledged, they are not included in the central projections. Undoubtedly, this is in part a reflection of the dichotomy between economic rationality and political experience that exists in the kingdom. In support of the third plan, it should be said that a detailed review and updating is planned after 2 yr elapsed and that the planners themselves are openly advocating "roll-over" planning on a year by year basis as a much more appropriate approach to development in the case of a rapidly changing and still largely uncharted economy like Saudi Arabia's [3].

Specifically, with regard to the plan itself, three medium range objectives have been identified and targeted: the structural change of the economy, the achievement of participation and social welfare in development, and greater economic and administrative efficiency.

In the analysis that follows attention will be largely focused on the structural change aspect of the model. Here Saudi policies are linked to three areas of economic activity: oil and gas production; the expansion of productive sectors in agriculture, mining and

industry; and the continued development of infrastructure.

Clearly the on going and primary goal of the government, that of economic diversification, requires development of the agricultural, industrial and mining sectors (Table 1). In the government view, the private sector can and ultimately should be responsible for the bulk of output in these sectors. The government envisions its role largely as a catalyst to private sector entrepreneurial activity and investment in these areas through its provision of information and research results, of a supportive financial framework and investment incentives, and through the provision of the required infrastructure. Given the government's commitment to free enterprise and market forces, a major objective of the country's development strategy is therefore the rapid displacement of government sector activity in GDP by that of the private sector.

In contrast to nearly all other Third World development plans, if the third plan fails to achieve its targets in the time frame allotted, it will not be due to financial limitations. Instead, inflationary pressures and productivity lags will ultimately the plan's likely course and eventual attainment.

Excessive inflation has been acknowledged in third plan as an area requiring constant government attention. Anti-inflationary policy during the second plan period included the introduction of subsidies on various items such as housing and essential foods. In the upcoming 5 yr, the government intends to drastically reduce or even abolish these subsidies. Politically, this action will be possible only if the government can restrain expenditures and thereby keep inflation within acceptable bounds—7–10%.

In many respects [1, p. 57] the quite short Sub-section 3.5, *Inflation* in Chapt. 3, *Strategy for the Third Plan* is the most illuminating single passage in the entire plan document, since within it is contained an appreciation of all the forces which have led to the current development formula. These include:

- (1) the gap between government financed demand on the one hand and the required supply of goods, services and labor on the other;
- (2) a steep rise in the level of government expenditure could generate serious inflationary pressures;
- (3) the danger depends not so much on the pres-

ures of demand for goods and services as on that for skilled manpower;

(4) outside the government there could be inflationary pressures arising from the private sector's own autonomous development; and

(5) the rate at which important inflation could affect the domestic cost and price levels remains subject to the efficiency of protective measures.

Each of these statements provides a valuable lead into the plan and the opportunities and problems which face the kingdom.

The third plan's development strategy largely revolves around rapid increases in productivity (Table 1). It is estimated that had not the second plan achieved the productivity increases it did, the labor force requirements would have been more than twice what they were. Similarly, the expected increase in productivity in the third plan would translate into 550,000 fewer workers needed—a figure of significance when compared to the 155,000 projected as required for the period. As the participation rate of the Saudis in the labor force has been declining slightly, the bulk of the workers who would be hired in the absence of increased productivity would be foreign [4]. It should be noted that the decline in Saudi participation is a direct result of the expansion of the kingdom's education and training programs.

Capital and skill intensive improvements and developments within each of the specific sectors will form the source for productivity growth. Despite continued out-migration of labor, agriculture is expected to contribute a significant amount to the country's productivity improvement. High productivity projects, financed with the aid of the Saudi Industrial Development Fund, provide the major impetus on which manufacturing is to achieve its targeted increases in productivity.

MACROECONOMIC LINKAGES

The estimated structural equations attempts to capture several of the more important linkages between government activity, economic growth and inflation.

Government spending (Table 2) has grown considerably over the last few years, with domestic spending fluctuating in part as a means of stabilizing the price

Table 1. Growth targets for non-oil economy 1980–1985 (% growth yr)

	Employment	GDP	Productivity
<i>Producing sectors</i>			
Agriculture	-2.46	5.35	8.0
Other mining	6.07	9.78	3.5
Other manufacturing	9.52	18.83	8.5
Utilities	8.33	29.46	19.5
Construction	-5.77	-2.48	3.5
<i>Sub-total services</i>			
Trade	1.80	8.42	6.5
Transport	5.05	12.93	7.5
Finance	5.18	7.29	2.0
Other services	0.94	2.95	2.0
Government	5.57	7.16	1.5
<i>Sub-total</i>	3.06	8.84	5.6
<i>Non-oil economy</i>	1.16	6.19	5.0

Source: EIU Special Report No. 116 *Saudia Arabia: The Development Dilemma*.

Table 2. Saudi Arabia: government cash-flow spending 1977-1981 (billions of riyals)

	1977	1978	1979	1980	1981
1. Government spending	128.3	138.0	145.0	188.4	236.6
2. Total cash-flow spending	104.9	142.2	148.9	178.2	230.7
(a) Direct foreign exchange spending	39.6	43.9	46.0	43.3	73.8
(b) Domestic spending	65.3	98.3	10.2	134.9	156.9
3. Domestic revenue	3.3	4.9	6.4	7.2	9.1
4. Net cash-flows through government spending	62.0	93.4	96.5	127.7	147.8
<i>Annual rates of growth</i>					
1. Government spending	56.8	7.6	7.2	27.3	25.6
2. Total cash-flow spending	59.8	35.6	4.7	31.1	16.3
(a) Direct foreign exchange spending	87.7	10.9	4.8	-5.9	70.4
(b) Domestic spending	46.7	50.5	4.7	31.1	16.3
3. Domestic revenue	69.6	48.5	30.6	12.5	26.4
4. Net cash-flows through government spending	45.6	51.6	3.3	32.3	15.7

Source: Saudi Arabian Monetary Agency, *Annual Report 1401* (1981), p. 2.

level (as evidenced in public statement and the fairly close relationship (Table 3) between government domestic spending and the net cash flows through government spending).

Imports have played a large role in reducing domestic inflationary pressure (Table 3). At the same time increases in world prices are directly transmitted into the domestic economy. For example in 1981 (1400/01) imports (CIF) of the non-oil private sector increased by 21% to R1s 101.6 billion. Adjusting these for the rise of 9.6% in dollar-based CIF import prices and for the appreciation of 1% in the exchange rate of the riyal against the dollar, the growth in real imports was about 11%. Consequent to the rise of 8.6% in riyal import prices and of 7.8% in the non-oil GDF deflator, the average cost of supplies rose by 8.3%.

However, the cost of living index is estimated to have risen by only 3.6%. This is because of a number of factors including the lower average of the basket of goods and services included in the cost of living index compared with that covered by both the non-oil GDP and imports, and the substantial weight in the index for rents, which have been declining, and a number of essential items subsidized by the government.

The government has been the major source of increased private sector liquidity (M3) (Tables 4-6). Of the gross liquidity pumped into the economy over the 10 yr, 94% came from government cash flows and only 6% from commercial bank credit. About 86% of these gross liquidity flows was absorbed by net private sector balance of payments deficit leaving a balance of 14% for increase in M3.

During the second plan period the government's share of gross liquidity flow was even higher (95%) and a greater proportion of these (87%) was absorbed by private sector balance of payments deficit. The government appreciates the fact that in an economy like that of Saudi Arabia, government domestic spending exercises a dominant influence on money supply growth. As noted when the inflationary pressures increase (Table 9) the government usually places primary reliance on fiscal policy.

Because of the strong link between government spending and the money supply, and given the freedom from all restrictions on foreign exchange transfers, the role of monetary policy has been limited in Saudi Arabia and major changes in monetary expansion have been brought about through the

regulation of government spending. This role of fiscal policy will continue to be important even in the near future [5].

POLICY INSTRUMENTS

The above trends immediately raise the issue of whether from an institutional perspective Saudi policy makers have adequate tools to implement the goals of the third plan while at the same time achieving their aims of price stability, strong positive growth rates in the non-oil private sector, increased private fixed capital formation, moderate interest rates, a good supply of domestic liquidity (to lubricate the kingdom's rapid economic expansion), and a predictable—if not stable—riyal exchange rate.

Starting with the exchange rate SAMA prefers a predictable riyal, as this helps traders who might otherwise be exposed to fluctuations in the rate. SAMA's policy is to peg the riyal within a narrow trading band to the International Monetary Fund's Special Drawing Right (SDR). However, the monetary authorities also want to keep riyal movements under control. The SDR has recently been moving erratically because of the general turbulence of foreign exchange markets. As a result SAMA's policy of adjusting the riyal to new parities slowly, means that in the first half of 1981 re-evaluations of exactly 100 points were made nearly every week [6]. On the whole it appears that the authorities are in control of the riyal rate and that exchange policy *per se* should not limit the policy makers in striving to achieve the third plan's goals.

As noted above, fiscal policy is also hampered by planning commitments. The fiscal balance is heavily if not overwhelmingly influenced by the 5 yr spending targets. These do not allow conventional fine tuning measures.

Nevertheless, the way in which the funds are disbursed acts a shorter term regulatory valve on private sector activity and consumption. Since the steep inflation of the 1970s, the finance ministry has imposed strict control over funds' allocation to spending departments. Delaying payments helps to prevent over-stimulation.

The government has shown it is prepared to cut spending programs to stop inflation. In the mid-1970s prices rose by nearly 50% a year and threatened to undermine the development strategy. Budget cuts with subsidies and special infrastructure programs

Table 3. Saudi Arabia: total supplies, deflators 1975-1981 (billions of riyals)

	1975	1976	1977	1978	1979	1980	1981	Average annual growth 1975-1981
1. Total supplies at current prices	41.7	70.8	105.1	142.8	171.4	214.2	258.6	35.5
(a) Non-oil GDP	28.1	47.3	67.7	89.9	107.2	129.9	157.0	33.2
(b) Imports (CIF) of non-oil private sector	13.6	23.5	37.4	52.9	64.2	84.3	101.6	39.8
2. Total supplies at 1970 constant prices	21.7	30.1	39.9	48.6	53.3	60.6	67.5	20.8
(a) Non-oil GDP (1a deflated by 3a)	12.6	15.1	17.7	20.2	22.5	25.2	28.2	14.4
(b) Imports (CIF) of non-oil private sector (1b deflated by 3b)	9.1	15.0	22.2	28.4	30.8	35.4	39.3	27.6
2(b) as % of (2)	41.9	49.8	55.6	58.4	57.8	58.4	58.2	5.6
3. Deflators (1970 = 1.0)								
(a) Non-oil GDP deflator	2.230	3.130	3.826	4.438	4.761	5.158	5.560	16.5
(b) Riyal important price deflator	1.489	1.565	1.680	1.865	2.084	2.382	2.586	9.6
(c) Total supplies deflator	1.922	2.352	2.631	2.936	3.214	3.536	3.830	12.2
(d) Cost of living index	1.646	2.215	2.915	3.043	3.228	3.285	3.402	12.9

Source: Computed from Saudi Arabian Monetary Agency, *Annual Report*, various issues.

Note: Riyal import price deflator computed by adjusting the dollar based CIF import price index for any appreciation or depreciation in the riyal-dollar exchange rate.

helped reduce inflationary pressures. These policies can be used again if the economy shows signs of running out of control. However, the option is becoming increasingly unattractive because of the private sector's continued dependence on the flow of public spending; i.e. tight fiscal policy could greatly hinder the continued development of many infant manufacturing industries which low cost government funds are helping to bring to maturity.

One feature of the Saudi economy is its negligible taxation, and thus limited means of regulating economic activity—particularly consumption. On the political side, any suggestion that government should attempt to take spending power out of the economy through higher taxes would likely be extremely unpopular [6].

Constraints on using fiscal instruments places a greater burden on monetary policy as an economic stabilizer. As with fiscal policy, however, there are few instruments available. A major problem is that the government does not issue debt such as treasury bills. In part the absence of government debt stems from the fact that there is no need to borrow to finance government spending [7]. More important is the fact that Sharia law does not allow interest payments.

The restriction prevents SAMA from using open market operations to drain liquidity from the banking system and rediscounting paper at penal interest rates to control bank lending. In effect two of the most powerful monetary tools available to most modern central banks cannot be used in Saudi Arabia.

SAMA exercises control through reserve requirements and through "moral suasion." As of mid-1981 the main regulation; were:

(1) a 7% reserve requirement on demand and savings deposits. This was relaxed from 15% in 1980 to help to relieve a liquidity shortage;

(2) a ceiling on the deposit-to-capital ratio of 15 to 1; and

(3) the requirement that the equivalent of 25% of deposits must be held in liquid assets—deposits with SAMA, cash and callable loans.

Despite the shortage of policy instruments, the Saudi economy has performed exceptionally well in the past. The government has been able to contain inflation while at the same time the private sector appears to have had access to the credit it requires for continued expansion. If the third plan period does not encounter any major unforeseen shocks, the policy tools available to the authorities should prove adequate for manipulating the economy.

MACROECONOMIC RELATIONSHIPS

The macroeconomic model developed below is designed to examine economy from the point of view of the resources and requirements associated with alternative growth scenarios. Ultimately within the framework of an optimal control program, it is capable of distinguishing the most efficient growth path to the end targets. The model's forecast determines the non-oil income growth rate, the inflation

Table 4. Saudi Arabia: factors affecting private sector liquidity, first and second plan periods 1970-1980 (billions of riyals)

	Plan I	Plan II	Total	Plan I	Plan II	Total
	(1970-75)	(1975-80)				
1. Increase in gross private sector liquidity	43.9	445.8	489.7	100.0	100.0	100.0
(a) Government cash flows	40.1	422.0	462.1	91.3	94.7	94.4
(b) Government bank credit	3.8	23.8	27.6	8.7	5.3	5.6
2. Net private sector balance of payments deficit	32.9	387.2	420.1	74.9	86.9	85.8
3. Increase in private sector liquidity MS (1-2)	11.0	58.6	69.6	25.1	13.1	14.2
(a) Money M1	8.4	45.0	53.4	19.1	10.1	10.9
(b) Quasi money	2.6	13.6	16.2	5.9	3.1	3.1

Source: Saudi Arabian Monetary Agency, *Annual Report 1400* (1980), p. 15.

rate and foreign workforce implications of alternative spending rates.

The model is based on the assumptions that [8]:

(1) only a limited number of exogenous variables determine all the kingdom's basic macro variables;

(2) government expenditures follow a pattern (albeit at a higher level) similar to that over the 1960-1979 period;

(3) that there are no major alterations in world economic conditions during this period;

(4) that the current world oil glut will continue throughout the third plan period (1981-1985).

Also implicit in the model is the presumption that the public sector's role in Saudi Arabia will continue to increase in the third development plan reflecting the government's commitment to long term structural change. Government involvement in the economy manifests itself in a greater provision of financial support and social services. It also involves more government intervention in every sector of the economy to ensure that the plan's aims are being fulfilled.

In short the model assumes a constant infusion of government expenditures into the economy. Furthermore, that government financed demand in Saudi Arabia has its own rather special characteristics which are determined fundamentally by the nature of

the national economy; i.e. that the economy will remain incapable of self-sustained growth without continuous government demand manipulation. In this regard, while a breakdown of the contribution to the GDP by the oil and non-oil sectors of the economy at the beginning and of the third plan estimates that the value of the former in relation to the latter will decline from 165 to 130%, this grossly underestimates the importance of national revenue ultimately derived from the export sale of oil. IMF estimates of 92% of total revenues from oil exports, as against 8% from investment income in 1975, provide a more accurate order of magnitude that is unlikely to have changed significantly. The third plan statistics themselves indicate very clearly that if one isolates the reasonable autonomous producing, commercial and financial sectors in the GDP from those which are ultimately reliant on demand created government oil revenues, the estimates of the proportional importance of the former are of the order of no more than 20% at the beginning and 25% at the end of the planning period [1, p. 58].

The econometric model used to depict the major economic forces at work in the economy was estimated (Table 7) by a 2 stage least squares estimation procedure with annual data over the period 1960-1979 [9], its main features include:

Table 5. Saudi Arabia: factors affecting changes in M3 (billions of riyals)

	1977	1978	1979	1980	1981
1. Gross liquidity flows	61.8	96.2	105.0	137.2	158.8
(a) Cash flows through government spending net loans disbursed by government-sponsored credit institutions	61.9	93.4	96.5	127.7	147.8
(b) Increase in commercial bank claims on the private sector	-0.1	2.8	8.5	9.5	11.0
2. Private sector balance of payments deficit	-48.3	-84.7	-97.5	-127.1	-146.6
3. Other items (net)	-0.6	4.8	0.3	1.2	2.6
4. Increase in M3	12.9	16.3	7.8	11.3	14.8

Source: Saudi Arabian Monetary Agency, *Annual Report 1401* (1981), p. 8.

Table 6. Saudi Arabia: money supply and real money demand 1977-1981 (average annual rate of growth)

	1977	1978	1979	1980	1981
1. M3	52.7	43.6	14.5	18.4	20.4
2. Real supplies of goods and services	30.6	21.8	9.7	13.6	11.5
3. Inflationary gap	22.1	11.8	4.8	4.8	8.9
4. Non-oil GDP deflator	22.4	16.0	7.3	8.3	7.8
5. Important price index	4.9	11.0	11.7	14.3	8.6
6. Supply deflator	11.7	11.6	9.5	10.0	8.3
7. Cost of living index	25.4	4.4	6.1	1.8	3.6

Source: Saudi Arabian Monetary Agency, *Annual Report 1401* (1981), p. 6.

(1) 17 real (constant 1970) national income accounting equations (equations 1-17) and 3 (equations 18-20) nominal monetary features;

(2) a distinction between oil (equations 15) income (OGDPNP) and non-oil (equation 16) gross domestic product (NOXNP);

(3) the influence of government expenditures (Δ GENANP) on private consumption (PCNP, equation 1), reflecting perhaps public-private competition for resources—crowding out of private consumption;

(4) the use of numerous dummy variables (D1...D5) to depict various structural changes occurring in the 1970s;

(5) a causal monetary link (equations 18-21) between government nominal expenditures (GENAN) government deposits in the banking system (SGD), reserve money (SRM), the money supply (M2), and inflation—the non-oil GDP deflator (NODF).

(6) the influence of world inflation (ICEUV) on the terms of trade (TT) and thus gives domestic product (equation 17).

(7) a series of exogenous variables, oil price (OilP), and export unit values (EUV) depicting the slowdown in world oil demand, and;

(8) the third plan goal of reducing foreign work

Table 7. Saudi Arabia: keynesian forecasting model (two stage least squares estimates)

Real Variable Block

1. Private consumption (PCNP) = $0.67\text{CNPL} + 0.30\text{NOXP} - 0.44\text{GENANP} + 0.068$ (4.74) (4.48) (-3.63) (0.21)	DW = 1.65; Se = 0.49
2. Private investment (IPP) = $0.11\text{NOXNPL} + 1.77\text{D3} + 0.33$ (6.42) (8.57) (2.71)	DW = 1.75; Se = 0.23
3. Government consumption (GCNP) = $0.65\text{GCNPL} + 0.57\text{IGP} + 0.67$ (2.81) (2.23) (1.60)	DW = 2.46; Se = 0.89
4. Change in stocks (ISNP) = $0.044\text{NOXNP} - 0.21$ (2.95) (-1.18)	DW = 2.27; Se = 0.42
5. Government non-oil revenue (GNREVP) = $0.11\text{NOXNP} + 1.27\text{D3} + 0.27$ (4.14) (3.62) (1.39)	DW = 1.84; Se = 0.37
6. Government oil revenue (GOREVP) = $7.45\text{VPE} + 6.76\text{TT} + 25.27\text{D3} - 6.61$ (2.62) (5.30) (9.87) (-4.35)	DW = 2.59; Se = 2.53
7. Imports (ZANP) = $-2.84\text{TINP} + 2.01$ (-49.17) (4.97)	DW = 1.20; Se = 1.27
8. Exports (EP) = $30.23\text{VPE} + 1.950\text{ILP} - 5.03$ (4.91) (5.44) (-1.60)	DW = 1.08; Se = 6.38
9. Net factor payments (NFPP) = $-0.032\text{EP} - 4.08$ (4.17) (-3.58)	DW = 0.49; Se = 3.47
10. Private savings (PSPP) = $0.80\text{BNOXNP} - 2.06$ (5.38) (-1.16)	DW = 2.10; Se = 4.18
11. Government savings (GSP) = $0.71\text{GREVP} - 1.01\text{GENANP} + 3.31$ (6.83) (-3.31) (2.31)	DW = 0.78; Se = 4.37
12. Investment in oil sector (IOP) = $0.34\text{IOPL} + 0.57\text{CPP} - 0.16$	DW = 1.92; Se = 0.22
13. SAMMA Domestic assets (SDAP) = $0.98\text{NSFAP} + 0.52\text{GENANP} - 1.71\text{D5} + 0.05$ (-53.16) (4.02) (-2.41) (0.10)	DW = 1.19; Se = 0.22
14. Monetary system net foreign assets (NSFAP) = $3.15\text{NOXNP} - 9.36$ (5.94) (-1.47)	DW = 0.60; Se = 14.93
15. Oil sector gross domestic product (OGDPNP) = $16.70\text{VPE} + 15.84\text{TT} - 20.93\text{D3} - 15.21$ (2.73) (5.77) (-3.80) (-4.65)	DW = 1.69; Se = 5.45
16. Non-oil gross domestic product (NOXNP) = $0.37\text{KP} + 0.059\text{EMPT} - 7.24$ (15.40) (5.71) (-3.66)	DW = 2.07; Se = 6.57
17. Gross domestic product (GDPNP) = $23.54\text{VPE} + 10.97\text{TT} - 6.66$ (3.93) (4.97) (-2.73)	DW = 0.98; Se = 5.42

Nominal-Monetary Block

18. Government deposits in banking system (SGD) = $1.23\text{GENAN} + 7.96$ (9.16) (1.16)	DW = 0.63; Se = 25.78
19. Reserve money (SRM) = $0.21\text{GENAN} + 0.076\text{SGD} + 1.21$ (3.42) (2.63) (0.87)	DW = 1.24; Se = 5.06
20. Money supply (M2) = $0.80\text{SRM} + 0.26\text{GENANL} + 0.33$ (17.67) (13.31) (1.01)	DW = 1.98; Se = 1.17

Table 7. *Continued*

Price Indices		
21. Non-oil GDP deflator (NODF) =	$0.035M2L + 0.096NOXNP + 0.12IGPL + 1.11D3 + 0.76$	DW = 1.92; Se = 0.09
	(3.29) (4.64) (1.90) (12.03) (17.61)	
22. Gross domestic product deflator (GDPDF) =	$1.19CPI + 0.160ILP - 0.34$	DW = 1.74; Se = 0.19
	(10.44) (11.43) (-97)	
23. Consumer price index (CPI) =	$1.51EXCESSEL + 0.62D1 + 0.62$	DW = 1.19; Se = 0.22
	(8.15) (4.19) (8.31)	
Identities		
24. Total consumption (TCNP) =	PCNP + GCNP	
25. Total investment (TINP) =	IPP + IGP	
26. Gross capital formation (GCF) =	TINP + ISNP + IOP	
27. Gross national product (GNP) =	GDPNP + NFPP	
28. Total savings (SNP) =	GNP - TCNP	
29. Domestic resource gap (SI) =	SNP - GCF	
30. External resource gap (EM) =	EP + ZNANP + NFPP	
31. Terms of trade (TT) =	EUV/ICEUV	
32. Domestic absorption (ABP) =	TCNP + TINP	
33. Excess monetary pressure (EXCESSE) =	M2/ABP	
Exogenous Variables		
34. Government investment (IGP) =	Design variable	
35. Crude petroleum production index (CPP) =	1.00	
36. Oil price (OILP) =	\$30 per barrel	
37. Volume petroleum exports (VPE) 1975 =	100.0	
38. Industrial country export unit value (ICEUV) 1970 =	100.0	
39. Labor force (EMPT)		
40. Export unit (EUV) 1970 =	100.0	

force—labor force (EMPT) set at an average annual growth of 1.16% per annum.

NATURE OF OPTIMUM CONTROL

The macro model is the key element in the optimum control exercises [10]. The literature on optimum control is highly technical, yet the concept itself is straightforward. The essential idea of optimal control is precisely to derive the optimal policy in order to steer the economy to the specified targets. A necessary step in applying control theory is to specify an objective function or a welfare loss function by which the outcome associated with the optimal policy or its alternatives can be evaluated. Given the welfare loss function and a dynamic model, a policy sequence can be found minimizing the expectation of the welfare loss for a given time horizon. In the present case where the welfare loss function is quadratic and the dynamic system is linear, the solution takes the form of a linear feedback control equation. That is to say, the optimal policy is a linear function of lagged endogenous variables and the exogenous factors including the target values of the target variables.

Once the objective function is determined the programming model together with the objective functions can be used to derive the optimal policy [11]. The optimal policy so derived does not require any further consistency check as required in the conventional programming exercises which usually do not make use of a well defined objective function and a simultaneous equation model.

While it is recognized that there are many particularly political elements which are not included in the calculations but which are nevertheless imperative in making a policy decision, policies derived within the

framework of optimal control have the merit of logical consistency and compatibility.

The welfare loss function is specified in quadratic form as:

$$W = \frac{1}{2} \sum_{t=1}^n (Y_t - Y_t^*)' K_y (Y_t - Y_t^*)$$

where Y_t^* indicates the target values of Y_t ; K_y is a diagonal matrix of rank q with q indicating the number of targets and n is the specified time horizon. The elements in the K -matrix indicate the weights of penalty which are attached to the squared deviations between the actual values and the targets values of the target variables. The deterministic optimal control problem for the kingdom is therefore to find x_t which minimizes the welfare loss functions given the macroeconomic relationships depicting the country's main economic linkages.

It should be noted that in most of the exercises described below, there was equality between the number of targets and the number of control variables so that the optimal policy solution was unique, not depending on the K -matrix (given the targets selected were compatible for the given set of control variables and that the control variables were independently and indefinitely variable).

SIMULATION METHODOLOGY

Utilizing the macroeconomic model presented above, the optimum control simulations were designed to test the consistency of the third five year plan's major objectives. Real government investment was selected as the instrument variable in each of the simulations on the assumption that the Saudi authorities will continue to have more control over capital expenditure than current expenditures (salaries, etc.).

Of course, this could change if the government decides to reduce military spending as part of a post-oil price decline austerity measure. Still, past government austerity measures (i.e. 1976–1977) have been characterized more by a postponement of new capital projects than either wage or public employment freezes. The same applies to military expenditures.

For purposes of the simulations the major economic objectives of the third plan are dichotomized into:

(1) a growth objective—real non-oil gross domestic product increasing at a minimum acceptable rate of 6.19% per annum over the 1980–1985 period;

(2) a social objective—the labor force increasing at a maximum of 1.16% per annum, reflecting the policy makers priority of gradually reducing the kingdom's dependence on foreign workers;

(3) a stability of absorptive capacity objective operationally specified as a rate of inflation less than 10%, and preferably in the 7–8% range; and

(4) an ideological objective—that of the private sector gradually replacing government involvement in an essentially free market economy—the share of private sector activity relative to government activity should begin to increase fairly rapidly, particularly in light of the completion of the kingdom's development. The actual target of private to government involvement in the economy has never been articulated by the Saudi authorities. Realistically, however, it makes sense for purposes of simulation to set as a target the rough balance between private and government expenditure existing prior to the 1973 oil boom, i.e. around one to one (compared with the 1980 ratio of private to government expenditures of 0.66).

SIMULATION RESULTS

The first set of simulations were made on the assumption that the Saudi authorities are determined

to implement a strategy of gradual reduction in the foreign work force, i.e. that a labor force growth target of only 1.16 average annual rate of increase would be adhered to under all circumstances arising during the third plan period.

The simulated growth paths produced by the optimal control program (Table 8) illustrate several fundamental trade-offs likely to confront the Saudi policy makers throughout the third plan period and possibly well into the fourth plan period (1985–1990):

(1) it is clearly apparent that high growth (6.19% per annum and above), price stability (inflation under 10% per annum), increased private sector participation in the economy, and a significant reduction in the foreign work force are incompatible objectives;

(2) real income growth in the target range (6.19% per annum) will be difficult to sustain without incurring double digit inflation (paths I, II and VI);

(3) a significant increase in the relative share of private sector expenditures can occur only at a great cost in terms of reduced real over-all non-oil gross domestic product growth (paths III and IV);

(4) similarly, inflation can be constrained at moderate rates (5–10% per annum) only at the cost of significantly reduced real income growth (paths III, IV);

(5) the best compromise among policy objectives (assuming each has more or less equal priority) appears to be one of moderate growth—non-oil income expansion in the 5% range, under conditions of minimum inflation (path V). If followed, this path would not only assure sustained real income increases but, perhaps more importantly, would also allow price stability to be maintained while meeting the foreign labor force objectives of the government. At the same time there would be a significant increase in the relative participation of the private sector in the economy (increasing its ratio to government expenditures from 0.66 in 1980 to 0.91 by 1985).

It should be noted that growth paths I through VI

Table 8. Saudi Arabia: alternative growth strategies under labor force constraints 1981–1985 (average and growth rates)

Growth strategy	I	II	III	IV	V	VI
Non-oil GDP	7.8	6.19	1.0	1.3	5.0	6.19
Private consumption	5.4	9.2	11.3	11.8	13.9	12.6
Private investment	4.1	4.9	2.4	2.4	4.0	5.1
Private expenditures	5.1	11.1	9.4	9.8	11.2	10.9
Government investment	14.1	4.7	-4.6	-6.4	-1.3	6.7
Government consumption	11.9	9.2	1.7	1.1	6.9	9.8
Government expenditures	12.8	7.4	-0.7	-1.7	3.8	8.6
Non-oil deflator	10.1	13.2	5.1	5.0	11.8	13.5
Ratio-private government expenditure (1985)	0.44	0.74	1.00	1.00	0.91	0.69

Notes: Average annual growth of labor force held at 1.16% in all strategies.

Growth Strategy Assumptions:

- I High growth with price stability—non-oil gross domestic product deflator maximum = 10% per annum; maximum rate of increase in non-oil GDP.
- II Third plan target growth under minimum inflation conditions—target growth in non-oil GDP = 6.19%; minimize inflation.
- III High private sector participation with growth—ratio private to government expenditures equal to one by 1985; maximum rate of growth.
- IV High private sector participation with price stability—ratio private to government expenditures equal to one by 1985; minimize inflation.
- V Moderate growth-high stability plan—target rate of non-oil GDP = 5.0%; minimize inflation.
- VI Third Plan growth target with maximum private sector participation—non-oil GDP growth = 6.19% per annum; maximize private-government expenditure ratio.

Table 9. Saudi Arabia: minimum patterns of inflation over alternative growth paths 1981-1985 (average annual growth rates)

	Non-oil gross domestic product Growth target 10.0					Non-oil gross domestic product Growth target 8.0				
	Average annual rate of increase in labor force					Average annual rate of increase in labor force				
	1.16	2.0	3.0	4.0	5.0	1.16	2.0	3.0	4.0	5.0
Non-oil GDP	10.0	10.0	10.0	10.0	10.0	8.1	8.0	8.0	8.0	8.0
Private consumption	13.6	13.0	11.8	13.4	14.2	11.6	13.7	12.4	14.4	13.5
Private investment	6.5	6.5	6.6	6.5	6.7	5.5	5.5	5.6	6.5	5.7
Private expenditure	12.1	11.5	10.6	11.8	12.5	10.2	11.9	10.8	12.6	11.7
Government investment	11.7	12.4	13.9	10.9	9.7	10.9	7.0	9.4	8.9	5.9
Government consumption	14.9	14.6	14.2	13.0	12.3	12.4	11.0	11.0	11.7	9.0
Government expenditures	13.7	13.8	14.1	12.2	11.3	11.8	9.4	10.4	10.6	7.7
Non-oil deflator	18.9	18.0	16.5	16.2	15.8	15.3	15.8	14.3	16.1	11.9
Ratio, private-government expenditures	0.58	0.56	0.53	0.61	0.66	0.58	0.70	0.64	0.68	0.75
	Non-oil gross domestic product Growth target 6.19					Non-oil gross domestic product Growth target 4.0				
Non-oil GDP	6.19	6.19	6.19	6.8	7.9	3.4	3.9	4.5	5.2	5.8
Private consumption	12.9	12.2	16.4	13.4	12.7	11.0	11.5	12.0	12.5	13.0
Private investment	4.8	4.7	4.6	4.8	5.6	3.4	3.6	4.0	4.3	5.6
Private expenditure	11.2	10.5	13.9	11.5	11.1	8.4	9.7	10.2	10.7	11.1
Government investment	4.7	5.4	-6.3	4.4	9.1	2.0	2.0	2.0	2.0	2.0
Government consumption	9.2	8.8	6.5	8.1	10.1	5.6	5.6	5.6	5.6	5.6
Government expenditures	7.4	7.5	2.0	6.8	9.7	4.2	4.2	4.2	4.2	4.2
Non-oil deflator	13.2	11.6	13.1	12.1	12.9	8.2	8.3	8.4	8.5	8.7
Ratio, private-government expenditures (1985)	0.74	0.71	1.09	0.77	0.66	0.79	0.81	0.82	0.84	0.86

Table 10. Saudi Arabia: maximum participation of the private sector over alternative growth paths 1981-1985 (average annual growth rates)

	Inflationary constraint 14.5					Inflationary constraint 12.5				
	Average annual rate of increase in labor force					Average annual rate of increase in labor force				
	1.16	2.0	3.0	4.0	5.0	1.16	2.0	3.0	4.0	5.0
Non-oil GDP	8.6	8.9	9.5	10.1	10.6	7.2	7.5	8.1	8.6	9.2
Private consumption	9.0	10.3	9.9	10.5	11.0	8.5	10.5	9.8	10.1	11.7
Private investment	5.5	5.8	6.1	6.3	6.5	4.6	5.1	5.1	5.3	6.0
Private expenditures	7.2	9.2	9.0	9.2	10.0	7.6	9.2	8.8	9.0	10.4
Government investment *	14.7	13.3	14.6	14.6	14.5	12.3	10.3	11.9	12.5	10.9
Government consumption	13.7	13.3	13.6	13.6	13.6	11.6	11.1	11.5	11.4	11.3
Government expenditures	13.9	13.3	14.0	13.8	13.9	11.9	10.8	11.7	11.6	11.1
Non-oil deflator	14.5	14.5	14.6	14.7	14.7	12.0	12.5	12.3	12.2	12.7
Ratio, private-government expenditures	0.47	0.52	0.50	0.51	0.52	0.52	0.58	0.55	0.55	0.60
	Inflationary constraint 10.0					Inflationary constraint 7.5				
Non-oil GDP	5.6	6.5	7.0	7.6	8.2	3.4	3.8	7.4	5.0	8.6
Private consumption	9.1	10.5	11.0	11.4	11.8	10.2	10.7	1.9	11.3	2.6
Private investment	3.8	4.6	4.8	5.1	5.4	3.1	3.3	2.9	3.8	3.4
Private expenditures	7.9	8.2	9.6	10.0	10.4	8.6	9.1	2.1	9.6	2.5
Government investment	8.1	6.9	6.8	6.8	6.8	2.5	2.3	17.5	2.6	16.9
Government consumption	9.0	8.8	8.8	8.8	8.7	5.5	5.4	11.2	5.2	11.5
Government expenditures	8.6	8.0	8.0	8.0	8.0	4.3	4.2	13.3	4.2	13.9
Non-oil deflator	9.9	10.0	10.0	10.0	10.0	7.5	7.5	7.5	7.3	7.5
Ratio, private-government expenditures (1985)	0.60	0.65	0.67	0.68	0.70	0.76	0.78	0.37	0.80	0.37

Table 11. Saudi Arabia: maximum participation of the private sector over alternative growth paths 1981-1985 (average annual growth rates)

	Non-oil gross domestic product Growth target 8.0					Non-oil gross domestic product Growth target 6.19				
	Average annual rate of increase in labor force					Average annual rate of increase in labor force				
	1.16	2.0	3.0	4.0	5.0	1.16	2.0	3.0	4.0	5.0
Non-oil GDP	8.0	8.0	8.1	8.0	8.0	6.19	6.19	6.19	6.19	6.19
Private consumption	12.9	13.3	13.8	13.9	14.3	12.6	12.8	13.1	13.3	13.3
Private investment	6.0	6.1	6.1	6.1	6.0	5.1	5.1	5.0	5.0	4.8
Private expenditures	11.3	11.7	12.1	12.2	12.4	10.9	10.1	11.3	11.5	11.4
Government investment	9.9	9.1	8.1	7.0	5.9	6.7	5.8	4.8	3.6	2.7
Government consumption*	12.4	11.7	11.0	10.1	9.2	9.8	9.1	8.3	7.3	6.3
Government expenditures	11.4	10.7	9.8	8.9	7.9	8.6	7.8	6.9	5.8	4.9
Non-oil deflator	16.1	15.6	15.0	14.1	13.2	13.5	12.8	11.9	10.9	9.6
Ratio, private-government expenditures	0.62	0.65	0.69	0.72	0.72	0.69	0.72	0.76	0.81	0.84
	Non-oil gross domestic product Growth target 4.0					Non-oil gross domestic product Growth target 2.0				
Non-oil GDP	4.0	4.0	4.5	5.1	5.7	1.9	0.1	1.9	0.9	0.1
Private consumption	11.5	11.8	12.2	12.6	13.1	10.3	9.3	10.2	10.5	11.2
Private investment	3.8	3.8	4.0	4.3	4.6	2.5	1.6	2.4	1.9	1.7
Private expenditures	9.7	10.7	10.3	10.8	12.3	8.5	7.6	8.5	8.8	9.2
Government investment	3.0	1.9	1.5	1.5	1.5	-1.5	-4.2	-2.8	-7.6	-12.4
Government consumption	6.6	5.8	5.4	5.4	5.4	2.8	-0.4	1.2	-2.1	-5.1
Government expenditures	5.2	4.2	3.9	3.9	3.9	1.1	-1.9	-0.4	-4.2	-7.8
Non-oil deflator	9.6	8.8	8.4	8.5	8.7	5.3	1.4	3.1	0.8	-1.3
Ratio, private-government expenditures	0.77	0.82	0.84	0.86	0.88	0.89	0.99	0.95	1.18	1.45

are financially feasible at oil prices of \$25 a barrel or more, and production rates above 5 million barrels/day. If the price and or production rates fall below these values, the rate of liquidation of the kingdom's overseas asset or portfolio would also have to be treated as a policy goal, and simulations made with this added constraint.

Depending on how one views things, the simulations are either encouraging or somewhat disturbing. With regard to the latter, it is readily apparent that without fundamental structural changes in the economy (together with unprecedented rates of increase in labor productivity) the kingdom will be unable to achieve its third plan objectives by simply throwing more money on infrastructure and related projects.

On the other hand the picture is likely to change fairly drastically if the authorities are willing to relax their policy on foreign workers. This latter hypothesis was tested through a series of optimum control simulations assuming: (1) fixed growth targets (Table 9); (2) inflationary ceilings (Table 10); and priority towards relative rates of private sector expansion (Table 11).

With the labor force expanding from the third plan targeted rate of 1.16–5.0% per annum it appears (Table 9) that:

(1) some inflationary pressures can be reduced with a greater than planned infusion and or retainment of foreign workers;

(2) with the labor force increasing in the 4–5% range, a rate of around 6% real growth might be achieved with inflation held around 8% together with a gradual increase in the relative share of private sector participation;

(3) growth rates of 8% and over are clearly undesirable under any reasonable labor force policy, i.e. expansion in this range would produce unacceptable levels of inflation together with a likely decline in the relative participation of the private sector in the economy.

In general, these results are reinforced by the results obtained by simulations identifying the maximum non-oil gross domestic product growth rates (Table 10) attainable under alternative inflationary constraints:

(1) rates of growth in the 6–7% range may be possible at the expense of relative private sector expansion;

(2) significant private sector expansion seems possible only under greatly reduced over-all growth conditions.

More specifically (Table 11) with regard to relative private sector expansion:

(1) relative private sector expansion is facilitated at higher labor force growth rates;

(2) significant increase in the relative contribution of the private sector to expenditures can be obtained only at the expense of over all income growth;

(3) moderate increases in the relative degree of private sector participation in the economy are possi-

ble over fairly high non double digit inflationary growth paths.

CONCLUSION

The above analysis had described a number of growth paths projections which differ from the original third plan targets, primarily because of alternative changed assumptions regarding the rate of growth in the labor force. As detailed earlier, the changes in labor force, capital stock and productivity assumptions required for these simulations are clearly within reasonable (albeit perhaps politically sensitive) bounds.

The situations explore the sensitivity of the economy to variations in policy priorities and are dependent on the way in which the variations are achieved. For example, if the same change in real output were achieved under reduced inflationary conditions, it is likely that the private sector could achieve a somewhat larger relative role in the economy, but at the expense of an increased number of foreign workers.

These caveats merely imply that there are no unique bounds to the kingdom's growth path over the third five year plan period. Any growth path ultimately selected will implicitly be at the expense of one of the plan's major priorities.

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