DISCUSSION PAPER

Report No.: DRD92

OIL WINDFALLS IN A CONTROLLED ECONOMY:

A "FIX-PRICE" EQUILIBRIUM ANALYSIS OF ALGERIA

Patrick Conway and Alan Ge'b

August 1984

Development Research Department
Economics and Research Staff
World Bank

Oil Windfalls in a Controlled Economy:

A "Fix-price" Equilibrium Analysis of Algeria

by

Patrick Conway and Alan Gelb

University of North Carolina at Chapel Hill and

Development Research Department, World Bank

August 1984

Disclaimer

We are grateful to Nicolas Mathieu and Sweder van Wijnbergen for comments and suggestions on various drafts and Shahrzad Gohari for computer programming.

Abstract

Algeria is distinctive among developing countries for its highly controlled, planned economy and the overwhelming weight of its public sector in production. Because of these characteristics the Algerian response to increased oil revenues after 1973 differed considerably from that of more market-oriented oil exporters, in terms of sectoral evolution and real exchange rate movements. This paper reviews the Algerian development strategy and develops and estimates econometrically a fix-price equilibrium model of the Algerian economy.

The model emphasizes spillovers of purchasing power from rationed wage goods onto domestic financial assets as the major equilibrating variable. The results are shown to account for Algeria's unusual adjustment pattern after 1974. They also have implications for a transition towards a flex-price system.

Table of Contents

List of Tables

List of Figures

Oil Windfalls in a Controlled Economy:

A "Fix-price" Equilibrium Analysis of Algeria

by

Patrick Conway and Alan Gelb

University of North Carolina at Chapel Hill and

Development Research Department, World Bank

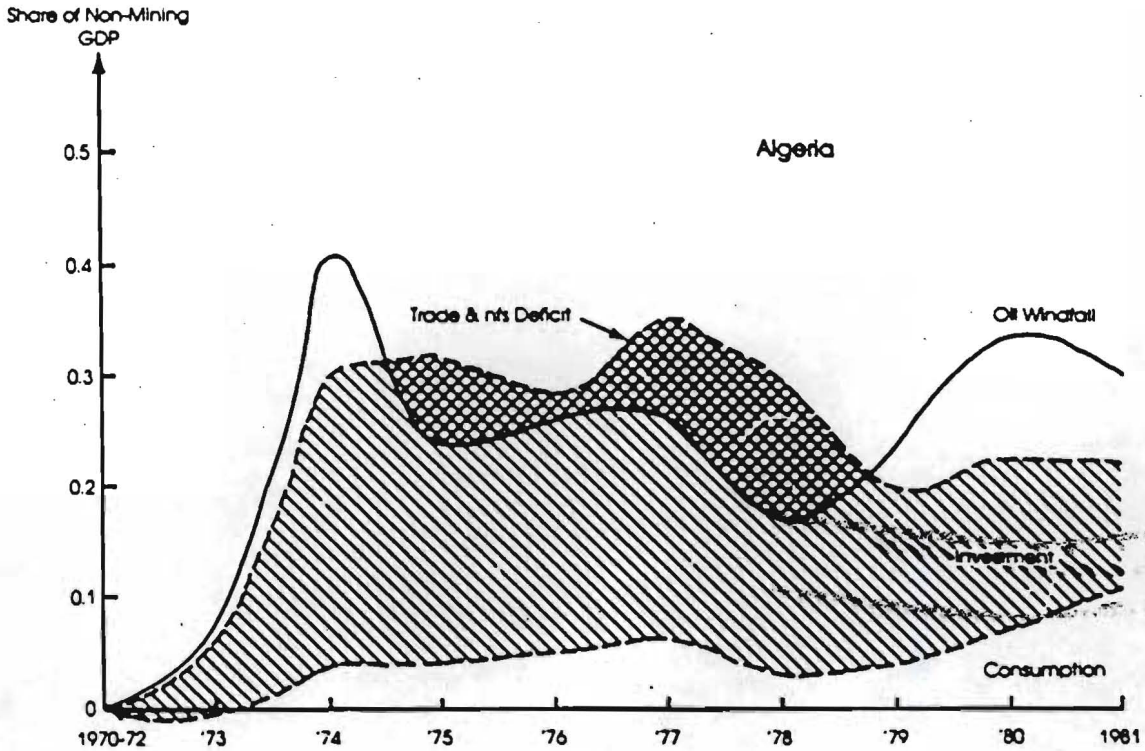
I. Introduction

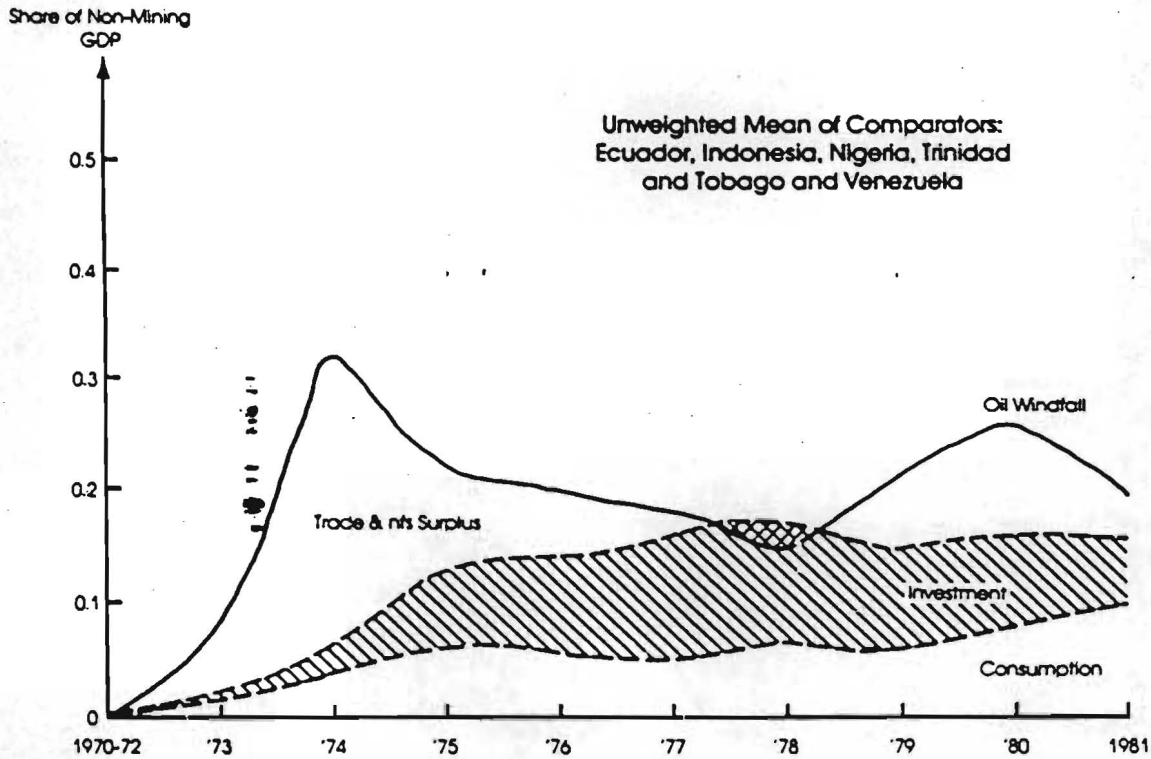
Half of Algeria's exports came from oil in the early 1960s. In the aftermath of the prolonged war of independence which severely disrupted the nonoil economy, this proportion had risen to three quarters by the early 1970s. In 1972 oil exports were equivalent to 16% of GDP. The quadrupling of world oil prices over 1973-74 and their redoubling over 1979-80 therefore conferred large windfall gains on Algeria as it did on other oil exporters. Taking into account both price and volume changes, the windfall, expressed relative to the size of the nonmineral economy in Figure 1, peaked in 1974 at the equivalent of 42% of nonmining GDP.[1/] It then declined to 26% and later to 18% as world oil prices eased and the volume of Algerian hydrocarbon output grew more slowly than its nonoil economy, before rebounding to 34% with the second oil price rise.

1/ Underlying Figure 1 is a hypothesized projection of the Algerian economy in balanced growth as between mineral (overwhelmingly oil and gas) and nonmineral components at relative prices set at their 1970-72 base levels. The Figure depicts the windfall as the proportional deviation of hydrocarbon value-added from its balanced-growth trend.

Figure 1

The Oil Windfall and Its Use: 1973-81





World Bank—26452

While the relative size of the oil windfall was not untypical for a capital-importing oil-exporting developing country, Algeria is exceptional among developing countries because of the highly controlled nature of its socialist economic system. All prices and formal wage scales are administratively determined. A system of Treasury subsidies to public enterprises essentially removes the constraint of even administered market forces on firms, which therefore face a "soft" budget constraint.[1/] Private enterprise has been marginal outside a part of agriculture and certain minor urban activities. The state has a virtual monopoly on the allocation of investible resources through its control of the banking system and the Treasury acts as a major financial intermediary. Trade takes place through official channels only, imports are controlled and foreign exchange tightly allocated. While "black markets" do undoubtedly exist, by all accounts they are minor. Despite moves after 1978 to liberalize and decentralize production and free certain markets (notably in agricultural products), Algeria is still well characterized as having a socialist, centrally planned "fix-price" economy.[2/]

The broad outline of how a market economy should respond to increased domestic spending out of oil (or other) windfalls is well established and follows the analysis of Bruno (1975).[3/] Relative prices play a major equilibrating role, particularly the price of nontraded relative to traded

---

1/ Kornai (1978) analyses the "soft" budget constraint of the production sector in the context of East European socialist countries.

2/ "Fix-price" does not imply that prices are constant; it rather means that price variations are not a major endogenous mechanism for clearing markets. The terminology is due to Hicks (1965).

3/ The model has, in fact, been known since the ninetenth century when it was applied by John Cairnes to analyze the impact of gold discovery on Australia over 1851-73: See Bordo (1975).

goods (the real exchange rate) which appreciates to shift factors of production to nontraded sectors and deflect demand onto nonoil exportables and imports. Such mechanisms cannot operate in a fix-price economy, which must substitute various rationing mechanisms (either on the demand or supply sides of individual markets) for the process of clearing through relative prices. If these mechanisms can be enforced, there is no presumption that the evolution of major price and resource indicators will follow the free-market paradigm. If, however, costs of enforcement rise or its effectiveness declines as the degree of divergence between the rationed and unrationed equilibria increases, it is likely that the state will make some adjustments in the setting of wages and prices and the allocation of investible resources — albeit reluctantly and with a lag.

This paper considers the Algerian government's response to the oil windfalls and the consequent evolution of the nonoil economy. How has the Algerian strategy differed from strategies characteristic of more market-oriented economies? How has the nonoil economy equilibrated in response to changing levels of public activity, and has it been able to avoid the "Dutch Disease" characterised by "overvalued" real exchange rates, contracting nonoil tradeable sectors and large resource shifts towards construction and services?

To comprehend a development strategy so consistent as that of Algeria it is necessary to appreciate the historical and institutional roots of the fix-price economy and the role of the public sector. Section II outlines these, and provides a set of indicators describing the structure of the economy before the first oil price increase. The main, distinctive elements of the strategy are brought out in Section III: they reflect (a) the priorities of the Algerian government and (b) the natural resource endowment of the country. The section also analyses the evolution of structural

indicators after the oil price increase, and notes the unusual development of the controlled Algerian economy by comparison with other oil-exporting countries.

Section IV develops a fix-price equilibrium macroeconomic model of the Algerian economy, tailored to reflect its institutions and the objectives of government. The model is used to investigate the importance of rationing in the goods market, and the consequent involuntary holding of cash balances by the private sector, as an explanation of the Algerian pattern. In Section V the model is estimated econometrically using techniques developed by Fair and Jaffee (1972) and Amemiya (1974) to incorporate "spillovers" of purchasing power due to the rationing of consumer demand. The results are of interest for two reasons: they offer evidence of significant "spillover" effects on demand for real money balances, and they provide coefficient estimates for a price-responsive model of Algerian demand behavior. These, in turn, permit an assessment of how Algeria might have adjusted in the absence of rationing and price controls. Section VI offers concluding comments.

II. Origins of the Fix-Price Economy and the Algerian Development Strategy.

The Algerian development strategy was first enunciated during the eight-year revolution which led to Algerian independence, and its substance was shaped by the bitter and costly nature of the war. Although the Algerian leadership has been characterized by factionalism reflecting differences in political outlook, generation and role,[1/] the essential elements of

---

1/ For analyses see Quandt (1970), Zartman (1975).

development policy appear to have been accepted by almost all groups. These elements can be summarized in three general principles: 1/

(1) Algeria should develop from a socialist perspective; income equalization was to be encouraged across regions and individuals. Growth and employment creation were important objectives.

(2) Economic policy should promote self-reliance and minimise long-run dependence on foreign financial and technical assistance.

(3) Economic planning was the responsibility of the State but should include some participation by workers.

The economic history of post-independence Algeria can be divided into three phases. The constitution of September 1962 established Algeria as a one party socialist republic with Ahmed Ben Bella as president. After three years he was toppled in a bloodless coup which placed Houari Boumedienne (1965-78) in the presidency. Boumediene was followed by Chadli Benjedid. Each president implemented a different policy regime, but all are best considered as emphasising different aspects of the three general principles.

Ben Bella adopted a pragmatic approach towards the major goal of reconstituting the economy after the revolution. He focused on the promotion of light industry (especially consumer goods) and on agrarian reform in the wake of a massive exodus of French colons during and after the revolution. Management of the abandoned industrial and agricultural firms was entrusted to workers (the autogestion program). An assessment of Ben Bella's contribution suggests that economic performance was disappointing and that problems of chronic rural and urban labor surplus in particular had not been resolved. (Mallarde, (1975)). While estimates are unreliable, perhaps two-thirds of the

---

1/ The documents enumerating the Algerian principles of development are: Program of Tripoli, May 1962; Constitution, September 1963; Charter of Algiers, April 1964; National Charter, June 1976; Constitution, November 1976; Three-Year Plan, (1967-1969); Four-Year Plan (1970-1973); Four-Year Plan (1974-1977); Five-Year Plan (1980-1984).

rural and one-fourth of the urban labor forces were un-or under-employed.[1/] But the period marked the emergence of "la nouvelle classe" — a middle class of public sector bureaucrats, technocrats and managers — which was to play an increasingly important role in future years.

Boumediene's accession in June 1965 marked a major shift in Algerian development policy. Influenced by Francois Perroux and G. Destanne de Bernis, a strategy was formulated of industrialisation, integration of domestic industry and closing off the economy to foreign influences. Drawing on the work of Hirschman, "industrialising" industries — those with strong backward and forward linkages — were to develop the economy.[2/]

Heavy producer-goods industries (steel, petrochemicals, fertilizers) were believed by Destanne de Bernis to promise the strongest linkages. The role of the hydrocarbon sector was considered particularly crucial: a "premier industrialising industry", it promised a source of investment demand, raw materials for downstream processing activities and resource rents to fund industrialisation. Perroux's study of "growth poles" suggested that regional integration would best be achieved by establishing new industrial centres at Arzew, Skikda and Annaba although they had small existing industrial bases. Finally, the objective of becoming a closed economy was heavily influenced by the work of Samir Amin, which identified a dependent economy as one with export and luxury consumer goods as dominant sectors and a "self reliant" economy as one which included the production of producer goods and necessities.

1/ Estimates of Ministere de la Planification.

2/ The intellectual origins of the Algerian strategy are discussed by Raffinot and Jacquemot (1977).

The shift in development policy involved a strengthening of the planning mechanism, initiation of a sustained public investment drive and a program of consumption austerity to finance capital accumulation. Over 1967-72 investment rose from 21.7% to 25.5% of GDP while private consumption fell from 58.9% to 55.2%. Over 1970-72 parastatal investment (representing the productive role of the public sector) rose by 60% in nominal terms and direct investment (representing its infrastructural role) by 50%, as the small private investment component (estimated residually) halved.

The Benjedid presidency has been marked by a moderation of the capital accumulation and central planning features of the Boumediene era. This movement began in Boumediene's last years, as la nouvelle classe of technocrats gained greater power, but Boumediene's death and Benjedid's accession in 1978 accelerated the process. More recent economic policy, as exemplified by the Five-Year Plan of 1980-1984, has placed greater stress on development of consumer-good industries and has introduced the market price mechanism for some agricultural products.

Thus, even at the start of the 1970s, the Algerian economy displayed distinctive structural characteristics. The ratio of total absorption of goods and services relative to the nonmining economy[1/] was high by international standards at 123%. The excess was financed mainly by oil exports but remittances of Algerians working abroad and foreign assistance also contributed significantly. Private consumption represented 65% of nominal nonmining GDP, however, against an international norm of 66% of total GDP for a typical developing country at Algeria's level of income per

---

1/ For purposes of international comparison it is necessary to divide the economy into mining and nonmining rather than oil and nonoil. This introduces only minor errors, since oil dominates the mining sector in the countries considered.

head.[1/] Public consumption at 18% slightly exceeded the norm of 14%, but the high absorption ratio was almost entirely due to public investment, which at 41% stood twice as high as its "normal" ratio. It is estimated that more than 85% of total investment was that of central government or public enterprises.

In production structure too, Algeria's economy was distinctive. The mining sector, with the equivalent of 18% of nonmining output in 1972, was of course a dominant sector. Agriculture provided only 11% of nonmining output (against a norm of 25%) and manufacturing industry 16% (norm 20%). These disparities reflected the size of construction (13% against a norm of 5%) and a service sector somewhat larger than normal. Overall, the nonoil tradeable sectors (agriculture and manufacturing) were smaller by some 18% of nonmining output than "normal" for a typical nonoil country at Algeria's level of development. This reflected (a) disruption of agricultural and industrial production by the exodus of the French, (b) high investment rates in the middle of the first Four-Year Plan (see below) and (c) the financing of imports through oil, aid and remittances rather than nonoil exports. In this sense, Algeria suffered quite severely from the "Dutch Disease" before 1974. The nonoil tradeable sectors in Venezuela and Nigeria, for example, were only 14% and 9% below their "normal" levels relative to their respective nonoil economies.

III. The Response to Higher Oil Prices

Over 1974-78 Algeria's domestic oil windfall averaged 22% of nonmining GDP and over 1979-81 30%. For comparison, the (unweighted) averages for Ecuador, Indonesia, Nigeria, Trinidad and Venezuela for the two periods

---

1/ The norms are estimated from Chenery and Syrquin (1975).

were 21% and 22% respectively. Over 1974-78 Algeria was, however, distinctive in its propensity to augment the windfall by borrowing abroad. As indicated in Figure 1, the trade and nonfactor service deficit increased, relative to its base over 1970-72, by the equivalent of 4.3% of nonmining GDP. The current balance deteriorated by 9.8% of nonmining GDP. Figure 1 also illustrates that the oil-exporting comparators reduced their trade and current deficits by 7.5 % and 8.7% respectively, so cutting the impact of the windfall on absorption by one-third. Algeria therefore reacted as an "ultra resource constrained" economy to the first oil shock, taking advantage of its improved credit- worthiness to boost absorption almost twice as much as its comparator average. The initial response to the second oil price rise was far more typical of the other oil exporters and more restrained, with an 8.9% shift to trade surplus relative to the base period. This represents an absorption contraction equivalent to 13.2% of nonmining GDP relative to 1974-78.

Over 1974-78 only 17% of increased absorption afforded by higher oil revenues and borrowing went to private and public consumption, (5% the latter) as indicated in Figure 1.[1/] The remaining 83% went to boost investment further, to the remarkable level of 72% of nonmining GDP by 1977. To a considerable extent this strategy was reversed during the Benjedid period of 1979-81; trade deficits were reduced, private and public consumption increased and investment cut by the equivalent of 13% of nonmining GDP.

Over 1973-79, the estimated share of public in total investment rose further from 86% to 92%. The breakdown of public investment by sector is

---

1/ The null projection for consumption and investment underlying Figure 1 follows the growth of the nonmining economy and the changing proportions of absorption according to the norms of Chenery and Syrquin (1975) which predict a fall in consumption's share with growth of output/head. The null projections for trade and nonfactor service deficits therefore are constant, relative to nonmining GDP at their 1970-72 levels.

given in Tables 1a and 1b. The Tables indicate the extent to which investment was concentrated in the capital-intensive industrial sectors, notably in hydrocarbon development. In 1963 a public enterprise, SONATRACH, was established to act as a channel for state expenditures in the hydrocarbon industry and its scope was steadily extended over the following years. By 1970 it controlled roughly half of the overall activity of the hydrocarbon sector, with a dominant role in exploration and domestic distribution but only a minor share in oil, LNG and petrochemical production. By 1980 all oil production and all but 5% of exploration activity was under the control of SONATRACH. This represents a remarkable achievement given that in 1963 foreign administrators and technicians in the hydrocarbon sector had outnumbered Algerians by nearly 4 to 1.[1/]

The high priority accorded to hydrocarbon investment resulted from two factors. As noted above, it was held to exemplify the premier "industrialising" industry. The development strategy of the 1970s also stressed the importance of Algeria's natural gas fields, estimated as the fourth largest in the world, in contrast to its limited proven oil reserves which were projected to be exhausted by the end of the century. As outlined in Bechtel's "Hydrocarbon Development Plan: 1976-2000", rapid depletion of oil was envisaged as a natural first stage with the proceeds earmarked for the creation of a viable natural gas export industry. Over the second half of the 1970s Sonatrach was host to 27 "macroprojects" (each with a capital cost over US$100 million), a greater number than any other single institution in the

---

1/ The urgency of the drive to control the oil sector was partly impelled by the experiences of the 1960s when it was discovered that, while 44% of the gross profits earned by public oil corporations accrued to the Treasury, only 17% of profits earned by privately owned companies accrued as tax or royalty: see Conway (1982), p. 40, Table 8.

Table 1a: PUBLIC INVESTMENT PROGRAMS BY SECTOR a/b/
(percentages)

Sector	4-Yr Plan 1970-73	4-Yr Plan 1974-77	Interplan 1978-79	5-Yr Plan 1980-84
Industry	53.2	53.5	56.5	38.6
Agriculture & fisheries	8.5	5.5	3.3	6.0
Water development	5.3	4.6	2.4	5.7
Tourism	2.5	1.0	0.4	0.9
Economic infrastructure and transportation	7.0	9.3	8.5	12.7
Construction	1.2	1.9	3.9	5.0
Housing	5.3	11.2	12.8	15.0
Education and training	9.9	7.6	7.4	10.5
Social infrastructure administration & others	7.1	5.4	4.8	5.6
	100.0	100.0	100.0	100.0

Source: World Bank.

a/ Investments for 1970-77 are realized; the later years are planned amounts.
b/ Including public enterprise investment.

Table 1b: PUBLIC INDUSTRIAL INVESTMENT a/
(percent of total industrial investment)

Sector	3-Yr plan 1967-69	4-Yr plan 1970-73	4-Yr plan 1974-77	Interplan 1978-79	5-Yr plan 1980-84
Hydrocarbons	51.3	47.0	48.5	47.6	40.8
Producer goods industries b/	30.7	38.4	34.7	34.1	36.7
Consumer goods c/	17.9	14.6	16.7	18.8	22.5

a/ Realized for 1967-79, and planned for 1980-84.
b/ Energy, mining, steel, machinery construction, building materials.
c/ Chemical products, agro-industry, textiles, leather, wood and paper products, artisanal products.

Source: World Bank.

developing world.[1/] By the early 1980s Algeria had become the world's largest LNG exporter, and gas was also being piped to Europe under the Mediterranean.

Within manufacturing, investment focused on heavy (producer goods) sectors at the expense of light (consumer goods) sectors, although the share of the latter (and that of housing) tended to rise with the shift in the Algerian development strategy towards increasing consumption after 1978.

Agricultural investment's share fell throughout the 1970s to only 3% of the total. The sector underwent many institutional changes in the 1970s including the land redistribution of the Agrarian Revolution of 1971, but continued to perform poorly with the consequence that one class of consumer goods — food — continued to be imported.

Algerian public investment has two components, which may be distinguished institutionally and by function. The largely infrastructural component directly financed by the Treasury (on average, around one third of the total) has been relatively steady over time. The investment of public enterprises has been more volatile. It is financed by (i) long-term loans from the Algerian Development Bank and similar domestic financial institutions, (ii) medium-term credits from domestic commercial banks and (iii) external credits from foreign banks and suppliers with approval of the Finance Ministry. In the early 1970s, Treasury savings financed about 55% of the public investment program. Much of the remainder was financed by the excess of domestic private savings over private investment, but foreign savings also financed a small share.[2/] The increase in oil taxes permitted the Treasury to fund 65% of the expanded program over 1974-78. Nevertheless,

---

1/ See Murphy (1982).

2/ Conway (1982), p. 52, Table 14.

over 1973-79, the private savings surplus channeled to fund the public investment program (estimated as a residual from the public budget and foreign accounts) represented on (unweighted) average, 7.6% of nonmining GDP.

The size of the Algerian investment program raises three questions for the adjustment of the nonoil economy. First, how could so massive a program be reconciled with the scarcity of domestic resources relative to foreign windfalls and borrowing? Second, how did government manage to extract so large a share of savings income to finance public accumulation? Third, what has been the impact of the Algerian growth and investment trajectories on the sectoral structure of the nonoil economy?

Roughly two thirds of total investment is estimated to have consisted of imported capital goods in 1974, and over 40% in 1978.[1/] This high import intensity followed from the sectoral distribution of investment. Certain large hydrocarbon projects typically have a direct import component of 80% with the domestic component being largely construction.[2/] The high import component lessened the demand for domestic goods which moderated pressure on the domestic economy; it also facilitated borrowing through suppliers' credits which represented 41% of public outstanding and disbursed debt by 1977. Nevertheless, the construction sector expanded its (constant-price) share in nonmining value added from 13.4% to 20.8% over 1972-81.

So massive a shift towards investment goods would normally be associated with substantial real exchange rate appreciation. The real rate actually depreciated in Algeria however, from an index of 100 over 1970-72 to

---

1/ Conway (1982), page 47, Table 11.

2/ Value added in construction is typically less than half of gross output, and the sector is known to import a high proportion of intermediates in Algeria. Gross construction expenditures therefore far overstate its domestic resource content.

an estimated average of 91 over 1973-79.[1/] This contrasts with real appreciation of 30-40% in such market-oriented economies as Indonesia and Nigeria. Real depreciation was associated with low increases in administered prices (see Figure 2) which, though higher than their rates over 1970-72, rarely exceeded 11%. Import prices thus tended to rise relative to domestic prices, and the administered domestic price structure moved rather uniformly as between major categories of production and demand.

In common with other developing countries, Algeria manifested a high income elasticity of demand for money. For M1, it stood at around 2.0 for the period 1967-80 with respect to nonmining income.[2/] Even in 1970-72 an unusually high share of M1 was composed of currency circulating outside banks, and this tended to increase over time rather than to decline as is usual with deepening financial intermediation. Over 1970-81 currency holdings increased from 25% to 42% of nonmining GDP, and the bulk is known to have been held by the private sector. This implied a continuous fall in the money multiplier and large seigniorage gains to the Central Bank, as shown in Figure 2. Seigniorage averaged 7.5% of nonmining GDP over 1973-79, virtually equal to the internal public financing gap as residually estimated above.

The exceptional propensity to hold cash absorbed about one-third of the domestic savings pool generated outside the Treasury over 1974-79, almost three times the corresponding average ratio for the above five comparator oil

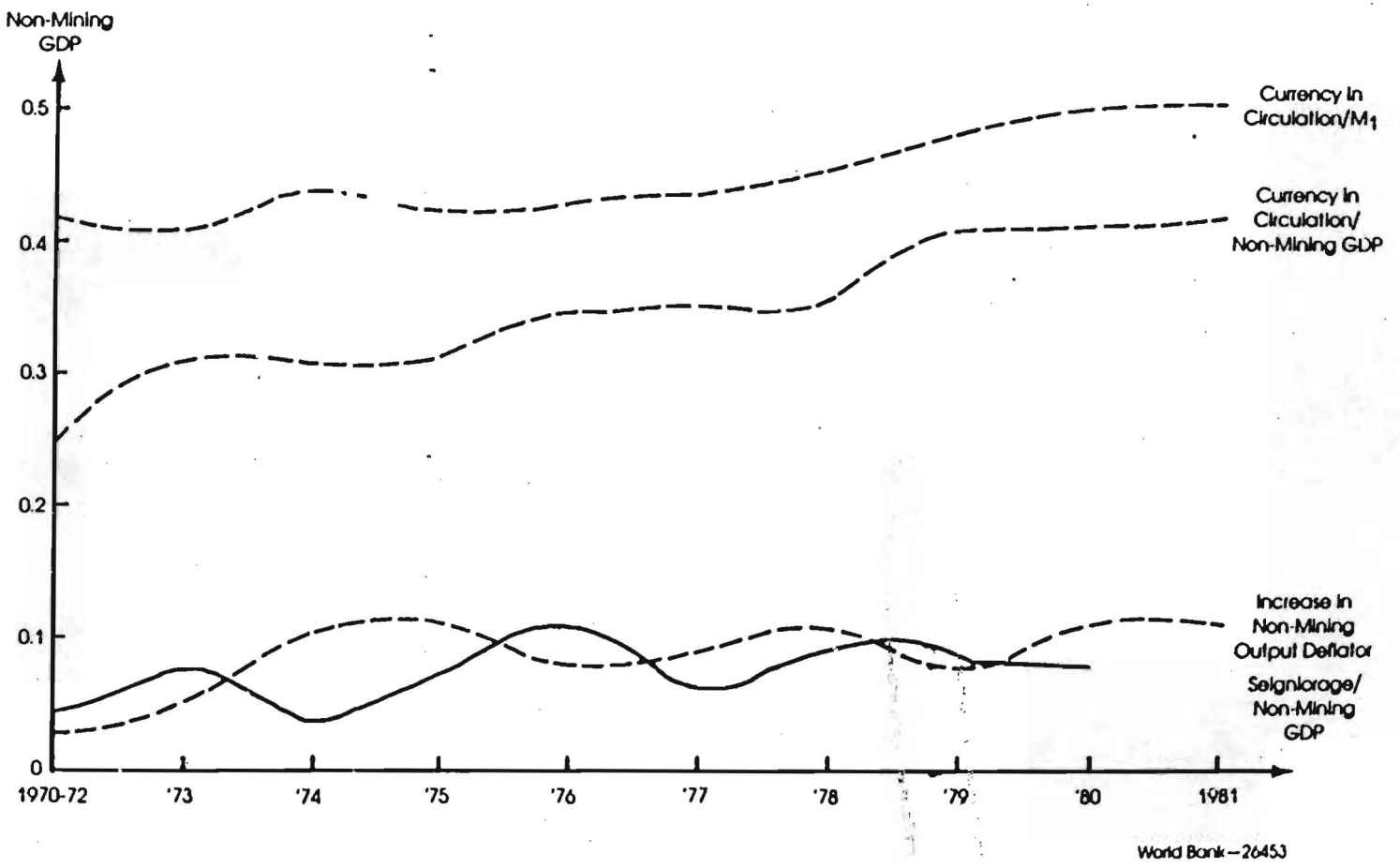
---

1/ The real rate here is measured as the production deflator for nonmining GDP relative to the U. S. dollar price of manufactures imported by developing countries adjusted by the nominal U.S. Dollar/Dinar exchange rate. The trade weighted real exchange rate also depreciated to 91 over 1974-78.

2/ A similarly high propensity to hold cash balances has been noted for the centrally planned economies of Eastern Europe by Portes and Winter (1980).

Figure 2

Currency, Inflation and Seigniorage: 1970-81



exporters despite their generally higher inflation rates.[1/] It represents a second leakage (after imported capital goods) from the multiplier process normally initiated by large increases in public investments out of oil revenues. Algeria's high propensity to hold money balances appears to have resulted from rationing in markets for both private consumption and investment goods, and to have been facilitated by moderate upward adjustment of administered prices and the low interest rates (2% - 4%) available on alternative financial assets. The strength of the public accumulation drive "crowded out" private consumption and the accumulation of real assets. Therefore, rather than further containing a moderate rise in wage rates relative to product prices or increasing a rate of nonoil taxation high by the standards of oil exporters (around 25% of nonmining GDP), Algeria opted for a strategy of deferring private consumption. As captured econometrically in Section V, financial claims were built up against the state, and their real unit value decreased only slowly over time through inflation.

Increased investment did not rapidly translate into accelerated output growth, although over 1972-78 the nonmining economy grew at a very respectable 9.0%. This is partly because 1970-72 had represented a period of recovery from the disruption of the Revolution, but in the 1970s incremental capital-output ratios (ICORS) were high and rising in the nonhydrocarbon economy—5.5 over 1970-73, 5.7 over 1974-77 and 7.0 over 1978-79.[2/] They

---

1/ Seigniorage (the rent accruing to government for its monopoly normally approximated by the creation of fiat money normally accounts for around 1.5% to 2.5% of GDP in developing countries. Morgan (1978) has noted the tendency for money stocks to rise unusually rapidly in the oil exporters, but even within this group Algeria is exceptional.

2/ Output and investment valued in constant 1978 dinars and output lagged one year.

were far higher in the hydrocarbon sector since real output remained constant over 1973-77 despite the sector receiving one quarter of public investment. Real hydrocarbon output expanded by 11% over 1977-79 and contracted sharply thereafter because of marketing constraints due to price resistance, economic slowdown and energy conservation in major markets.

Increased capital intensity of production did not, either, have as a counterpart a rise in labor productivity. Employment in the hydrocarbon sector grew from 10,000 to 92,000 over 1967-80, but, with static output, average labor productivity in the sector declined to offset totally this shift to a high value-added/man sector. Productivity changes in the nonhydrocarbon economy, both within sectors and resulting from compositional shifts between sectors, have just offset the effect of a rising labor force share in hydrocarbons.[1/] Algeria's performance appears to have fallen a little behind that of other oil exporters, which usually experienced larger overall productivity gains over the period.

The sectoral evolution of Algeria's nonmining economy after 1972 was, however, distinctive. Despite an average annual increase of 0.82% in the constant-price share of construction in nonmining GDP over 1972-81, rapid expansion of manufacturing resulted in the tradeable sectors — taken as agriculture and manufacturing — raising their share by 0.68% relative to their "normal" evolution in an economy developing at Algeria's level of income/head and rate.[2/] By 1981, Algeria's "Dutch Disease Index" — defined

---

1/ This excludes small productivity gains made possible by the absorption of part-time agricultural workers by growth of other employment at 7.0% over 1967-80.

2/ Agriculture and manufacturing would normally have seen their aggregate share contract by 0.54% per year according to the Chenery-Syrquin norm. They expanded their share in the nonmining economy by 0.14% annually in Algeria.

as the imbalance between nonmining tradeables and nontradeables relative to the size of the nonmining economy — had almost halved, falling below the corresponding indices for Nigeria, Trinidad and Tobago and Venezuela. The pervasive system of state controls, while contributing to lower effectiveness of resource use, played some part in limiting the skewing of the economy away from nonoil tradeables by reducing multiplier effects emanating from public investment expenditures.

IV. A "Fix-price" Equilibrium Model for Algeria.

As the preceding sections indicate, pervasive government control of economic activity has been the fundamental characteristic of the Algerian economy. Commodity and factor prices are fixed, with the markets clearing through queuing, rationing and (rarely) unsold surplus. Investment is undertaken almost exclusively by the government, and the technologies selected have been on average highly capital-intensive. This type of economy is best modelled by fixed coefficient production technologies and the fix-price equilibrium concept as put forward by Dreze (1975), Benassy (1975) and Malinvaud (1977). There are two major insights of such an analysis:

(a) Rationing in goods and labor markets is consistent with equilibrium; in particular, Algerian consumers of final goods and those desiring work are rationed.(b)Rationing in one market can lead to "spillovers" into other markets. The most notable such spillover in Algeria is from rationing in the goods market into forced saving, largely in the form of increased money balance holdings.

Production Decisions.

In a fix-price equilibrium, in any period t, the quantity actually transacted does not reflect both the quantity supplied and demanded at the

fixed prices, but only the lesser of the two. In an aggregate model with two markets -- non-hydrocarbon output (Y_t)[1/] and labor (L_t) — market clearing conditions are:

$$(1) \qquad Y_t = \min(Y_t^s, Y_t^d)$$

$$(2) \qquad L_t = \min(L_t^s, L_t^d)$$

where s and d are superscripts denoting supply and demand, respectively. Output supply and labor demand are determined by firms — in Algeria, mostly government-owned — which are assumed to produce efficiently, using a given stock of capital (K_t) and labor in fixed proportions.[2/] The output/labor ratio is $1/\alpha$; the output/capital ratio is β.

$$(3) \qquad Y_t^s = \min(\frac{L_t}{\alpha}, \beta K_t)$$

The firm's demand for labor is a fixed proportion α of the equilibrium level of output; it can be limited either by the size of the capital stock, or by demand for the firm's output.

$$(4) \qquad L_t^d = \min(\alpha Y_t^d, \alpha\beta K_t)$$

1/ In the interests of examining the impact of increased oil and natural gas rents on the rest of the economy, the hydrocarbon sector is treated as a separate "export enclave." Although not strictly true, this is a useful simplication.

2/ The government sets the factor intensity of production through long-term plans. This tends to "lock in" productive technology choices, and leads to production having fixed-coefficient characteristics. Inefficiency in production is also a major issue for Algerian planners, but is abstracted from here.

If, for example, aggregate demand were less than full capacity output, the constraint on labor would be the first term in parentheses.

Private-sector Behavior.

Private consumers are assumed to make their consumption and money balance holding decisions through intertemporal utility maximisation taking into account present constraints on labor demand and goods supply. This decision is reformulated in each period t.[1/] Individual decision-making is aggregated to obtain macroeconomic functions for estimation.

Consumption and money-balance holding choices for individual i will then depend on initial money holdings (m_{it-1}), present after-tax real wages ($\frac{w_t}{P_t} x_{it}(1-\tau_t)$) and expected future after-tax wages.[2/]

A utility-maximizing individual will have desired consumption defined by the following function:

$$(5) \qquad c_{it} = (\delta/T)((w_t/P_t)x_{it}(1-\tau_t)) + (\frac{1+r}{T})(m_{it-1}/P_t)$$

where T is the time horizon of the individual and r the rate of time preference. The first term is consumption out of present after-tax income; (1/T) is the fraction of total discounted income to be consumed in any one period, while δ reflects the relationship between expected future labor income and present realised income. The second term represents consumption out of real balances.

1/ A mathematical presentation of the decision-making process is given in Appendix 1.

2/ (w_t/P_t) is the real annual wage in period t for a fully employed individual. x_{it} is the fraction of desired annual employment which the individual spends working. τ_t is the ad-valorem tax on labor income.

Individual demand for real balances is determined analogously.

$$(6) \qquad m_{it}/P_t = (1-(\delta/T))((w_t/P_t)x_{it}(1-\tau_t)) + (1-(1+r)/T)m_{it-1}/P_t$$

Note that the two summed together equal total disposable wealth in period t: $(w_t/P_t)x_{it}(1-\tau_t) + m_{it-1}/P_t$. The individual has two choices for allocation of wealth — consume, or save in the form of money balances.

Aggregate consumption and real balance demand behavior is found through summing across private individuals. There are L_t^s individuals in period t desiring full employment; $L_t = \sum_{i=1}^{L_t^s} x_{it}$ is the number of fully employed individuals equivalent to period-t employment.

$$(7) \qquad C_t = \sum_{i=1}^{L^s} ((\delta/T)(w_t/P_t)(1-\tau_t)x_{it} + ((1+r)/T)(m_{it-1}/P_t))$$

$$C_t = (\delta/T)(w_t L_t/P_t)(1-\tau_t) + ((1+r)/T)M_{t-1}/P_t$$

$$(8) \qquad M_t/P_t = \sum_{i=1}^{L^s} (m_{it}/P_t) = (1-\delta/T))(w_t L_t/P_t)(1-\tau_t) + (1-(1+r)/T)M_{t-1}/P_t$$

Labor supply is assumed to be inelastic at any point in time, but to grow at a constant rate (n). 1/ Unemployment is the difference between labor supply and demand (L^s-L^d); $u = ((L^s-L^d)/L^s)$ is the unemployment rate.

1/ In the Algerian case, extensive government control of employment, wages and prices has reduced incentives to increased productivity and may have eliminated the possibility of a labor-leisure trade-off in the formal sector. The assumption that the labor force either works full time or is unemployed seems a reasonable approximation.

(9) $L_t^s = L_o e^{nt}$

Government.

The government's operations are separated into hydrocarbon and non-hydrocarbon components; each has associated expenditures and revenues. We abstract from hydrocarbon investments, which represent essentially an effort to stretch out the time profile of rents by effecting a transition from oil to natural gas. Revenues in excess of expenditures in the hydrocarbon sector ($q_t E_t$)[1/] are available for use by the government in the non-hydrocarbon sector. Public revenues also come from foreign borrowing (B_t), taxation of labor income ($\tau_t \frac{w_t}{P_t} L_t$), public-enterprise profits ($\pi_t = Y_t - (\frac{w_t}{P_t})L_t$) and money creation ($\theta_t$).

Net hydrocarbon receipts and foreign borrowing ability are considered autonomous since they are mainly determined by external factors. Money creation is the residual source of government financing, as defined below.[2/]

Government expenditures in the non-hydrocarbon sector are either investment (I_t) or consumption (G_t). The government investment program aims to eliminate unemployment. It responds to the availability of foreign exchange since a large proportion of capital goods is imported. In the simplest formulation:

1/ Hydrocarbon production is assumed to be constant $\bar{E}$ in physical volume for each period in the theoretical section. Actual volumes are used for econometric purposes, with net revenues from the sector following from subtracting hydrocarbon investments.

2/ Internal bond financing, a minor feature of the Algerian economy, is assumed away.

(10) $I_t = \lambda(u.L_t^s)\,[i_o + i_2(q_tE_t+B_t)]$ $\lambda(0) = 0$, $\lambda'(u.L_t^s) > 0$

More generally, it can be assumed that investment and the accumulation of capital creates its own dynamic, so that planned investment is related to the capital stock (whose rapid growth is, in the last resort, financed by oil receipts), but that fluctuations in the availability of foreign exchange cause deviations around that trend:

(10a) $I_t = \lambda(u.L_t^s)[i_o + i_1K_t + i_2(q_tE_t+B_t)]$

In both cases λ is a speed of adjustment parameter dependent on the number of unemployed. Investment therefore proceeds at a steady growth rate, λi_1, except in periods of increased or decreased foreign financing. i_2 represents the dependence of the investment program on the availability of foreign exchange. As i_2 increases, reliance on foreign financing sources rises, so that fluctuations in those sources have larger repercussions on the level of investment undertaken. Greater dependence could either be due to higher import intensity in investment projects, or greater complementarity between domestic and foreign capital goods.

Government consumption (G_t) is assumed to represent a constant fraction (g) of non-hydrocarbon output.

(11) $G_t = g_o + gY_t$

Money creation ($\theta_t = \frac{M_t - M_{t-1}}{M_{t-1}}$) is the final source of government financing, and is determined residually by the excess of expenditures over other sources of financing as the budget deficit is monetised.

$$(12) \qquad \theta_t \cdot \left(\frac{M_{t-1}}{P_t}\right) = \left(G_t - \pi_t - \tau_t \frac{w_t}{P_t} L_t\right) + I_t - (B_t + q_t E_t)$$

The first right-hand term represents the current expenditure deficit; the second, spending for investment; the third, foreign exchange financing sources.

In Algeria, current non-hydrocarbon government revenues have roughly equalled current government expenditures. Capital investment expenditures have thus been financed mainly through foreign exchange or money creation sources, and, to a degree, domestic borrowing.

The non-hydrocarbon balance of payments, which is also under exclusive government control, is then:

$$(13) \qquad (X_t - IM_t) + (B_t + q_t E_t) = 0$$

where $(X_t - IM_t)$ is the net export of non-hydrocarbon products.

Aggregate Demand.

Aggregate demand can be assembled from these elements:

$$(14) \qquad Y_t = C_t + I_t + G_t + (X_t - IM_t)$$

One decomposition of this relationship (using (7), (10), (11) and (13)) indicates both the dependence of aggregate demand on equilibrium values of Y_t and L_t and the principal exogenous variables which induce demand:

$$(14a) \qquad Y_t^d = \frac{\delta}{T}\left(\frac{w_t}{P_t}\right)(1-\tau_t)L_t + gY_t + \frac{(1+r)}{T}\frac{M_{t-1}}{P_t} + \lambda i_o + \lambda\, i_1 K_t + (\lambda i_2 - 1)(q_t E_t + B_t)$$

Increased real balances, planned investment and labor income all serve to stimulate aggregate demand. The effect of $(q_t E_t + B_t)$, however, is ambiguous. Through raising investment it stimulates Y^d_t, but through financing imports it permits demand to be switched abroad.1/

Another decomposition of (14) defines aggregate demand in terms of its sources:

$$(14b) \qquad Y^d_t = C_t + \pi_t + \tau_t \frac{w_t}{P_t} L_t + \theta_t (M_{t-1}/P_t)$$

The first right-hand side variable is private consumption demand; the second and third are together government demand out of current income; and the final component is government demand financed by the monetisation of the budget deficit.

Non-Walrasian Equilibrium Regimes.

The levels of Y^d_t, Y^s_t, and L^d_t will depend upon the economy's equilibrium output and labor use levels. Four equilibrium conditions, or regimes, are possible. There could be excess supply of both labor and output ($Y_t = Y^d_t$ and $L_t = L^d_t$); this is called the regime of Keynesian unemployment (KEY). This could be excess demand in both markets ($Y_t = Y^s_t$ and $L_t = L^s_t$); this is the Repressed Inflation (REP) regime. There could be excess demand for goods and excess supply of labor ($Y_t = Y^s_t$ and $L_t = L^d_t$); this is the Classical Unemployment (CLA) regime. Finally, balance in both markets

1/ This formulation differs from the conventional Salter-Swan model underlying most analysis of oil economies because increased foreign exchange availability is not allowed to bid up non-traded good prices; the government shifts domestic resources to non-traded good production and meets traded-good demand through increased consumer imports.

($Y_t = Y^s_t = Y^d_t$ and $L_t = L^s_t = L^d_t$) is the Walrasian equilibrium (WAL) 1/ These four regimes span the set of possible combinations of Y and L.

Transforming variables into per capita terms ($m_{t-1} = \frac{M_{t-1}}{L^s_t}$, $k_t = \frac{K_t}{L^s_t}$ and so forth) permits a diagrammatic examination of the regimes as in Picard (1983). There are three boundary conditions for the economy — the combinations where one or both markets clear without rationing.

Walrasian equilibrium is characterized by unrationed equilibria in markets for both labor and output and a government budget constraint. Manipulation of these conditions yields the Walrasian values of real balances and the capital stock shown in Figure 3: 2/

$$(15) \qquad k^* = \frac{1}{\alpha\beta}$$

$$(16) \qquad \frac{m^*}{P} = T[\frac{1-g}{\alpha} - \frac{\delta}{T} z^* + (b_t+q_te_t)] = (\frac{T-\delta}{1-\delta n})[\frac{1-g}{\alpha} + b_t + q_te_t]$$

These values are invariant with respect to time so long as there are no shifts in government policy or in external financing. The equilibrium level of real balances depends negatively upon the government consumption decision (g); as government consumption rises, private consumption must fall through lower consumption out of real balances. An increased nonoil trade deficit ($b_t+q_te_t$) not offset by increased public spending has the opposite effect, since it increases leakages via imports of consumer goods. The variable z^*_t is full employment per capita disposable wage income. The second equality follows

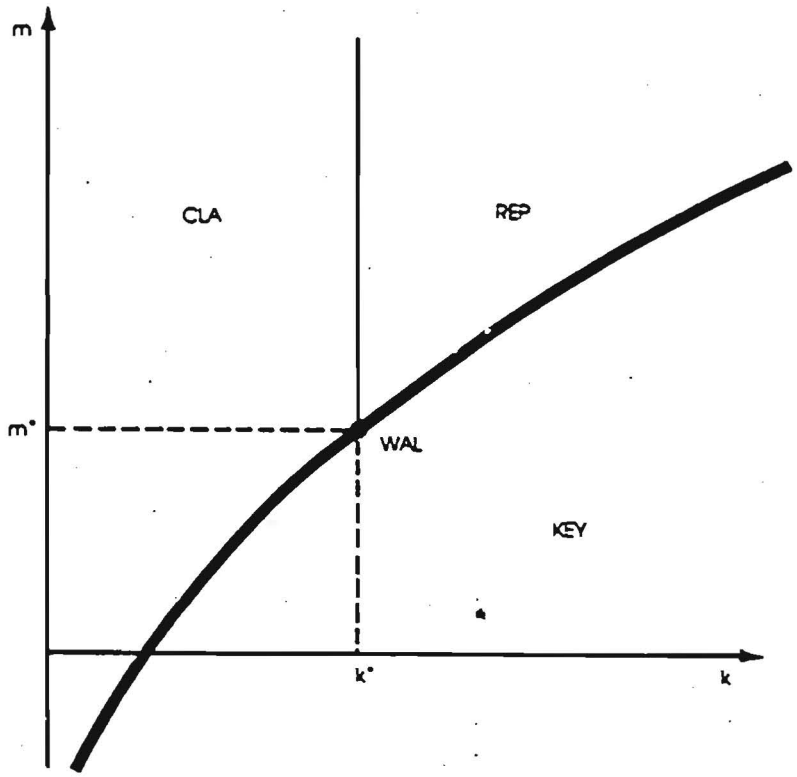
---

1/ The other combination — excess supply of goods and excess demand for labor — could not occur in this model, which does not allow inventory accumulation. It also seems a remote possibility for Algeria.

2/ Equations underlying the following discussion are provided in Appendix 2.

Figure 3

Fix-Price and Walrasian Equilibria



World Bank—26454

from the time-invariance of m_t and P_t in Walrasian equilibrium. In steady-state money creation occurs at the labor growth rate which imposes a long-run government budget constraint. The Walrasian output per capita is fixed.

(17) $y^* = \frac{1}{\alpha}$

(18) $\dot{P}/P = 0$

(19) $\theta = n$

Away from Walrasian equilibrium, the regime CLA is characterised by underemployment and "too high" levels of real balances leading to excess demand for output; the regime KEY may or may not be characterized by sufficient capital stock to employ everyone, but has insufficient demand to generate full capacity employment due to "too low" levels of real money balances. Regime REP represents excess demand for goods and excess productive capacity leading to excess demand for labor.

The level of capital where the labor force is fully employed remains $\frac{1}{\alpha\beta}$ in non-Walrasian equilibrium, and defines the vertical boundary between REP and CLA. The level of real money balances per capita which sets supply and demand for product equal at given prices, and separates REP and KEY, is increasing in k as a result of desired disinvestment. The diagonal boundary between CLA and KEY is defined by the condition that increased capacity creates its own demand for output; as consumption is a fraction of output, real balances must be higher to ensure the equality.

The Government's Role.

Government policy is an important determinant of the equilibrium regimes. First, it controls the capital intensity of production through the planning process. Increasing $\alpha\beta$ will decrease the capital intensity of production; this would make full employment more accessible, by moving the Walrasian equilibrium point in Figure 3 to the left. (This could be effected by a shift in the mix of investment from highly capital-intensive sectors to less capital-intensive ones; for example, from cement production to textiles.)

Second, it can regulate government consumption (g) or taxation (τ) during the adjustment process. Raising g or lowering τ causes increased demand for product and a higher rate of money creation (θ), leading to a lower Walrasian level of real money balances and a greater probability of excess demand for goods (the CLA and KEY regimes).

Third, it can regulate the speed with which it pursues a goal of full employment through varying the planned growth rate of investment (λi_1); higher λi_1 increases the slope of CLA-KEY and KEY-REP boundaries.

Fourth, the government can alter its demand for domestic goods by varying the dependence of its investment on foreign sources of financing. Increasing i_2 represents an increase in reliance on foreign sources; for fixed $q_t E_t + B_t$, this will lead to increased aggregate demand as in (14a). It will also increase the variability of I_t around planned levels. The CLA-KEY and REP-KEY boundaries in Figure 3 become less steep.

The government cannot, however, regulate money creation (θ) directly; that depends on its financing needs which are determined by the instruments I, τ, g and external factors. A strongly capital- and import-intensive development strategy corresponds to a low $\alpha\beta$.

Algeria: a Classical Unemployment Equilibrium.

Data are insufficient to test whether Algeria is in REP, KEY or CLA in Figure 3, or at the Walrasian equilibrium.[1/] However, the available evidence strongly suggests that the economy has been in CLA, since widespread un- and under-employment has coexisted with excess demand for a broad range of consumer goods. This is closely linked to increased oil income and foreign borrowing over the past decade, as may be seen from the effect of higher net hydrocarbon revenues on the boundaries of Figure 3.

By equations (15) and (16) the Walrasian capital stock per head k* is constant but m* rises; with desired investment rates limited by labor force growth oil revenues imply a higher nonoil trade deficit for external balance, which must be achieved by relaxing import restrictions. To maintain aggregate demand at full-employment level higher m* is needed to raise consumption. As shown in Appendix 2, the CLA/KEY and REP/KEY boundaries become steeper and at some level of $k<k^*$ the new CLA/KEY boundary crosses the old. At this point higher public investment just offsets the effect of allowing in more imports. For still lower values of k the expansionary impact of the public investment response dominates any contractionary effect due to trade liberalisation. For goods-market equilibrium consumption must therefore be lower which requires lower real balances.

Consider an economy with the above response (like Algeria) and on the CLA/KEY boundary prior to the oil price rise. Higher oil revenues shift the boundary downwards and move the economy into CLA. There are several ways of reattaining the boundary. As the higher investment raises capital stock and output the economy shifts to the right. Government could reduce its own

---

1/ Portes and Winter (1980) describe an econometric test for determining the probability that a market is either in excess supply or excess demand.

demand, which shifts the boundary back towards its original position. Or, a once-for-all increase in the price level could reduce real money balances to their new equilibrium level.

Implications of "Classical Unemployment" Equilibrium.

There are three concepts of consumption demand in the CLA regime; notional demand (C^*), effective demand ($\tilde{C}$) and realized demand ($\bar{C}$). Holdings of real balances can be examined analogously.

(1) The individual consumer has a notional demand (c^*) for output corresponding to zero excess demand in both product and labor markets:

$$c^*_{it} = \frac{\delta}{T} z^*_{it} + \frac{1+r}{T} \frac{m_{it-1}}{P_t} \tag{20}$$

Aggregate notional demand is found through summation across consumers.

$$C^*_t = \frac{\delta}{T} \left(\frac{w_t}{P_t} (1-\tau_t) L^s_t\right) + \frac{(1+r)}{T} \frac{M_{t-1}}{P_t} \tag{21}$$

Aggregate notional real balances take a similar form.

$$\frac{M^*_t}{P_t} = \left(1 - \frac{\delta}{T}\right)\left(\frac{w_t}{P_t} L^s_t (1-\tau_t)\right) + \left(1 - \frac{1+r}{T}\right) \frac{M_{t-1}}{P_t} \tag{22}$$

(2) The existence of unemployment leads to effective aggregate demands ($\tilde{C}$ and $\tilde{M}/P$) based on actual disposable income.

$$\tilde{C}_t = \frac{\delta}{T}\left(\frac{w_t}{P_t} L_t (1-\tau_t)\right) + \frac{1+r}{T} \frac{M_{t-1}}{P_t} \tag{23}$$

$$= C^*_t - u \cdot \frac{\delta}{T} \left(\frac{w_t}{P_t} (1-\tau_t) L^s_t\right) \tag{24}$$

$$(25) \qquad (\tilde{M}_t/P_t) = (1-\frac{\delta}{T})(\frac{w_t}{P_t} L_t(1-\tau_t)) + (1-\frac{1+r}{T}) \frac{M_{t-1}}{P_t}$$

$$(26) \qquad = (M^*_t/P_t) - u\cdot(1-\frac{\delta}{T}) (\frac{w_t}{P_t} L^s_t (1-\tau_t))$$

The second right-hand terms in (24) and (26) represent spillover contractions of demand from less than full employment levels. Consumers are still "on the demand curves," with aggregate income adjusted for the level of unemployment.

(3) In classical unemployment, there is still more rationing, since effective demand for output exceeds supply.

$$(27) \qquad Y^d_t = I_t + G_t + (X_t - IM_t) + \tilde{C}_t > Y^s_t$$

A realistic allocation assumption is that government spending is not rationed. Consumption rationing is shared equally by all, leading to increases in real balances involuntary saving and a still lower realised demand ($\bar{C}_t$).1/

$$(28) \qquad \bar{C}_t = Y^s_t - I_t - G_t - (X_t - IM_t)$$

$$= Y^s_t - I_t - G_t + (B_t + q_t E_t) .$$

This level of realized demand is not that desired by consumers given incomes and real assets; the difference ($\tilde{C}_t - \bar{C}_t$) represents savings held in real balances due to a lack of alternative uses of disposable income. Net non-hydrocarbon imports can relax the rationing constraint. Given the

---

1/ There would be further reverberations if labor supply responses were allowed; these are neglected here.

specification of the labor supply decision, any unemployment also represents a level of leisure off the supply curve.

Involuntary consumption and employment levels have implications for estimation and interpretation of consumer demand behavior. In a Walrasian world, notional consumption and real balance demands are observed as functions of disposable income and the level of real money balances. In classical unemployment, supply-side factors and resource constraints dominate. Realised demands are observed as functions of government spending, productive capacity and net exports. Higher investment or current government expenditure crowds out private consumption one-for one. Real balance accumulation is partly involuntary; it will rise with public spending and fall with real output.

$$(29) \qquad \frac{\bar{M}_t}{P_t} = (1-\tau_t)(\frac{w_t}{P_t} L_t) + G_t + I_t - (B_t + q_t E_t) - Y_t^s + \frac{M_{t-1}}{P_t}$$

This will increase with government expenditures.

The investment program, rather than the "Dutch Disease", determines the pattern of resource allocation. Sectors favored by public investment grow; sectors serving rationed private demands shrink.

V. Econometric Results.

For reasons described above, we maintain the hypothesis that the economy is in CLA and examine the implications econometrically. The above model defines a simultaneous economic system. Estimation is complicated by the fact that two endogenous variables — effective consumption and effective demand for money balances — are unobserved. A technique by Amemiya (1974) is used to redefine these variables in terms of their observed, realised levels. Error terms are assumed multivariate and normally distributed.

Estimation of the equation system is done by two-stage least squares (2SLS).[1/]

Estimation has two purposes:

(1) Determination of the accuracy of the fix-price equilibirum construct as applied to the Algerian economy;

(2) Measurement of the impact of rationing in the Algerian economy, including both the size of the shortfall in available goods and the increased inflation which would have been necessary to reach a flex-price equilibrium.

Data.

The data used in estimation are annual observations over the period 1967-1980, and have been drawn from official Algerian sources and from World Bank reports; many of the time series are described in detail in Conway (1982). All variables, with the exception of the money supply and prices, are in real terms, with 1974 as the base year. M1 (currency + demand deposits) is used as the measure of the money supply.[2/]

The non-mining GDP deflator is used as the index of the price level (P). The U.S. consumer price index (P*) is used as a proxy for world prices. The non-hydrocarbon capital stock (K) is formed through the perpetual inventory method from a base K_0, depreciation rate, and subsequent investment levels; K_0 is found by positing an average non-hydrocarbon capital/output ratio of 2 for 1967.[3/] The tax rate (τ) is derived through dividing non-hydrocarbon taxation receipts by non-hydrocarbon domestic income. Wage income

---

1/ Only 14 annual observations are available for all variables, which precludes the use of system estimation techniques.

2/ In 1974, the components of M1 represented 94 percent of the components of M2; in 1980, 90 percent.

3/ Non-hydrocarbon figures are approximated by use of official non-mining statistics. Hydrocarbons represent about 95 percent of the mining sector.

is based on time series for the public sector scaled to be compatible on average with national value added.

Production Decisions.

The model presented in section IV suggests simple linear forms for the production function and labor demand equations under classical unemployment. Because OLS residuals are highly correlated, estimates are also given with first-order autoregression correction ρ:

(30) $Y_t = a_0 + a_1 K_t$

(a) uncorrected: $Y_t =$	1.03 +	.268 K_t	$R^2 = .99$
	(13.17)	(35.25)	DW = .71
(b) corrected: $Y_t =$	.97 +	.275 K_t	$\bar{R}^2 = .98$
	(8.29)	(25.39)	$\rho = .53$
			(2.36)

(31) $L_t = b_0 + b_1 K_t$

(a) uncorrected:	L = 2.12 +	.10 K	$R^2 = .94$
	(29.04)	(14.35)	DW = .92
(b) corrected:	L_t = 2.10 +	.10 K_t	$\bar{R}^2 = .93$
	(24.77)	(12.52)	$\rho = .15$
			(.55)

The equations have good explanatory power. Both intercepts are positive and significant, indicating an inelastic response of output and employment to investment. 1/ The point estimate of the incremental capital-output ratio

1/ This and all following statistical tests of significance are evaluated in a two-tailed test at the 95 percent level of confidence.

$(\frac{1}{\beta})$ as given by $(1/a_1)$ is 3.6 for the corrected estimate; this is high by cross-country standards, but expected in view of the capital intensity of Algerian production. b_1 represents the labor-capital ratio $\alpha\beta$; the implied average estimate of elasticity of labor demand with respect to output is 0.40. Technological progress growth terms were tried in both equations as independent regressors, but were statistically insignificant.

Government Demand.

Policy functions for non-hydrocarbon investment and government spending are drawn from section IV. Where residuals are highly autocorrelated, estimates are also given with first-order correction ρ .

(32) $I_t = \lambda i_0 + \lambda i_2 (q_t + E_t + B_t)$

(a) uncorrected $I_t = .52 + 1.12 (q_t E_t + B_t)$ $R^2 = .70$

(2.79) (5.54) DW = 1.10

(b) corrected $I_t = .86 + .78 (q_t E_t + B_t)$ $\bar{R}^2 = .75$

(3.61) (3.69) $\rho = .40$

(1.50)

(33) $I_t = \lambda [i_0 + i_1 K_t + i_2 (q_t E_t + B_t)]$

$I_t = .14 + .11 K_t + .30 (q_t E_t + B_t)$ $\bar{R}^2 = .89$

(1.02) (4.87) (1.45) DW = 1.61

In equation (32), the estimate of λi_2 demonstrates that the hypothesis that the level of investment responds one-for-one to the contemporaneous availability of foreign financing cannot be rejected. Equation (33) separates investment into "planned" capital accumulation at rate

λi_1 (itself related to the trend of $q_t E_t + B_t$ over the period) and the deviations from plan due to foreign financing fluctuations (λi_2). Although the magnitude of the coefficient and its explanatory power (β value = .22) are considerable, it is significant only at the 30% level. This is not unexpected given the shift in investment policy implemented by the Benjedid regime after 1978. Introducing a dummy variable for 1979-1980 to capture this policy shift yields similar and more precise estimates:

$$(34) \qquad I_t = -\ .08 + .14\ K_t + .36\ (q_t E_t + B_t) - .60\ DUM \qquad \bar{R}^2 = .36$$
$$\qquad (.73) \quad (8.53) \qquad (2.66) \qquad (4.04) \qquad DW = 1.81$$

Equation (34) suggests a planned investment growth rate of 14% annually until 1979. At that time, the dummy coefficient suggests a 21% fall in investment below trend following the Benjedid policy revisions. This shift is also reflected in total investment, as shown in Figure 1. The estimate for λi_2 indicates roughly one-third of fluctuations in foreign financing are passed through to investment demand. As shown below, domestic involuntary saving in money balances provides the main alternative source of financing.

Government consumption is treated as a linear function of non-hydrocarbon output, which is treated as a simultaneously determined variable in 2SLS:

$$(35) \qquad G_t = g_0 + gY_t$$

(a) uncorrected: $G_t = -.10 + .23\ Y_t$ (2.70) (22.91) $R^2 = .98$, $DW = 1.18$

(b) corrected: $G_t = -.10 + .23\ Y_t$ (2.24) (19.29) $\bar{R}^2 = .97$, $\rho = .20$ (.76)

The estimate indicates a marginal propensity to spend from non-hydrocarbon domestic product of .23, and an elasticity of 1.17.

Private Demands.

Rationing in the goods market implies that the observed levels of private consumption and holdings of money balances are realised, not effective. A method for estimating the underlying effective behavioral equations was first suggested by Fair and Jaffee (1972).

In a command economy, prices are often adjusted to reflect the level of excess demand for goods in the previous period. The government in effect follows a slow tatonnement rule. Assuming that only consumers are rationed:

(36) $$(P_t - P_{t-1}) = \frac{1}{\gamma}(\tilde{C}_t - \bar{C}_t)$$

where γ is the speed-of-adjustment parameter. As γ becomes smaller, price adjustment approaches that of an auction market; as it becomes larger, prices are increasingly unresponsive to excess demand. If such a relationship holds exactly, the observed price change will serve as an indicator of the rationing deviation between observed $\bar{C}$ and effective $\tilde{C}$. 1/

The government's price-updating equation (36) may be used to identify effective demand ($\bar{C}_t$):

(37) $$\bar{C}_t = \tilde{C}_t - \gamma\,(P_t - P_{t-1})$$

where $\tilde{C}_t$ is specified in equation (23), and is observed only with a random error. This relationship is illustrated in Figure 4. In classical

---

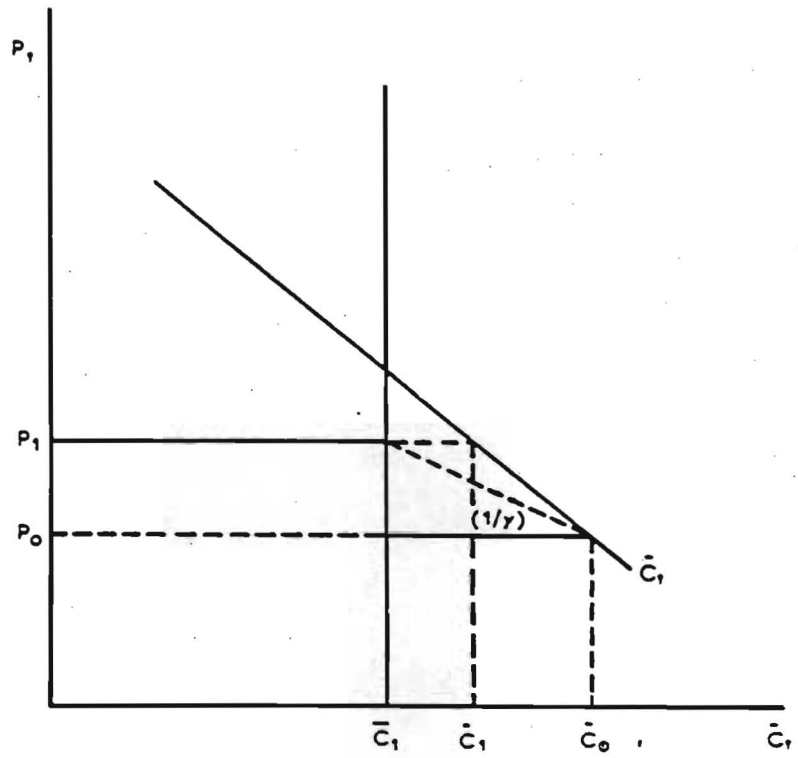
1/ Excess demand may be only one of a number of causes of increases in prices. Another might be a desire to reconcile stable real and nominal exchange rates by "passing through" world price increases to the domestic market. In this case, the left-hand variable would be $((P_t - P_{t-1}) - (P^*_t - P^*_{t-1}))$ and the expanded price adjustment equation would be:

$$(P_t - P_{t-1}) = (P^*_t - P^*_{t-1}) + (1/\gamma)(\tilde{C}_t - \bar{C}_t)$$

This formulation has been used in some estimations.

Figure 4

Updating Administered Prices



World Bank—26455

unemployment in period 1, only $\bar{C}_1$ may be available for private-sector consumption. The previous-period price (P_0) creates excess consumption demand through its effect on real balances. Excess demand is given by $(\tilde{C}_1 - \bar{C}_1)$. The government then raises prices to P_1 according to the excess demand rule (36). Knowledge of the change in P_t for all periods and the government's rule allows calculation of $\tilde{C}_1$ and the $\tilde{C}_t$ schedule.

Effective demand for money can be treated similarly. The observed money holdings then include both effective demand holdings ($\tilde{M}_t$) and involuntary saving, whose magnitude is measured by the price adjustment.

$$(38) \qquad \bar{M}_t - \tilde{M}_t = (\tilde{C}_t - \bar{C}_t) \cdot P_t$$

$$(39) \qquad \bar{M}_t = \tilde{M}_t + \gamma(P_t - P_{t-1}) \cdot P_t$$

Equations (7) and (8) of Section IV indicate the functional relationships between <u>effective</u> consumption and real balance demand and their determinants. Combining these with (37) and (39) yields estimable expressions for <u>realised</u> consumption and real balance demands:

$$(40) \qquad \bar{C}_t = f_0 + f_1(w_t L_t(1-\tau_t)/P_t) + f_2\left(\frac{M_{t-1}}{P_t}\right) + f_3(P_t - P_{t-1}) + e_{ct}$$

$$(41) \qquad \bar{M}_t/P_t = m_0 + (1-f_1)(w_t L_t(1-\tau_t)/P_t) + (1-f_2)\left(\frac{M_{t-1}}{P_t}\right) - f_3(P_t - P_{t-1}) + e_{mt}$$

The cross-equation restrictions on coefficients demonstrate the linkage between the two demands in the private-sector decision process. The individual has two options for the use of present after-tax labor income or past saving: to spend on consumer goods or to add to saving held in real balances. The restrictions on the coefficients of labor income and lagged money holding reflect this choice by summing to one across equations.

$(P_t - P_{t-1})$ represents the effect of rationing; the cross-equation restriction on its coefficient indicates that increased rationing must decrease consumption and increase real balance holdings by the same factor.

Labor income plays a dual role in estimation. It is the labor income of the present period, but it is also a proxy for the expectation of the income stream over future periods. f_1 is then expected to lie between zero and one, most probably in the range .6 - .9. f_2 is an indication of the time horizon of the consumer; as it approaches zero, it indicates a lengthening of the time horizon. A consumer with an infinite horizon would have an effective propensity to consume from real balances which is infinitely small, and long horizons may result in f_2 being statistically indistinct from zero in small samples. f_3 near zero indicates that the market for goods is not rationed; the larger it is, the more important rationing becomes in determining realized demands.

The ρ point estimate of autocorrelation of consumption equation errors was slightly greater than one, and indicated that (40) should be estimated in first-difference form. The estimate of the consumption equation intercept is then lost, but theory predicts zero intercepts in both equations.

This specification of the private-sector decision demonstrates high explanatory power. Comparison of the results with unconstrained estimation indicated almost no difference in explanatory power for consumption demand, but a loss in explanatory power in the real balance equation. 1/

1/ This appears to be due to the fact that when estimated separately, the real balances equation confounds supply and demand characteristics in the money market. The cross-equation restrictions imposed here then act to identify the demand-equation parameters.

The most striking feature of these results is the importance of the rationing coefficient. 1/ Using the estimate of $-f_3 = \gamma = 2.36$, the level of rationing implied by the government price-updating rule (35) is shown in Table 3, and appears to have been a significant fraction of realised private consumption demand. Although government outlays were sizeable throughout the period under consideration, in the pre-1973 period they tended to be financed through taxation, thus leaving the private sector closer to its demand curve. In the post-1973 period, the government relied more and more on rationing and seigniorage to finance expenditures; this led to larger involuntary saving. By the start of the Benjedid period in 1979, the government was shifting away from its high-investment-growth and high-saving strategy. This is reflected in lower rationing levels in 1979 and 1980. Subsequent years would likely indicate still less rationing, as government policy has diminished the scarcity of consumption goods.

The other coefficients in Table 2 are consistent with theory. f_1 lies in the interval between .6 and .9, and accords remarkably well with estimates from other countries of the marginal propensity to consume from disposable income. 2/ f_2 is small, and is insignificantly different from zero, which suggests that Algerian consumers make decisions for a long time horizon. m_0 is also insignificantly different from zero, as theory suggests.

Finally, the link between investment and rationing can be drawn from the above results. Consider the residuals of equation (33), (RES_t), which represent the component of investment not explained by contemporaneous foreign

---

1/ The alternative specification of the government price-updating rule which incorporated a "world price pass-through" yielded poorer results in terms of explanatory power, possibly because so small a share of consumption is traded.

2/ See page 45 for footnote.

Table 2

Estimation of Consumption and Real Balance Demands

Parameter	Estimate	T-statistic a/
f_0	not obtained	
f_1	.82	4.92
f_2	.19	.70
f_3	-2.36	2.58
m_0	.07	.55
$\bar{R}^2(C) = .97$ b/		
$\bar{R}^2(M/P) = .98$		

a/ The critical T-value for the 95 percent level of confidence ~~and~~ 10 degrees of freedom is 2.23.

b/ First-differencing was accomplished by placing all lagged values on the right-hand side of the equation.

Table 3

Rationing in the Goods Market

Year	Rationing as percent of $\bar{C}$
1967	2
1968	4
1969	1
1970	4
1971	6
1972	3
1973	5
1974	10
1975	11
1976	8
1977	9
1978	15
1979	7
1980	8

financing. From the public budget constraint these should be positively associated with the degree of rationing in Table 2 (RAT_t) as drawn from equation (41). In the absence of other financing, as pointed out in equation (20), investment residuals should completely explain rationing. Rationing and foreign credit should together account for the financing of the investment program.1/ In fact, the two variables are highly correlated:

$$(41) \quad RAT_t = \underset{(8.55)}{6.64} + \underset{(3.30)}{7.43}\ RES_t \qquad \bar{R}^2 = .43 \qquad DW = 1.26$$

Support for the above view of the Algerian budgetary process also comes from the fact that variations in $(q_t E_t + B_t)$ and RAT_t capture 92% of the variance of investment.

1/ As shown in the budget equation (13), a perfect correspondence would require that current government expenditures equalled current revenues. It would also require perfect consistency between the national, fiscal, monetary and balance of payments accounts.

(footnote from page 43)

1/ The results of estimates for the U.S. of the consumption function are almost identical. The Ando/Modigliani results reported in Froyen (1983) for the U.S. included the following statistical relation:

$$C_t = .06A_t + .72w_tL_t$$

where A_t is the value of presently held assets, and w_tL_t is pre-tax labor income. The comparable regression result for Algeria, using pre-tax labor income and real balances, yields:

$$C_t = \underset{(2.14)}{.26}\ (M_{t-1}/P_t) + \underset{(7.87)}{.73}\ w_tL_t - \underset{(2.78)}{2.29}\ (P_t - P_{t-1})$$

There is a striking similarity in the marginal propensity to consume; the asset coefficient is Algeria is larger in point estimate, perhaps because of the exclusion of non-financial assets, but it is indistinguishable statistically from the Ando/Modigliani result. The rationing term represents the distance the consumers are from their demand curve.

VI. Conclusions.

The Algerian pattern of development since the early 1960s has differed from that of other developing countries in two major respects. First, Algeria's economy, under the influence of its massive investment program and its commitment to socialism, has been centralised and state-controlled. The public sector undertakes nearly all formal investment and production, and the government exercises strict control over prices in goods, labor, financial asset and foreign exchange markets.

Second, Algeria stands out among oil exporters in the way it has managed to channel its crude oil revenues since 1973 into investment without bringing about soaring inflation or a "Dutch disease" shrinking in the relative size of nonoil tradeable sectors.

The theoretical and empirical analysis of this study indicates that Algeria's performance over 1967-80 has been largely due to its command, or fix-price, economic structure. This represents an alternative to flex-price adjustment for oil exporter or other countries experiencing windfalls gains. It also offers insight into the economic forces with which the Algerians will have to contend as they move to a more flex-price market economy.

Over the past decade Algeria appears to have been in the classical unemployment variant of fix-price equilibrium, with excess demand for goods and excess supply of labor. In this framework, involuntary holdings of money balances result from goods market rationing. Econometric results reported here offer strong support to this view of the Algerian economy. Estimation of the theoretical model indicates both strong explanatory power and the importance of rationing in explaining realised consumption and real balance holdings.

These results lead to both theoretical and policy conclusions. First, in the fix-price economy, efforts to estimate consumer demand parameters through Walrasian demand equations will yield biased results. For example, past studies (including the authors') have concluded that the Algerian economy has a low propensity to consume. However, as noted above, estimates taking rationing into account lead to effective consumption propensities almost identical to those in the U.S.

Second, these results have important implications for the design of economic policy in Algeria. The impressive historical Algerian ability to accept high national saving rates and to defer consumption does not imply that such behavior will carry over to a liberalised economy with market-clearing prices. The effective demand functions indicate that higher income, and more goods available for purchase, will lead to demand responses similar to those found in market economies. Planning for a shift from a fix-price economy towards a liberalised one should not extrapolate past trends without correcting for this rationing effect. Consumption could increase more quickly, and lead to higher inflation, than might have been expected from the historical evidence. Indeed, the rationing estimates above indicate that without rationing the Algerian price level would have had to increase by some 40% more than its historical trend over 1974-78 to hold consumption at its historical levels, even under the favorable assumption that desired real balances are invariant to inflation. With any appreciable sensitivity of desired real balances to inflation, the Algerian strategy of the 1970s would have been infeasible without far tighter wage control or higher nonoil taxes since it would not have been possible for the state to have secured so large a share of purchasing power.

Have the distinctive features of Algeria's controlled economy been an advantage or a liability in dealing with the variations in its terms of trade after 1973? On the one hand, there are indications that Algeria has not used its investment as productively as planned, both in the hydrocarbon and non-hydrocarbon economies and that it has failed to stimulate nonhydrocarbon exports, but the same might be said for certain other oil producers. An equally serious feature is the capital intensity of the public investment program in the face of widespread underemployment. On the other hand, an excessive shift to nontraded goods was avoided at the cost of postponing private consumption. Steps have also been taken to diversify away from oil, a rapidly depleting natural resource, to natural gas, one with a far longer expected lifetime. The payoff to these hydrocarbon investments, a topic not explicitly addressed in this paper, depends on the relationship between gas prices and world interest rates since the moderate element of natural rent in gas prices is sensitive to changes in capital costs. Algeria was also been spared the sharp contraction occasioned by the massive outflows of private capital which characterised Venezuela, Mexico and other exporters with open financial markets after 1981.

In sum, it will be possible to evaluate the Algerian strategy only when the costs and benefits of the phase of rapid accumulation becomes clear. These will depend on three key factors, two external and one internal: (a) developments in the world gas market relative to (b) the level of world interest rates, and (c) the efficiency with which non-hydrocarbon investment and domestic labor can be used. If external factors are favorable and domestic policies encourage efficiency, the transformation of oil income and borrowing into domestic capital will permit substantial growth of real consumption. Otherwise, alternative strategies such as saving abroad or

increasing domestic consumption more directly through relaxing import restriction, and easing nonoil taxation will appear, in retrospect, to have been more promising.

Bibliography

Amemiya, T.: "A Note on a Fair and Jaffee Model," Econometrica, vol. 42 (July 1974), pp. 759-762.

Amin, S.: Accumulation on a World Scale. London: Monthly Review Press, 1974.

Benassy, J. P.: "Neo-Keynesian Disequilibrium Theory in a Monetary Economy," Review of Economic Studies, vol. 42 (October 1975), pp. 503-524.

Bordo, M.D.: "John E. Cairnes on the Effects of the Australian Gold Discoveries, 1851-37: An Early Appreciation of the Methodology of Positive Economics", History of Political Economy 7, No. 3 (1975), pp. 337-359.

Bruno, M., "The Two Sector Open Economy and the Real Exchange Rate", Falk Institute, Hebrew University of Jerusalem (August, 1975).

Chenery H. and M. Syrquin, Patterns of Development: 1950-1970. Oxford: Oxford University Press, 1975.

Conway, P.: "Oil Rents and Development Strategy: A Case Study of Algeria," World Bank mimeo, 1982.

Drazen, A.: "Recent Developments in Macroeconomic Disequilibrium Theory," Econometrica, vol. 48 (March 1980), pp. 283-306.

Dreze, J.: "Existence of an Exchange Equilibrium under Price Rigidities," International Economic Review, Vol. 16 (June 1975), pp. 301-320.

Fair, R. and D. Jaffee: "Methods of Estimation for Markets in Disequilibrium," Econometrica, vol. 40 (1972), pp. 497-514.

Froyen, R., Macroeconomics, New York: MacMillan, 1983.

Hicks, J.: Capital and Growth. Oxford: Oxford University Press, 1965.

Kornai, J.: The Economics of Shortage. Amsterdam: North-Holland, 1978.

Lewis, W. A., "Economic Development with Unlimited Supplies of Labor", Manchester School of Economics & Social Studies, 20 (May 1952), pp. 139-191.

Mallarde, E.: L'Algerie Depuis. Paris: Le Table Ronde 1975.

Malinvaud, E.: The Theory of Unemployment Reconsidered. Oxford: Basil Blackwell, 1977.

Morgan, D.R., "Fiscal Policy in Oil Exporting Countries", IMF Staff Papers (March 1978), pp. 55-86.

Muellbauer, J. and R. Portes: "Macroeconomic Models with Quantity Rationing", Economic Journal, vol. 88 (1978), pp. 788-821.

Murphy, K.J , Macroprojects in the Third World. New York: Westwind Press, 1983.

Picard, P.: "Inflation and Growth in a Disequilibrium Macroeconomic Model," Journal of Economic Theory, vol. , (1983), pp.

Portes, R. and S. Winter: "The Demand for Money and Consumption Goods in Centrally Planned Economies", Review of Economics and Statistics, vol. 60 (February 1978), pp. 8-17.

Portes, R. and S. Winter: "Disequilibrium Estimates for Consumption Goods in Centrally Planned Economies", Review of Economic Studies, vol. 47 (January 1980), pp. 137-157.

Quandt, R.: "Testing Hypotheses in Disequilibrium Models," Princeton Econometric Research Program #197, (1976).

Quandt, W.: Revolution and Political Leadership: Algeria, 1954-1968. Cambridge, MA: MIT Press, 1971.

Raffinot M. and P. Jacquemot; Le Capitalisme d'Etat Algeria. Paris: Maspero, 1977.

Zartman, I.W., "The Elites of the Maghreb: A Revue Article", International Journal of Middle East Studies 6, No. 4 (December 1975).

Appendix 1

The Individual Consumer's Decision

Suppose a Bernoulli utility function for individual i (the subscript i is suppressed until summation across individuals)

$$u = \sum_{t=1}^{T} \frac{1}{(1+r)^t} \ln c_t \tag{1}$$

to be maximised subject to a budget constraint for all t: $1<t<T$ where T is the consumer's horizon:

$$B_t = \frac{m_{t-1} - m_t}{P_t} + \frac{w_t\, t^n}{P_t}(1-\tau_t) - c_t = 0 \tag{2}$$

From the Lagrangian Λ, defined with multipliers λ_t, obtain first order conditions (4) - (6) which hold for the above range of t and the transversality condition which ensures that final-period money holding is zero:

$$\Lambda = u + \sum_{t=1}^{T} \lambda_t B_t \tag{3}$$

$$\frac{\delta\Lambda}{\delta c_t} = \frac{1}{c_t}\left(\frac{1}{1+r}\right)^t - \lambda_t = 0 \tag{4}$$

$$\frac{\delta\Lambda}{\delta m_t} = \frac{\lambda_{t+1}}{P_{t+1}} - \frac{\lambda_t}{P_t} = 0 \tag{5}$$

$$\frac{\delta\Lambda}{\delta\lambda_t} = \frac{m_{t+1} - m_t}{P_t} + \frac{w_t n_t}{P_t}(1-\tau_t) - c_t = 0 \tag{6}$$

$\lambda_{T+1} = 0$ so that $m_T = 0$.

Define:

$$z_t = \frac{w_t}{P_t} n_t(1-\tau_t) \tag{7}$$

$$\delta = \sum_{t=1}^{T} \frac{1}{(1+r)^t} \phi^t \tag{8}$$

$$R^t = (1+r)^t \tag{9}$$

To obtain a form of consumption function which may be estimated, assume:

$P_t = P_1$ for all t (static expectations of prices); (10)

$z_t = \phi^t z_1$ (expectations of future after tax wage income are proportional to current income, and static if $\phi = 1$); (11)

R-1 is small and $T(R-1) \ll 1$. (12)

By (4), (6) and (5), which together with (10) imply that $\lambda_t = \lambda$:

$$c_t = z_t + \frac{1}{P_t}(m_{t-1} - m_t) = \frac{1}{\lambda R^t} \tag{13}$$

$$\sum_{t=1}^{T} c_t + R^t = \sum_{t=1}^{T} R^t\left(z_t + \frac{1}{P_t}(m_{t-1} - m_t)\right) = \frac{T}{\lambda}. \tag{14}$$

By assumption $z_t = \phi^t z_1$ so that

$$z_1\delta + \frac{1}{P_1}[Rm_0 + \sum_{t=2}^{T} R^{t-1}(R-1)m_{t-1}] = \frac{T}{\lambda} \tag{15}$$

Unless the consumer's horizon is very long, the distributed lag on future money balances will be small relative to Rm_0, so that, to a first order of approximation:

$$z_1\ \delta + \frac{R}{P_1} m_0 = \frac{T}{\lambda} \tag{16}$$

Equation (16) establishes the relative weighting of wage incomes and money balances in setting levels of consumption in each period. By (13), for decisions made in period t:

$$c_t = \frac{1}{T}[z_t\delta + \frac{R}{P_t} m_{t-1}] \tag{17}$$

which implies

$$\frac{m_t}{P_t} = (1-\frac{\delta}{T})z_t + (1-\frac{R}{T})\frac{m_{t-1}}{P_t} \tag{18}$$

Aggregating over individuals i:

$$C_t = \sum_{i=1}^{L^s} c_{it} = \frac{\delta}{T}(\frac{w_t}{P_t}L_t(1-\tau_t)) + \frac{R}{T}\frac{M_{t-1}}{P_t} \tag{19}$$

$$\frac{M_t}{P_t} = \sum_{i=1}^{L^s} \frac{m_{it}}{P_t} = (1-\frac{\delta}{T})(\frac{w_t}{P_t}L_t(1-\tau_t)) + (1-\frac{R}{T})\frac{M_{t-1}}{P_t} \tag{20}$$

Appendix 2:

Steady State Equilibrium and Boundary Conditions

A. Walrasian Steady-State Equilibrium.

All variables are in per capita terms and time subscripts are omitted for period t. The labor force grows at rate n.

(i) Goods market:

$$y^s = \frac{1}{\alpha} = y^d = c + i + g + (x-im) \qquad (1)$$

Let $z^* = (1-\tau)\frac{w}{P}$ = private disposable wage income. Investment consists of the Walrasian steady state level $\frac{n}{\beta}y$, which for notational convenience is subsumed into government spending: $g' = g + \frac{n}{\beta}y$. Out of Walrasian equilibrium investment i is defined also has a component $\lambda(u.L^s)[i_1 i_{t-1} + i_2(b+qe)]$, reflecting imbalances in the labor market as indicated by unemployment $u.L^s$, with i_1 and i_2 as parameters. From the consumption function as derived in Appendix 1:

$$\frac{1}{\alpha} = \frac{\delta}{T}z^* + g'y + \frac{1+r}{T}m_{t-1} + \lambda i_1 i_{t-1} + (\lambda i_2 - 1)(b+qe). \qquad (2)$$

$\lambda = 0$ since $u = 0$, and by the government budget constraint which is

$$g'y + i = \tau\frac{w}{P} + (y - \frac{w}{P}) + \theta m_{t-1} + (b+qe) \qquad (3)$$

$$\frac{1}{\alpha} = \frac{\delta}{T}z^* + \frac{1+r}{T}m_{t-1} + \theta m_{t-1} + y - \frac{w}{P} + \tau\frac{w}{P} \qquad (4)$$

$$y = (\frac{\delta}{T} - 1)z^* + y + (\theta + \frac{1+r}{T})m_{t-1}. \tag{5}$$

or $$\theta m_{t-1} = (1 - \frac{\delta}{T})z^* - \frac{1+r}{T}m_{t-1}$$

Accumulation of real balances equals saving out of wage incomes less dissaving out of assets.

(ii) Labor market:

$$L = L^s = L^d \tag{7}$$

$$l = \alpha\beta k$$

or $$k^* = \frac{l}{\alpha\beta} \tag{8}$$

(iii) Government budget:

$$\theta m_{t-1} = (g-1)y + (1-\tau)\frac{w}{p} + i - (b+qe) \tag{9}$$

(iv) Combining the goods market and government budget:

$$0 = (\frac{\delta}{T} - 1)z^* + \frac{1+r}{T}m_{t-1} + (g'-1)y^* + z^* - (b+qe) \tag{10}$$

$$= \frac{\delta}{T}z^* + \frac{1+r}{T}m_{t-1} + (g'-1)y^* - (b+qe) \tag{11}$$

$$= c^* + (g'-1)y^* - (b+qe) \tag{12}$$

Therefore

$$y^* = \left(\frac{1}{1-g'}\right)\{c^* - (b+qe)\} = \frac{1}{\alpha}. \tag{13}$$

By (11):

$$m^*_{t-1} = \frac{T}{1+r}\left\{-\frac{\delta}{T}z^* + \frac{(1-g')}{\alpha} + (b+qe)\right\} \tag{14}$$

Equation (13) indicates the relationship between c* and y* and (14) the Walrasian level of real balances dependent on parameters and policy variables.

(v) In equilibrium m* is constant so that $\theta = n$; inflation is zero because $y^s = y^d$. Government spending and taxes are linked by the budget and the steady state constraint on financing:

$$mn = (g'-1)/\alpha + \frac{w}{p}(1-\tau) - (b+qe)$$

or (15)

$$g' = \alpha[mn - \frac{w}{p}(1-\tau) + (b+qe)] + 1.$$

Noting that $\frac{w}{p}(1-\tau) = z^*$ and using (14) to eliminate z*:

$$m^* = \left(\frac{T-\delta}{1+r+\delta n}\right)\left[\left(\frac{1-g'}{\alpha}\right) + (b+qe)\right] \tag{16}$$

Together, (8) and (16) determine the Walrasian equilibrium in (k*,m*) space.

B. <u>The Boundary Conditions.</u>

(i) Repressed inflation/classical unemployment (REP/CLA):

(a) labor market is in balance: $L^s = L^d$ and $l = \min\{\alpha y^d, \alpha\beta k\}$

(b) product demand exceeds supply: $y^d > y^s$ which implies:

(c) for the labor market, $l = \alpha\beta k$, and (17)

(d) on the goods market $\frac{l}{\alpha} < \frac{\delta}{T}z^* + g'/\alpha + \frac{1+r}{T}m_{t-1} - (qe+b)$

Therefore by (14) $m_{t-1} > m^*_{t-1}$. (18)

(ii) Repressed inflation/Keynesian unemployment (REP/KEY):

(a) product market is in balance: $y^d = y^s = \min(\frac{l}{\alpha}, \beta k)$

(b) labor market is supply constrained: $l < \min(\alpha y^d, \alpha\beta k)$ which implies:

(c) $l < \alpha\beta k$ or $\frac{l}{\alpha\beta} < k$, and (19)

(d) in the product market, by (5)

$$\frac{l}{\alpha} = (\frac{\delta}{T} - 1)z^* + \frac{l}{\alpha} + (\theta + \frac{1+r}{T})m_{t-1}. \tag{20}$$

Replacing θm_{t-1} from the government budget constraint (3):

$$0 = (\frac{\delta}{T} - 1)z^* + \frac{1+r}{T}m_{t-1} + i + \frac{g'-l}{\alpha} + z^* - (qe+b) \tag{21}$$

or $$\frac{l-g'}{\alpha} = \frac{\delta}{T}z + \frac{1+r}{T}m_{t-1} - (qe+b) + \lambda\{i_1 i_{t-1} + i_2(qe+b)\} \tag{22}$$

or $$m_{t-1} = T\{-\frac{\delta}{T}z^* + (\frac{l-g'}{\alpha}) + (b-qe) - \lambda(i_1 i_{t-1} + i_2(qe+b))\}$$

$$= m^*_{t-1} - T\lambda\{i_1 i_{t-1} + i_2(qe+b)\} \tag{23}$$

If investment is adjusted to the labor shortage by reducing capital formation this is formally equivalent to allowing λ to be negative so that

$m_{t-1} > m^*_{t-1}$: to hold the product market in balance consumption out of money balances must be large enough to compensate for reduced investment.

(iii) Keynesian unemployment/classical unemployment (KEY/CLA):

(a) the labor market is demand constrained: $1 > \min\{\alpha y^d, \alpha\beta k\}$

(b) product market is in balance: $y^s = y^d = \min\{\frac{1}{\alpha}, \beta k\}$.

This implies:

(c) $1 > \alpha\beta k$ so that $u > 0$, and

(d) in the product market, by (1)

$$y = \beta k = \frac{1+r}{T}[\delta z + m_{t-1}] + g'\beta k + \lambda i_1 i_{t-1} + (\lambda i_2 - 1)(b+qe) \tag{24}$$

where $$z = (1-\tau)\frac{w}{p}(\alpha\beta k) \tag{25}$$

$$\beta k(1 - \frac{\delta}{T}(1-\tau)\frac{w\alpha}{p} - g') = \frac{1+r}{T} m_{t-1} + \lambda i_1 i_{t-1} + (\lambda i_2 - 1)(b+qe). \tag{26}$$

$$\text{Let } \Delta = 1 - \frac{\delta}{T}(1-\tau)\frac{w}{p}\alpha - g' \tag{27}$$

$$\beta k = \frac{1}{\Delta}[\frac{1+r}{T} m_{t-1} + \lambda i_1 i_{t-1} + (\lambda i_2 - 1)(b+qe)] \tag{28}$$

The locus (m,k) in (28) has positive slope (except possibly for $k \gg k^*$) positive since $\frac{\partial m}{\partial k} = \beta T[\Delta + \lambda'\alpha(i_1 i_{t-1} + i_2(b+qe))]$. If $k=0$, $m_{t-1} < 0$, if $m=0$, $k>0$. If k is at its Walrasian level, $k = \frac{1}{\alpha\beta}$, then $u=0$ and by (28):

$$m_{t-1} = \frac{T}{1+r}[\frac{1-g'}{\alpha} - \frac{\delta z^*}{T} + b + qe] = m^*_{t-1} \text{ by (14).}$$

The locus thus passes through the point of Walrasian equilibrium.

C. The Effect of Increased Foreign Resources.

The effect of permitting a higher nonoil trade deficit qe+b depends on the response of public investment, as given by λi_2. The greater the response, the less does private demand need to rise to offset the increased nonoil trade deficit.

(i) Walrasian equilibrium: by (8) and (16), if qe+b rises, k* is unchanged but m* increases. Unless public spending g' rises, the increased nonoil trade deficit will require higher domestic demand (consumption out of money balances) to maintain full capacity use.

(ii) REP/CLA boundary: by (17) this is unchanged except that the vertical line extends begins at the higher m* by (18).

(iii) REP/KEY boundary: by (23)

$$\frac{\partial m_{t-1}}{\partial(qe+b)} = \frac{\partial m^*}{\partial(qe+b)} - T\lambda i_2$$

This is positive, both when u=0 and when there is excess demand for labor (assuming this is formally equivalent to $\lambda<0$ so that a rise in qe+b results in a fall in investment and lower public demand).

(iv) KEY/CLA boundary: by (28) and substituting out for m*.

$$\frac{\partial m_{t-1}}{\partial(b+qe)} = \frac{\partial m^*}{\partial(qe+b)} - T\lambda i_2$$

This is positive when unemployment is near zero, but may be negative for high levels of unemployment and large i_2. In this case a rise in qe+b results mainly in a large increase in public investment, which needs to be balanced by a fall in private consumption. The locus in figure 3 therefore tends to become steeper with the increase in foreign resources.