Policy, Research, and External Affairs

WORKING PAPERS

International Economic Analysis and Prospects

International Economics Department
The World Bank
June 1990
WPS 452

Modeling Investment Behavior in Developing Countries

An Application to Egypt

Nemat Shafik

This model of investment behavior takes into account certain characteristics common to developing countries, such as the oligopolistic structure of markets, putty-clay technology, the inelastic supply of nontraded capital goods, and financial repression.

Policy, Research, and External Affairs

WORKING PAPERS

International Economic Analysis and Prospects

WPS 452

This paper — a product of the International Economic Analysis and Prospects Division, International Economics Department — is part of a larger effort in PRE to understand the determinants of private investment in developing countries. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Joseph Israel, room S7-218, extension 31285 (66 pages with figures and tables).

Investment functions are notoriously difficult to estimate, particularly in developing countries. Shafik presents a model of the determinants of private investment that takes into account common characteristics of a developing economy.

Firms' decisions about investment are outcomes of the oligopolistic structure of markets, putty-clay technology, the inelastic supply of nontraded capital goods, and financial repression. These factors result in an important role for markups, internal financing, demand, and the cost of investment goods — defined, not as the interest rate, but as the price outcome from the interaction of supply and demand in the market for capital goods.

By constructing an index of the relative price of investment goods, it is possible to provide a more meaningful indicator of the true cost of capital to the firm under a repressed financial system. In an economy with a well-functioning credit market, the Keynesian equilibrium condition equating the marginal efficiency of investment with the interest is likely to hold. But under financial repression or where credit markets are imperfect, the interest rate is not a true reflection of the cost of capital to the firm. Instead, a combination of the price of investment goods and the quantity of capital available to the private sector appears to be a more realistic proxy.

Shafik tests the model econometrically for Egypt, using the recent literature on cointegration and error correction to avoid spurious regressions and to estimate the long-run equilibrium relationship between investment and its determinants.

She discusses the limit of testing econometrically whether the government "crowds in" or "crowds out" private investment and the impossibility of constructing the counterfactual. It is not possible to conclude whether crowding out or in occurred at the macroeconomic level (to accept the alternative hypothesis) but it is possible to draw conclusions about what did not happen (the null hypothesis).

The model also provides a framework for analyzing the effects of government policy by considering explicitly the role of a number of possible instruments such as the exchange rate, the quantity of credit available to the private sector, and the composition and financing of the government budget. Future research may choose to test other empirical proxies, such as protection, within the same framework.

TABLE OF CONTENTS

TEXT PAGES

I am grateful to Paul Armington, Ajay Chhibber, William Easterly, and Mohamed A. El-Erian for helpful comments and suggestions.

TABLES PAGES

FIGURES PAGES

1. Introduction: The Issues

1.1. Introduction

The economic literature on investment has been characterized by considerable controversy, even by the standards of economists. A number of different, often overlapping, models of investment determination have been hypothesized and the empirical evidence has done little to clarify which, if any, are accurate representations of the way in which capital formation occurs in the economy. This is particularly true for developing countries where there has been less empirical work, the data are less reliable, and the appropriateness of existing theoretical models is debatable.

It is against this background that this paper suggests some methodological innovations in modelling aggregate investment behavior. A theoretical framework for analyzing investment decisions is presented in Section 2 that takes into account some of the structural features of a developing economy. Starting from the firm's optimization problem, an aggregate investment function is derived that reflects the results of a survey of decision-making in fifty private sector firms in Egypt. The model is then tested at the macroeconomic level in Section 3 using new econometric techniques that have emerged in the recent literature on stationarity testing and cointegration. The relationship between investment and an array of government policies is highlighted in the econometric analysis. The conclusions, both methodological and empirical, are presented in Section 4.

1.2. Background: The Literature on Investment in Developing Countries

Since there are a number of good surveys of the investment literature available,[1] this section focuses on empirical models that are relevant to developing countries. The relatively few attempts to estimate investment functions for developing economies have tended to use fairly eclectic models that combine features of the flexible accelerator, neoclassical, and structuralist approaches. Few studies have attempted to apply "q" models, which use the ratio of the market valuation of the existing capital stock to its replacement cost, to developing countries since stock market valuations of corporate fixed assets are often non-existent or else are not meaningful.[2]

A number of these studies, particularly the country-specific ones, have provided considerable insights into the factors that influence capital formation in developing countries. For example, Behrman's work on Chile explores the validity of putty-putty versus putty-clay assumptions across a number of different economic sectors.[3] His results revealed that investment functions tended to differ across sectors, both in terms of the variables that were relevant and in

---

[1]See Serven and Solimano, 1989; Precious, 1987; Brunker, 1985; Nickell, 1978; Helliwell, 1976; Rowley and Trivedi, 1975; and Meyer and Kuh, 1957. The accelerator and flexible accelerator models are described in Samuelson, 1939; Eisner, 1960; Meyer and Glauber, 1964; Brown, Solow, Ando and Karenken, 1963; and Eisner, 1967. The neoclassical model originates in the work of Jorgenson, 1963; Jorgenson, 1967; Jorgenson and Siebert, 1968; and Hall and Jorgenson, 1971. The "Q" theory of investment and the related adjustment costs literature are presented in Tobin, 1967; Tobin, 1969; Tobin and Brainard, 1977; Hayashi, 1982. Modern versions of Keynes' model based on the supply of capital goods can be found in Haavelmo, 1960; Witte, 1963; and Precious, 1987. The Kaleckian profits model of investment determination is described in Kalecki, 1971. An example of a structuralist model of investment behavior is provided in Taylor, 1987. Disequilibrium models of investment are described in Malinvaud, 1980; Malinvaud, 1982; and Sneessens, 1987. Investment models that focus on financial constraints can be found in Fazzari and Mott, 1984; Fazzari, Hubbard and Peterson, 1988a; and Fazzari, Hubbard and Peterson, 1988b.

[2]For example, in many developing country stock market shares are not truly traded so that quoted prices do not reflect the market valuation and expectations of future profitability. Dailami uses "q" models to explain private investment in Brazil and Korea. Dailami, 1987, 1990. Solimano applies a "q" model to Chile, but also adds a number of additional explanatory variables. Solimano, 1989.

[3]Behrman, 1972.

terms of their lag structure. Pinell-Siles' study of private investment in India highlights the dampening effect that the tax system has on capital formation because of the failure to adjust taxable income for inflation.[4] Using panel data on Colombian firms, Bilsborrow found that the availability of foreign exchange to implement planned capital formation and the internal flow of funds were the most important determinants of investment.[5] The importance of cash flow effects reflect the uncertainty, informational constraints, and weak capital markets faced by Colombian entrepreneurs.[6]

These earlier studies by Behrman, Bilsborrow, and Pinell-Siles were followed by a number of more ambitious multi-country analyses that highlighted the role of government policy, particularly public investment, on private capital formation in developing economies.[7] The theoretical framework adopted was sometimes ad hoc or some combination of neoclassical and flexible accelerator models with additional variables to capture the effects of government policies. Fry estimated investment functions for sixty-one developing countries using demand, relative prices, the exchange rate, and the availability of domestic credit.[8] His estimates find significant effects on the investment ratio from the growth rate of GDP, the ratio of foreign exchange receipts to GDP, the ratio of domestic credit to GDP, the purchasing power of exports, the ratio of actual to expected prices, and the lagged investment ratio. Tun Wai and Wong's estimates of

---

[4]Pinell-Siles, 1979.

[5]Billsborrow, 1977.

[6]More recent work by Dailami on Colombia found that the high real marginal cost of capital, especially for small- and medium-size firms, served to constrain the expansion of capacity in the private sector. Dailami, 1989.

[7]Fry, 1980; Sundararajan and Thakur, 1980; Tun Wai and Wong, 1982; Blejer and Khan, 1984.

[8]Fry, 1980.

private investment functions for five countries used government investment, the change in bank credit to the private sector, and the inflow of foreign capital to the private sector as explanatory variables.[9] The econometric results indicated that government investment was the most important explanatory variable for Greece, Korea, and Malaysia, whereas bank credit was critical in Thailand and foreign capital inflow in Mexico. Retained earnings were included in the regressions for Greece and Korea, the only countries for which data were available, but had insignificant coefficients.

Private investment functions were estimated by Sundararajan and Thakur as part of a growth model intended to measure the effects of public investment in India and Korea.[10] They use a combined neoclassical and flexible accelerator model with additional terms for the public sector capital stock and real savings available to the private sector.[11] They found significant coefficients on all the variables for India and Korea except for the public sector capital stock When the long run multipliers for public investment were calculate the effects for India and Korea were strikingly different. For India, the effect of public investment on private capital formation was weak because of an initial strong crowding out effect that was not offset for many periods. These negative effects were attributed to the high incremental capital-output ratio in the public sector in India. In Korea, they found that the effect of public capital formation on private investment was unambiguously positive in the short and long run.[12]

---

[9] Tun Wai and Wong, 1982.

[10] Sundararajan and Thakur, 1980.

[11] Real savings available to the private sector was defined as total savings minus public investment in real terms.

[12] For an analysis of the impact of stock markets on private investment in Korea, see Dailami, 1990.

Blejer and Khan's paper is one of the few that uses an optimizing framework for the firm to derive an aggregate investment function to evaluate the effects of government policy.[13] The resulting model is essentially a flexible accelerator that allows for government policy to affect the speed of adjustment to the desired capital stock through a standard partial adjustment mechanism.[14] Blejer and Khan hypothesize that the factors that affect the speed of adjustment to desired levels of capital are the stage of the business cycle, the availablity of financing, and the level of public sector investment. They argue that it is important to distinguish between public investment in infrastructure, which is more likely to "crowd in" private investment, from that in other areas. However, the empirical testing of this distinction is weakened by the empirical proxies used for infrastructure investment.[15] Their empirical results from twenty-four developing countries found an important positive effect on private investment from the degree of capacity utilization and the availability of credit. They also claim evidence in support of their

---

[13] Blejer and Khan, 1984.

[14] Note that there are problems with such an approach that stem from the deficiencies of the standard partial adjustment model. Under partial adjustment, agents incur costs for any kind of change, even a desirable one. Consequently, in a growth situation, the model results in consistent undershooting of the desired capital stock. It is possible to address this by using a generalized version of the partial adjustment model, the error correction model, that will be described later. See Nickell, 1985.

[15] Blejer and Khan used two different proxies for infrastructure investment: (1) a proxy based on the premise that infrastructure investments have a long gestation period and therefore the trend level of total public investment can represent infrastructure; and (2) a proxy that posits that because of its long run nature, infrastructure investment is more likely to be anticipated. However, infrastructure investment is usually very lumpy. Therefore, the measure based on the trend level of investment may be reflecting other types of investment spending that are fairly stable over time. Similiarly, expenditure on infrastructure is often unexpected since it can, by its nature, be postponed if neglect or deterioration is tolerable. Also, because public investment in infrastructure in developing countries is often associated with borrowed resources from banks or donors, there is likely to be even greater uncertainty in formulating expectations about future outlays.

position that government infrastructure investment crowds in private investment whereas other public investment crowds out private activity.[16]

A later study of the effect of public policy on private investment in Turkey by Chhibber and van Wijnbergen used Blejer and Khan's framework, but used actual data on government infrastructure spending.[17] They also calculated real effective interest rates that took explicit account of compensating balances. Compensating balances are a means by which banks circumvent low administered interest rates by requiring borrowers to place deposits in non-interest bearing accounts as guarantees for loans.[18] Their econometric results show significant coefficients for output, the real effective cost of borrowing, and private sector credit as a share of GNP. The other two explanatory variables tried, an index of capacity utilization and the share of infrastructure in total public investment, did not have significant coefficients. They conclude that the effect of government policy on private investment is complex and must be analyzed in light of a range of relevant policies including exchange rates and institutional factors such as export promotion programs. The high rate of public investment in Turkey resulted in some inflation and a raising of interest rates; however, it also insured that the economy's adjustment effort was growth-oriented.

In summary, the empirical work on investment in developing countries has tended to draw from the standard models in the literature and add elements that are relevant to the economy under

---

[16] In contrast, Balassa finds evidence that public investment and private investment are negatively correlated using Blejer and Khan's data set. Balassa, 1988.

[17] Chhibber and van Wijnbergen, 1988.

[18] Chibber and van Wijbergen use a technique based on the relationship between commercial bank deposits for transactions purposes and commercial bank loans for transactions uses to assess the importance of compensating balances in Turkey. The excess of deposits over uses reflects the importance of compensating balances. See Chhibber and van Wijnbergen, 1988 for a description of a technique originally proposed by Ersel and Sak, 1989.

consideration. Many of the early studies, such as those of Fry and Tun Wai and Wong, simply produced a list of variables that are correlated with investment in particular countries. Despite the problems associated with fixed factor coefficients in the accelerator model and the limitations of the partial adjustment model described above, Blejer and Khan's model represented an early attempt to develop the theoretical underpinnings of an investment model tailored to a developing economy. The model developed below is in the same spirit, but attempts to use realistic microfoundations as the starting point for a macroeconomic model of investment that incorporates the effects of government policy. In addition, the econometric testing that follows will incorporate the recent literature on stationarity testing and cointegration to avoid the spurious correlations associated with trended time series and to allow for an analysis of the long run equilibrium relationship between investment and its determinants.

2. Microfoundations for a Developing Economy

The microfoundations described below have emerged from a survey of fifty private sector firms in Egypt. The purpose of the survey was to identify those factors that influenced private sector investment decisions in order to develop a realistic analytical model and to contribute to the interpretation of the econometric results. The methodology, questionaire and detailed survey results are available elsewhere.[19] The discussion here will be limited to deriving a theoretical model of the firm's investment decision-making process that reflects the conditions that may prevail in many developing, as well as in some developed, economies.

[19] Shafik, 1989.

2.1. Market Structure, Pricing and Optimization

Because most private firms in developing economies are managed by their owner, the "black box" assumption that the objectives of shareholders are the same as those of the firm's managers is fairly plausible. Such an assumption would not necessarily be as credible in an economy where, because of separation between management and shareholders, there may be multiple objectives within the firm on the part of different decision-makers.[20] Consequently, the objective function hypothesized is a standard maximization of the expected utility (EU) of operating profits (π):

(1) Max $EU(\pi)$.

Output markets in developing countries are often characterized by oligopoly because of market size, government policies, financial barriers, technological considerations, supply constraints and a variety of structural features of developing economies. Consequently, it is important to allow for the possibility of a divergence between price and marginal cost when considering the firm's optimization problem. Similiarly, because investment decisions tend to be irreversible since second hand markets for capital goods often do not function efficiently, and there are large costs associated with asset liquidation, expectations about future demand and profits are important.

---

[20] "Managerial" models consider the nature of the objective function in a corporate structure. See Marris, 1964; Marris and Wood, 1971. The assumption of profit maximization may also be valid where corporate managers have a shareholding stake in the firm or where the firm is faced with the threat of bankruptcy. See Jensen and Meckling, 1976 and Grossman and Hart, 1982. The more recent literature on "principal-agent" problems considers how principals (shareholders) can manipulate the incentive structure so as to produce optimizing behavior on the part of agents (managers).

Consider the following definition of costs that distinguishes between direct production costs and the indirect cost of capital as well as differences between imported and domestically produced inputs:

$$(2) \qquad C = WL + (1-\phi)P_m^D M^D + \phi e P_m^W M^W + [(1-\Theta)P_k^D + \Theta e P_k^W] [(\delta + r - z)(1-i)/(1-u)]$$

where

C	=	total costs
W	=	wages
L	=	labor
ϕ	=	share of imported raw materials and intermediates
P_m^D	=	price of domestic materials and intermediates
P_m^W	=	price of imported materials and intermediates
e	=	exchange rate
M^D	=	domestic raw materials and intermediates
M^W	=	imported raw materials and intermediates
I	=	investment
Θ	=	share of imported capital goods
P_k^D	=	price of domestic capital goods
P_k^W	=	price of imported capital goods
δ	=	depreciation rate
r	=	interest rate
z	=	capital gains
i	=	present value of tax savings from investment incentives
u	=	rate of corporate taxation

The disaggregation of costs into a domestic and foreign component is useful because it allows for the consideration of an explicit role for the exchange rate, an important feature of the investment process in developing economies.[21] This is because in many developing economies

[21]This is highlighted in Chhibber and Shafik, 1990.

foreign exchange is rationed and investment is usually highly import dependent given the small size of the domestic capital goods industry.

Consider the simple case where there are N producers of a standardized product, a single selling price, no new entry, cost functions of firms may be different, and inputs and outputs are sold to price-takers. It is then possible to derive the markup over costs from a standard profit maximizing framework that takes into account the interdependence of firms' decisions under oligopoly.[22]

Each firm has a profit function:

$$(3) \qquad \pi_i = p(Q)q_i - C_i(q_i)$$

where $p = f(Q)$ and $Q = \Sigma q_i$.

The profit maximizing first and second order conditions are:

$$(4) \qquad d\pi_i/dq_i = p + q_i (dp/dQ \cdot dQ/dq_i) - dC_i/dq_i = 0$$

$$(5) \qquad d^2\pi_i/dq_i^2 < 0 \text{ for all i.}$$

[22] For a detailed derivation, see Waterson, 1984. It is possible to derive the model with heterogeneous products, differentiated prices, and potential entry of competitors, but the assumptions made here serve to simplify the exposition.

Rearranging equation (4) and using the above definition of Q, it is possible to derive the deviation of price from marginal cost as:

(6) $$\tau_i = s_i(1+\alpha_i)/\mu$$

where τ_i = mark up over costs for the ith firm.
α_i = dQ/dq_i = effect of the ith firm's output on other firms' output
s_i = ith firm's market share
μ = price elasticity of demand.

The outcome of the firm's optimization problem depends on those features that characterize an oligopolistic situation: the industry demand elasticity, market structure or concentration, and beliefs about rival behavior. The price cost margin, or mark up, in equation (6) allows for situations in which firms may have different marginal costs of production, be of different sizes, and hold different conjectures about how their rivals will react. Policies such as protection would affect the mark up through the firm's market share and the price elasticity of demand.

The firms profits are determined by the mark up rate, costs, and the level of aggregate demand in the economy:

(7) $$\pi = f(\tau, Y, C)$$

where π = profits
Y = aggregate demand
C = costs.

In addition to determining aggregate investment in the economy, profits are crucial at the firm level because they generate the internal funds that facilitate investment. This is particularly important in developing countries where capital markets usually do not satisfy the conditions for the Modigliani-Miller theorem to hold.[23] Because stock markets, where they exist, are usually underdeveloped and shareholders are rarely anonymous, there is little pressure on management to distribute dividends. Where financial markets are characterized by artificially low adminsitered interest rates, firms have a greater incentive to use debt financing since their borrowing costs are being subsidized by depositors.

The firm's desired investment (I^*) depends on expected mark ups, demand and costs:

$$(8) \qquad I^* = f(\tau^e, Y^e, C^e)$$

These determinants of the capital stock in equation (8) reflect an array of variables outlined above including market shares, price elasticities, rival behavior, exchange rates, wages, interest rates, taxes, investment incentives, and the price of capital goods.

---

[23] The Modigliani-Miller theorem posits that firms are indifferent between internal and external sources of financing under specific assumptions about the way in which capital markets operate. Modigliani and Miller, 1958. Even in industrialized economies with well-functioning capital markets there is considerable empirical evidence that retentions are an important determinant of investment. For example, in the United Kingdom, retained profits accounted for approximately 75% of the finance for new investment. See King, 1977, p. 209.

2.2. Investment Dynamics: An Error Correction Approach

The process by which firms move from actual to desired levels of capital stock is hypothesized to follow an error correction process. There are a number of advantages to such an approach. Firstly, error correction models have proven to be useful for explaining a variety of long run macroeconomic relationships.[24] Secondly, unlike the more common partial adjustment model, the error correction approach implies that firms incur no costs for changes that are planned.[25] Thirdly, the recent literature on cointegration provides a theoretical rationale for the empirical success of error correction models.[26] Specifically, the error correction levels term captures the long run equilibrium relationship between variables while the differenced terms capture the dynamics. Granger establishes that error correction models produce cointegrating sets of variables and that cointegrating series can be represented by an error correction process.[27] Series are said to cointegrate if some linear combination produces a stationary, or "white noise," error. Fourthly, the error correction framework is intuitively appealing because it provides a realistic representation of how rational, but fallible, agents make decisions. In the context of a developing country in which information may be far from perfect, decisions about the long run capital stock desired are likely to be characterized by gradualism and revision.

---

[24] Davidson, Hendry, Srba, and Yeo, 1978; Bean, 1981; Currie, 1981; Salmon, 1982; Henry and Minford, 1988.

[25] Nickell, 1985.

[26] Engle and Granger, 1987; Jenkinson, 1986; Dolado and Jenkinson, 1987; Giovanetti, 1987; Henry and Minford, 1988.

[27] Granger, 1983 and 1986.

The firm's intertemporal optimization problem is to minimize the costs associated with adjusting to the desired capital stock over an infinite horizon. Given the following quadratic cost or loss function:[28]

$$(9) \qquad \text{Min} \sum_{t=0}^{\infty}[c(I_t - I_t^*)^2 + (I_t - I_{t-1})^2].$$

Differentiating the above, an equation of the error correction form is obtained:

$$(10) \qquad \Delta I_t = a_0 \Delta I_t^* + a_1(I_{t-1} - I_{t-1}^*) + a_2 \Delta I_{t-1}.$$

This formulation implies that investment responds both to changes last period as in the partial adjustment model as well as to changes in the target, I^*. The levels term, $(I_{t-1} - I_{t-1}^*)$, captures the divergence from the long run equilibrium relationship caused by the costs of adjustment.

The relationship between the desired level of investment and the desired capital stock is defined conventionally as:

$$(11) \qquad I_t^* = K_t^* - (1 - \delta)K_{t-1}.$$

where δ = rate of depreciation.

---

[28] For other derivations of error correction models, see Nickell, 1985; and Davidson, Hendry, Srba and Yeo, 1978. For an earlier derivation of an error correction-type model intended to explain farmers' supply response to prices, see Nowshirvani, 1971.

Thus the firm chooses a desired level of investment given a lagged capital stock so as to achieve its desired capital stock. With irreversible or putty-clay technology, it is necessary to assume that $I_t^* \geq 0$.

Using equation (8) that defines the stochastic process generating the optimal target investment to substitute into equation (10) and assuming that expectations are realized, one obtains the dynamic reduced form for investment:

$$(12) \quad \Delta I_t = \beta_0 \Delta \tau_t + \beta_1 \Delta Y_t + \beta_2 \Delta C_t + a_1 (I_{t-1} - \beta_3 \tau_{t-1} - \beta_4 Y_{t-1} - \beta_5 C_{t-1}) + a_2 \Delta I_{t-1} + e_t$$

where e_t = error term.

This is the equation that will be estimated econometrically below.

The above model provides a framework for analyzing the consequences of an array of government policies for private investment. Policies that affect aggregate demand enter directly through the accelerator term. Protective tariffs and quotas as well as a domestic licensing system that restricts new entrants alter firm mark ups and result in higher investment in those sectors. Government policies that affect the costs associated with investment can enter through a number of channels defined in equation (2) including the exchange rate, interest rate, tax incentives, and rate of corporate taxation.

3. Empirical Evidence

3.1. The Data

The period chosen for econometric analysis, 1960-1986, was, to some extent, determined by data availability. The sample encompasses two different periods in Egypt's economic history, especially in terms of the relationship between the public and private sectors. Prior to 1974, Egypt followed an essentially statist import substitution policy whereas after 1974 the government sought to encourage the private sector under the banner of the "open door policy," or "infitah." The evolution of private investment over the sample period is depicted in Figure 1. Whether the underlying determinants of investment were stable under these two subperiods will be explored econometrically.

The data in Egypt, like that in most developing countries, are limited in terms of both quantity and quality. Quarterly observations are not available for the vast majority of economic variables and methods for their estimation are sometimes shrouded in mystery.[29] Consequently, a number of different sources were used and cross referenced whenever possible. Even when reasonably reliable series are available, there is the perpetual problem of matching theoretical concepts in economics to the statistics compiled by governments. Nevertheless, while the precise magnitudes of the variables are debatable, the general trends are confirmed by the historical experience as well as by the survey results.

---

[29]For a useful description of data sources and causes of discrepancies, see Mabro and Radwan, 1976, pp. 242-65. For a more recent discussion of the idiosyncrasies of Egyptian economic data, see Hansen, 1988.

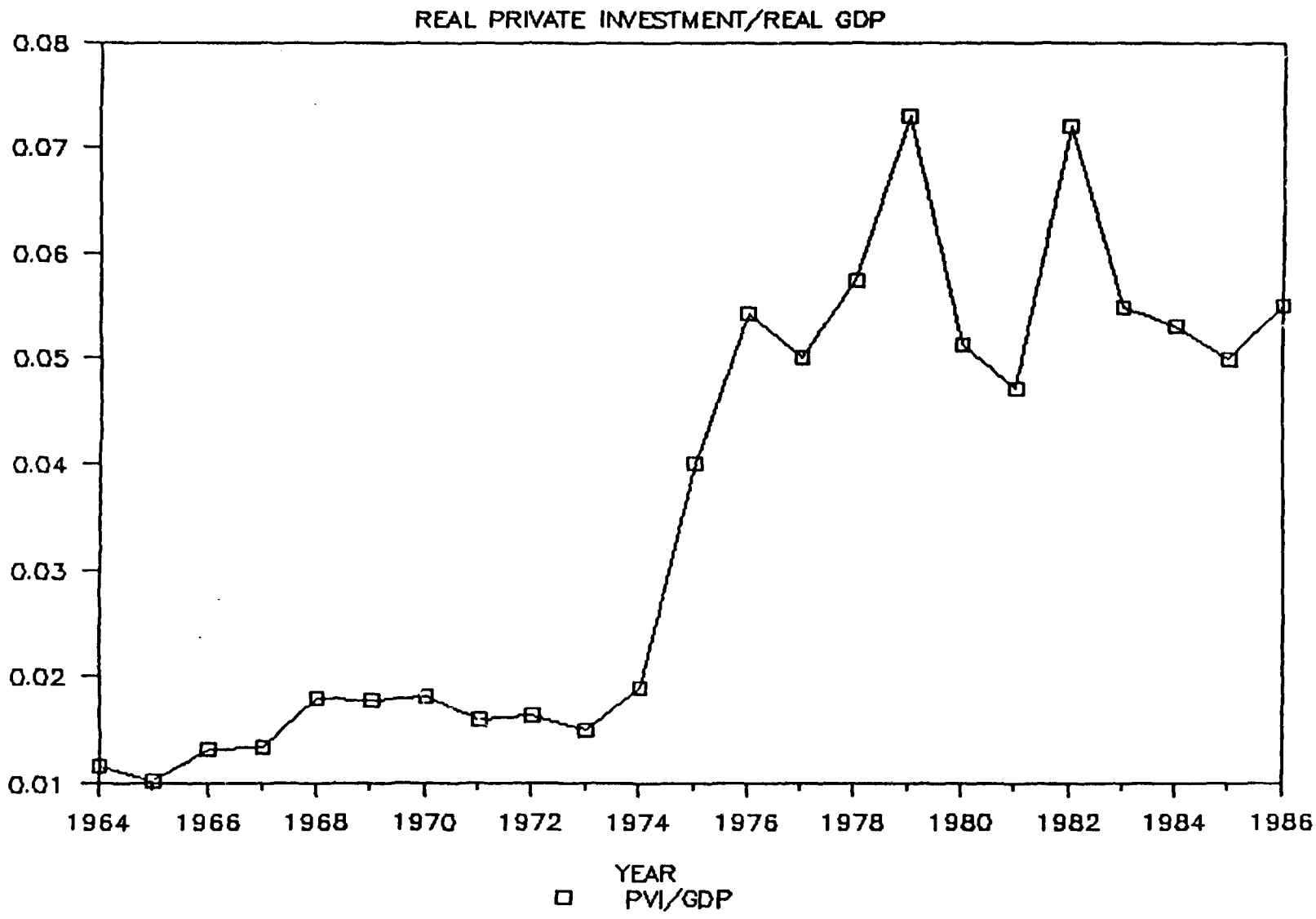


Figure 1: PRIVATE INVESTMENT RATIO

The definitions, derivations, and sources of the variables used in the equations that follow are available in the data appendix to this paper. A few comments concerning their definitions are made below, but the detailed derivations are provided in the appendix. All data are annual, expressed in real 1980 prices and are in logarithms.[30] In the discussion that follows, a "D" before a variable name represents a differenced variable where the lag operator, (1-L) is used. The first lag of a variable is represented by (-1) and the second lag by (-2). The following acronyms are used:

PRIVI	=	private investment
GDP	=	GDP at factor costs (non-oil)
R	=	real interest rate
R/W	=	real interest rate/average wage
MARKUP	=	markup
ICOSTS	=	relative price of investment goods
PRVCRD	=	private credit
PVCRDY	=	private credit/GDP
GVIINF	=	government investment in infrastructure

An investment deflator was constructed using a weighted average of the investment components of the wholesale price index (domestic machinery, imported machinery, construction, and transport equipment) with variable weights based on actual shares of these inputs in total investment costs. Because the machinery component of the official WPI only includes

[30] It is conventional in the econometric literature on investment to express all variables in real terms since the investment process is perceived as a "real" phenomenon. This view was challenged by Anderson who argued for the use of nominal prices since signals are transmitted in nominal terms and it is not possible to accurately represent the process by which agents translate these signals into a real expenditure framework. However, Bean has pointed out that using a nominal framework implies that all price movements are unanticipated, whereas only divergences of actual from expected prices should matter. In a developing economy accustomed to a fairly steady rate of inflation as in Egypt, economic agents are likely to anticipate inflationary trends. Consequently, Anderson's nominal framework seems inappropriate and all variables have been expressed in real terms. For a discussion, see Anderson, 1981, p. 89 and Bean, 1981, p. 104. In a hyperinflation economy, nominal prices may become important signals for investors. See Oks, 1987 for an analysis of the Argentine experience.

domestically produced capital goods (which only constitute about 20% of total machinery inputs), a separate weight was given to the price of imported capital goods. This was constructed by using a price index for machinery exports of the major industrial countries, Egypt's major trading partners, multiplied by the parallel market exchange rate in Egypt. Thus, the exchange rate enters as an explicit determinant of investment costs in order to reflect its importance in determining the price of imports. The resulting investment deflator was used to put private and public capital formation in real terms and to analyze the evolution of investment costs.

In order to test the microfoundations, empirical proxies were needed to represent profits which are a function of demand, costs and the markup. The demand proxy used is the non-oil gross domestic product. Revenues from petroleum were removed to avoid double counting since they accrued to the government and did not act directly as a source of private demand. Instead, the effect of oil rents operated through the government budget rather than directly through the accelerator. The effect of remittances of migrant labour on demand is ambiguous. Remittances are repatriated to Egypt either in the form of financial assets or, possibly more importantly, in kind as imports of goods. Financial remittances held in Egyptian pounds (LE), foreign exchange accounts in Egypt are invested by the banks in the Eurocurrency market and imply no net inflow of foreign exchange to Egypt, although interest income from abroad does accrue to the migrant investor and a commission is earned by the bank. Financial remittances held in LE, however, have the effect of increasing domestic credit and the country's net foreign exchange reserves. In contrast, remittances repatriated in the form of goods have a dampening effect on domestic

demand since they substitute for domestic production. Consequently, GDP, rather than GNP which includes some estimate for remittances, is used here as the preferred proxy for demand.[31]

Two different empirical representations of the cost of capital goods have been considered. Some elements of the theoretical representation of the cost of capital defined in equation (2) will not be considered in the empirical work for Egypt. As with most empirical analyses of investment, the effect of the rate of appreciation of capital goods (z) is neglected because of the absence of data and the fact that without an active second hand market for machinery, this capital gain cannot be readily realized. The effect of taxation (u) and investment incentives (i) will not be included, again for lack of data and because they are relatively unimportant because of widespread tax evasion and the introduction of tax holidays under the "open door" policy Data on the rate of depreciation of the capital stock is not available and the practice of using a constant rate as a proxy will have no effect on the econometric results. Although the view that depreciation is an economic variable that depends on the firm's scrapping and maintenance decisions is more attractive, it is empirically intractable in most countries.[32]

The elements of the cost of capital that will be evaluated directly will be the cost of credit, (r-p), the relative cost of factors, (R/W) and the relative price of capital goods, [(1-θ)PkD+θePkw]. The cost of credit is proxied by the WPI-deflated discount rate (R).[33] The

---

[31] Although the government tries to estimate the value of remittances, including those in kind, it is generally believed that the official statistics are underestimates.

[32] See Nickell, 1978 for a discussion.

[33] The discount rate is an adequate proxy for borrowing costs since the difference between the two has been fairly constant as a result of central bank regulation of fees and commissions.

relative cost of factors is represented by the ratio of the real interest rate to the average wage in the economy (R/W). The cost of capital term does not take into account the implications of compensating balances for the effective cost of borrowing. Since the practice of requiring compensating balances is not legal, there are no data available to evaluate the impact on real borrowing costs. In the absence of data in the Egyptian case, it was necessary to assume that the degree to which compensating balances respond to higher inflation is constant and therefore will have no effect on the coefficient estimates.

The relative price of capital goods is represented by the variable ICOSTS which is based on the ratio of the investment deflator to the GDP deflator. Treating the cost of investment goods separately from the cost of borrowing is desirable because it isolates the effect of neoclassical price factors from Keynesian considerations about the interaction of demand and supply in the capital goods market. In effect, the ICOSTS variable operationalizes Keynes' marginal efficiency of capital for an economy where, because of credit market imperfections, it is distinct from the interest rate.[34] For traded capital goods, supply is highly elastic and therefore the price to firms depends solely on the world price and the exchange rate. However, for nontraded capital goods, supply is more inelastic and one would expect considerable increases in the price of construction and land, for example, in the case of an investment boom. The use of variable weights in the investment deflator also captures the effect of relative prices on changing shares of tradable and nontradable capital goods. It is hypothesized that ICOSTS is a

[34] Recall from the standard presentation of Keynes' model, investment occurs until the marginal efficiency of investment is equal to the rate of interest. However, this equilibrium relationship emerges out of the interaction between demand and supply in the capital goods producing industry. Because the supply function for capital goods is upward sloping, the response of investment to a change in the rate of interest is gradual. For a discussion, see Precious, 1987.

more realistic representation of the cost of capital to the firm in a financially repressed developing economy than the neoclassical interest rate variable.

The movement of the relative cost of investment goods is depicted in Figure 2. The downward trend in the price of investment goods after the 1967 war reflects some of the early attempts of the government to encourage private investment. Investment incentives, such as subsidies to buildings materials and machinery, and the real appreciation of the exchange rate during the oil windfall had the effect of reducing the relative cost of investment goods. This is consistent with the survey findings where firms, especially those established during the "open door policy," were found to be characterized by greater capital intensity. After 1980, the price of investment goods rose sharply reflecting the increasing price of both imported investment goods subject to a depreciating exchange rate and non-traded investment goods responding to growth in demand. This pattern in the movement of investment costs had important implications for firms' decisions about factor shares, an issue that will be discussed at a later stage.[35] The proxy used for markups is the ratio of the wholesale price index to an index of wages in the economy. Although this proxy does not capture the complexity of mark up determination described above, it does provide a crude indicator of the evolution of the profit rate at the aggregate level. Alternatively, this mark-up variable can be interpreted as the inverse of real wages. Figure 3 depicts the movement of markups over the period. Markups were relatively high during the 1960s, a pattern that coincides with the survey findings that, for firms that survived the nationalizations, the 1960s were a highly profitable period. Specifically, the absence of competition, subsidies to inputs, relatively low wages and considerable unsatisfied demand meant that firms were able to

[35] Evidence about firms' technological choices in favour of greater capital intensity emerged from the survey. See chapter 4 in Shafik, 1989 for a discussion.

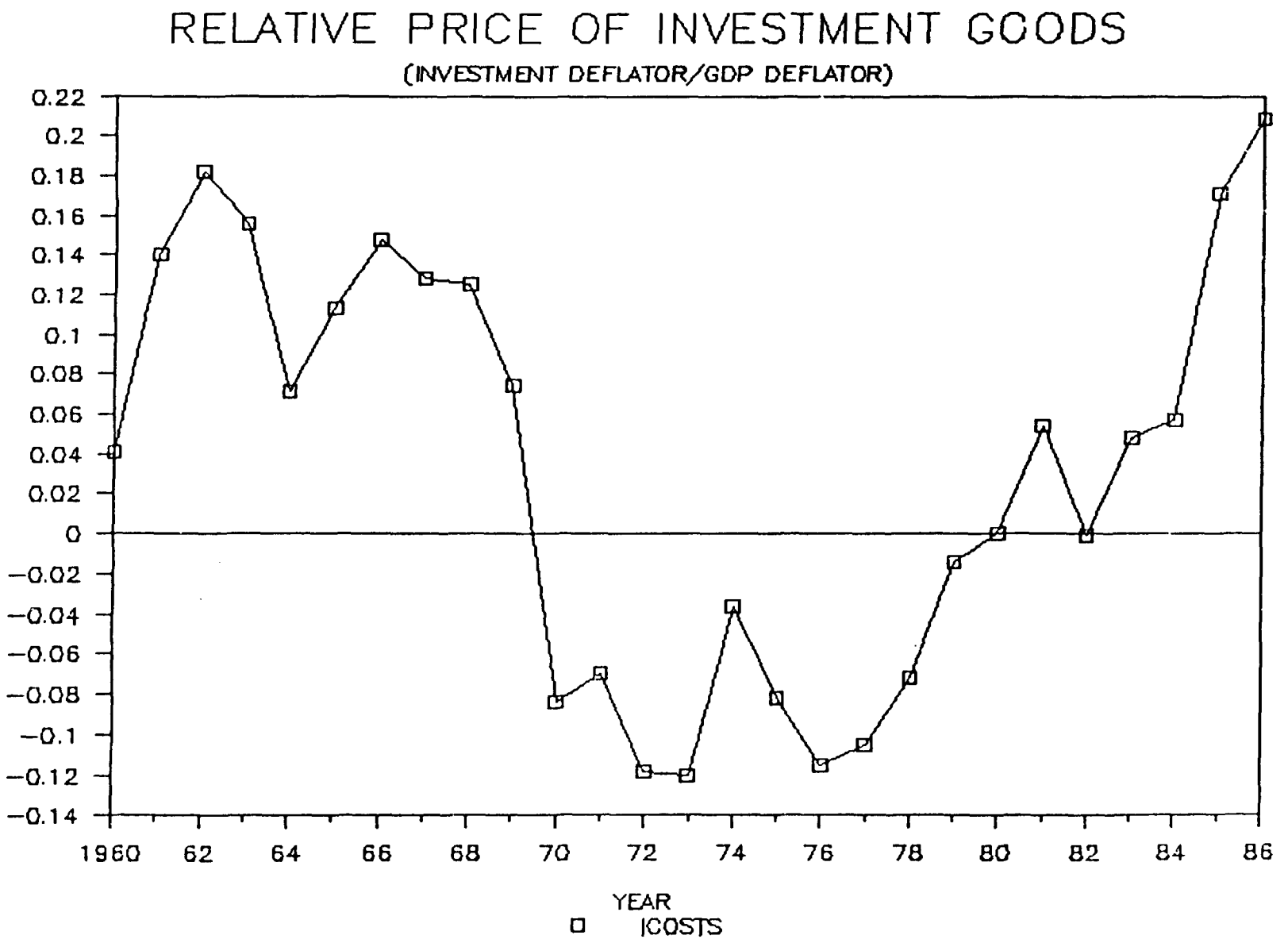


Figure 2: RELATIVE PRICE OF INVESTMENT GOODS

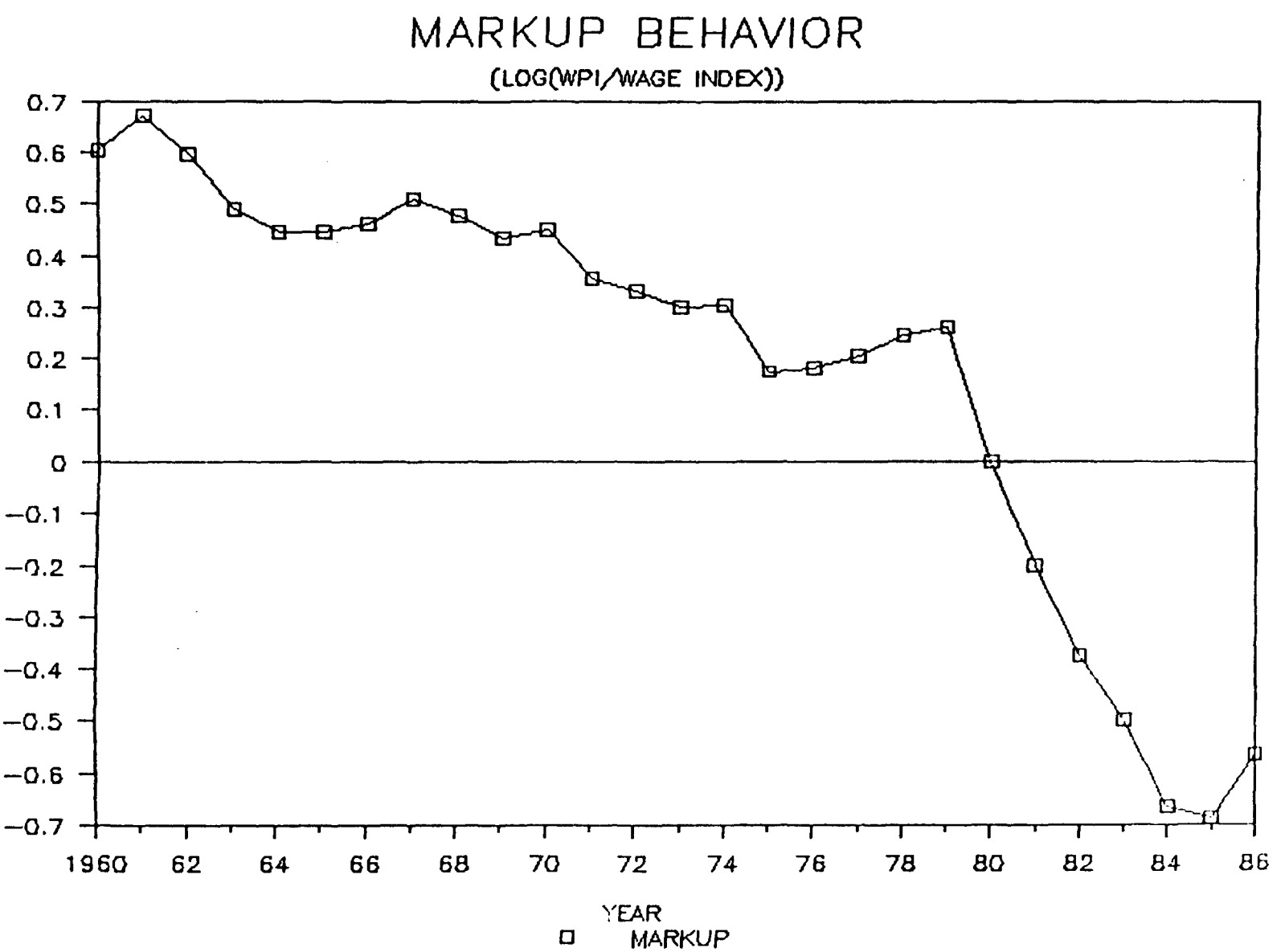


Figure 3: MARKUP BEHAVIOR

charge a high markup over costs. Part of this markup can also be considered a risk premium given the highly uncertain environment in which firms were operating. The trend of markups is generally downward with small upturn during the oil boom of the late 1970s. After 1980, there is a squeeze on markups as a result of rising wages. This does not imply that markups were negative after 1980, but only that wages were increasing at a faster pace than were output prices.

An important factor that it has not been possible to capture econometrically is the effect of protection. The importance of securing protection, often before an investment is made, was an important theme among the firms surveyed. However, because rates of effective protection are industry-specific, and often firm-specific, it is virtually impossible to construct a meaningful indicator of the overall protective regime and its effect on markups. Instead, the implications of protection for firms' markups were considered at the sectoral level and are available elsewhere.[36]

The justification for introducing government policy variables in the econometrics is that they may affect costs, markups or demand independently of the empirical proxies used here. For example, government investment in infrastructure may reduce the costs faced by firms, although it may not be reflected in the ICOSTS variable. Similarly, government borrowing on the domestic credit market may reduce credit availability to the private sector in a rationed market directly although it may have no effect on administered interest rates. The effect of public policy will be evaluated through both government expenditure variables, particularly public investment in infrastructure (GVIINF), and through the implications of the financing of the government deficit on the availability of private credit.

---

[36] Shafik, 1989.

The variable for government investment in infrastructure is the sum of public investment in agriculture, irrigation, electricity, transport, construction and utilities.[37] The evolution of government investment expenditure in infrastructure (GVIINF) and in other areas is depicted in Figure 4. There is a general decline in public investment in the wake of the 1967 war with a recovery during the windfall period of 1975-80. Aggregate investment and that in infrastructure grew as a share of GDP during the oil boom of the 1970s. The squeeze on public investment did not occur until the early 1980s and seems to have fallen disproportionately on infrastructure and industry

In order to evaluate the potential rationing effect of government administered interest rates, quantity variables for credit will be considered in addition to the more conventional real interest rate term. The quantity of credit to the private sector, both the level (PVCRD) and as a share of GDP (PVCRDY), will be considered. The quantity of credit is likely to be important in a credit market where interest rates are subsidized, balance sheets are unreliable, and reputation is an important determinant of access to bank credit. In addition, the quantity of credit captures the effect of financial remittances held in Egyptian pounds, which may be an important factor in investment determination. The more commonly discussed channel for crowding out, the government deficit, will also be considered. The conventional view is that deficit financing bids up interest rates which reduces private capital formation and results in

[37] Total government investment and non-infrastructure public investment were also tried as explanatory variables but were found to be insignificant. Non-infrastructure investment was defined as the residual from total investment which consisted of government investment in industry, petroleum, trade and finance, housing, and services. This in part reflects the very long lags associated with public investment in areas such as health and education services.

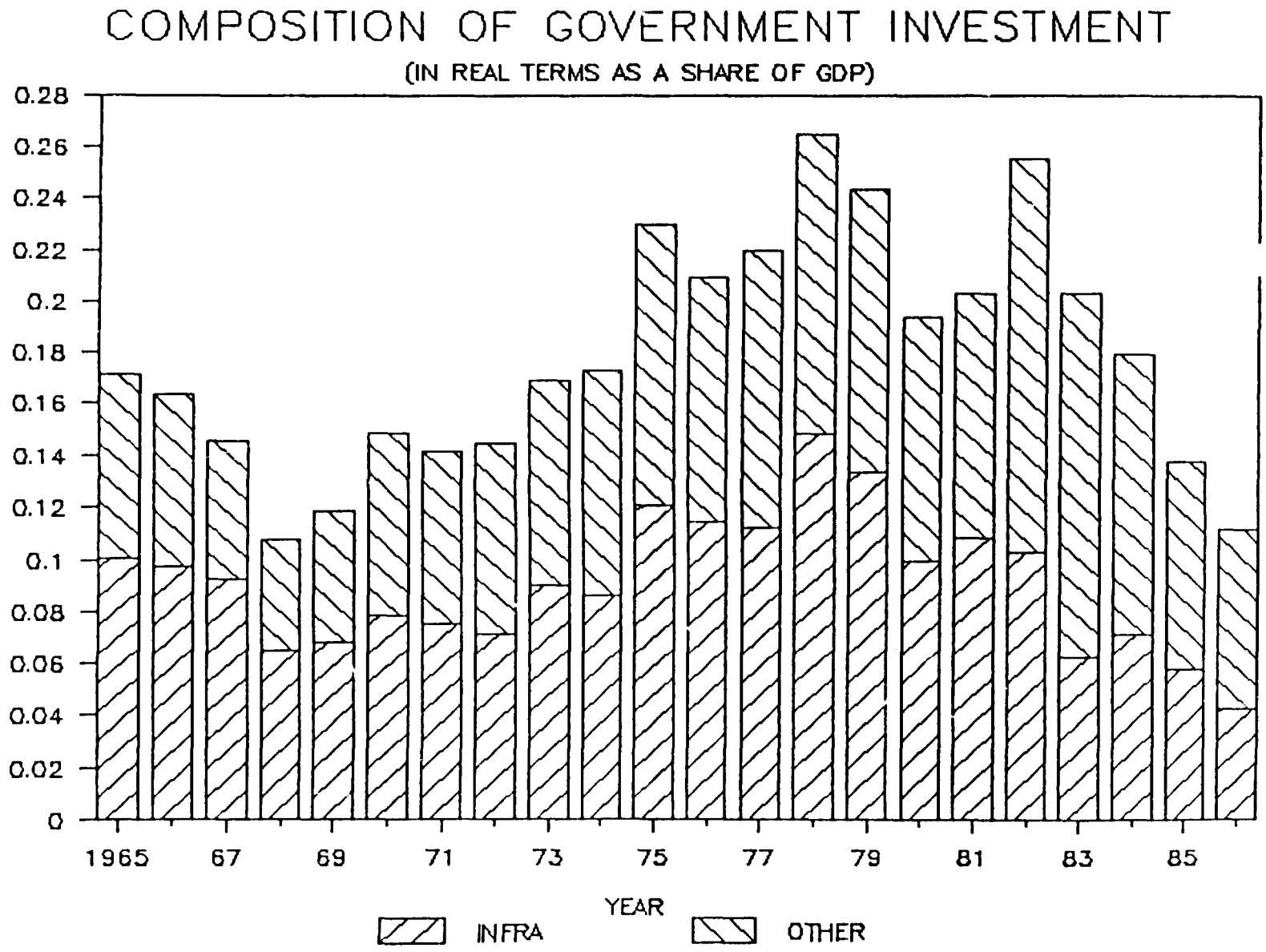


Figure 4: COMPOSITION OF GOVERNMENT INVESTMENT

indirect crowding out.[38] However, in a rationed credit market with administered prices, the effect of deficit financing will be on the quantity of credit rather than on the price and therefore is more likely to be reflected in the PVCRD variable.

3.2. Econometric Estimation: Methodology

Investment functions are notoriously difficult to estimate, often for two very different reasons. Many of the macroeconomic time series that are relevant to investment decisions, such as output, are trended and tend to generate spurious regressions. In addition, other variables that are expected to matter, such as the interest rate, are often not significant because they are stationary whereas investment is usually characterized by a trend.

Granger and Newbold recommend differencing data when spurious correlations are suspected.[39] By differencing, stationarity of the time series is more likely and more meaningful parameter estimates can be obtained. However, simply differencing all of the time series is both ad hoc and results in the loss of information about the equilibrium relationship between the levels. In addition, it is possible to introduce a trend into already stationary time series by indiscriminate differencing.

---

[38] There is also an indirect channel for crowding in when bonds are closer substitutes for money than they are for capital. The resulting portfolio effects as agents switch into capital reinforces the expansionary effect of a fiscal stimulus. This result is obtained by B. Freidman in a three asset model with bonds, money and capital. B. Freidman, 1978, 1985. Given the absence of an active bond market in most developing economies, this channel for indirect crowding is not very relevant.

[39] Granger and Newbold, 1974.

As an interesting aside, some of the standard models of investment in the literature (accelerator, flexible accelerator, neoclassical, putty-clay, partial adjustment, and profits models) were estimated in the levels on Egyptian data.[40] The results in the levels indicated that some combination of putty-clay, profits and partial adjustment would produce a well-fitting investment function. However, once the data were differenced, virtually all of the models collapsed. This implies that what has been interpreted as causality in a number of empirical studies of investment may have been spurious correlations between trended variables.

The recent literature on cointegration and stationarity testing provides a more rigorous framework for avoiding spurious regression while retaining long run information about the equilibrium relationship in the levels. Essentially, the intutition behind cointegration is that econometric results are legitimate only when time series are stationary.[41] Therefore it is necessary to test the time series properties in order to determine what degree of differencing, if any, is necessary to de-trend the data. Once stationarity is achieved, if some linear combination of the variables results in a "white noise" error term, the series are said to be cointegrated. This implies that it is possible to explain the evolution of the time series through the interaction of a set of non-trended data that results in an error term that is random, thereby leaving nothing left to explain econometrically.

---

[40] See Shafik, 1989 for these results.

[41] For a survey of the literature, see a special issue of the Oxford Bulletin of Economics and Statistics with articles by Hendry, 1986; Granger, 1986; Hall, 1986; Jenkinson, 1986; as well as work by Dolado and Jenkinson, 1987; and Engle and Granger, 1987.

3.4. Stationarity Testing

Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), and the Cointegrating Regression Durbin-Watson (CRDW) test proposed by Sargan and Bhagrava were used to test whether variables were stationary (I(0)) or needed to be first differenced (I(1)) or second differenced (I(2)) to induce stationarity.[42] The Dickey-Fuller test where the null hypothesis is a simple unit root (I(1)) takes the form:

$$\Delta Xt = \beta X_{t-1} + \sum_{j=1}^{n} \alpha_j \Delta X_{t-j} + e_t \quad \text{where } H_0\text{: I(1).}$$

Where the null hypothesis is I(2), the test statistics is:

$$\Delta\Delta Xt = \beta \Delta X_{t-1} + \sum_{j=1}^{n} \alpha_j \Delta\Delta X_{t-j} + e_t \text{ where } H_0\text{: I(2).}$$

The test statistics is the standard "t" test on the lagged dependent variable (β). Because the test is sensitive to whether a drift (C) and/or a time trend (T) are included, it was repeated in different forms for each variable. The Augmented Dickey-Fuller test includes second and third lags of the left hand side variable to capture any additional dynamics. The critical values for the ADF test are the same as those for the DF test.[43]

---

[42] Dickey and Fuller, 1979; Dickey and Fuller, 1981; and Sargan and Bhargava, 1983.

[43] Engle and Granger, 1987, p. 269.

The Cointegrating Regression Durbin-Watson test is the standard Durbin-Watson statistic that results from regressing the difference of the variable on a constant when the null is I(1) and the second difference on a constant when the null is I(2). The need to try an array of test statistics reflects the low power of the alternative tests of stationarity and the evolving nature of this literature.

The results of the DF, ADF and CRDW tests are presented in Table 1. The DF and ADF tests are reported separately for regressions with only the lagged dependent variable and with the addition of a constant term (C) and with a time trend (T). The results indicate that the majority of the time series have simple unit roots, or are I(1). The only exception is the real interest rate, R which is I(0). However, the relative price of factors, R/W, is I(1).

The fact that the time series have simple unit roots is analytically convenient since stationarity is achieved by first differencing. The levels of the series can be used to express the long run equilibrium relationship by which agents are adjusting their actual to desired capital stock. Because their target capital stock is changing over time, agents correct for their expectational errors in the levels terms.

Two different methods for estimating an error correction model with cointegrating series will be used below. The first will be a two step procedure advocated by Engle and Granger which tests for cointegration at the levels stage before considering the dynamic properties.[44] The validity of the second stage dynamic results depends on having an appropriate specification

---

[44] Engle and Granger, 1987.

Table 1: TESTING FOR UNIT ROOTS: DICKEY-FULLER (DF), AUGMENTED DICKEY-FULLER (ADF) AND COINTEGRATING REGRESSION DURBIN-WATSON TESTS (CRDW)

VARIABLE	DF H0:I(1)	DF H0:I(2)	ADF H0:I(1)	ADF H0:I(2)	DF W/ C H0:I(1)	DF W/ C H0:I(2)	ADF W/ C H0:I(1)
PRIVI	2.85	-3.48	1.88	-2.81	-0.75	-4.30	-0.46
GDP	3.39	-3.54	2.32	-3.13	0.13	-4.81	0.82
R1	-3.83	-6.99	-3.51	-6.49	-3.75	-6.85	-3.51
R/W	0.31	-5.87	0.31	-5.30	-1.61	-6.18	-1.47
MARKUP	-0.69	-2.53	-0.80	-1.99	0.53	-2.95	0.77
ICOSTS	-0.79	-4.67	-0.78	-3.77	-0.96	-4.58	-0.85
PVCRD	2.74	-4.20	1.51	-3.54	1.22	-5.21	0.88
PVCRDY	-1.01	-5.34	-1.02	-4.79	-0.02	-5.48	0.16
GVIINF	0.19	-3.36	0.53	-2.92	-1.04	-3.26	-2.41
CRITICAL VALUES	t=2.61				t=3.20		

	ADF W/ C H0:I(2)	DF W/ C&T H0:I(1)	DF W/ C&T H0:I(2)	ADF W/ C&T H0:I(1)	ADF W/ C&T H0:I(2)	CRDW H0:I(1)	CRDW H0:I(2)
PRIVI	-3.30	-1.75	-4.21	-1.74	-3.21	0.04	1.76
GDP	-4.44	-1.55	-4.79	-1.86	-4.89	0.05	2.00
R	-6.30	-4.00	-6.69	-3.46	-6.15	1.46	2.68
R/W	-5.29	-3.58	-5.91	-3.08	-5.39	0.49	2.59
MARKUP	-2.23	-1.32	-2.64	-1.34	-1.98	0.06	1.10
ICOSTS	-3.65	-0.60	-5.03	-0.44	-5.15	0.32	1.70
PVCRD	-4.47	-1.00	-6.24	-1.59	-5.46	0.06	2.16
PVCRDY	-5.01	-1.54	-6.11	-1.76	-5.42	0.22	2.25
GVIINF	-2.93	-0.80	-3.22	-0.71	-3.95	0.17	1.57
DBFGD	-5.84	-2.82	-8.04	-4.11	-5.67	0.33	2.87
GOVEX	-2.37	-1.58	-2.73	-2.54	-1.95	1.33	2.47
GOVI	-2.02	-0.88	-2.83	-1.20	-1.94	1.09	2.29
NIGVEX	-3.92	-1.44	-4.61	-0.74	-4.35	1.98	2.71
CRITICAL VALUES		t=2.85				CRDW=1.07	

NOTE: W/ C IS WITH A DRIFT TERM; W/ C+T IS WITH BOTH A DRIFT TERM AND A TIME TREND.

at the levels stage. Because of the limitations of the Engle-Granger procedure and the weak power of cointegration tests, the model will also be estimated using a full dynamic version. Starting from the most general unrestricted dynamic equation possible, the model will be reparameterized until the most parsimonious version is obtained. This data-based approach to modelling stems from the view that although economic theory should guide the selection of variables that are included, the actual model should emerge from the data.[45] Some authors have argued that general dynamic modelling is superior to the Engle-Granger two stage procedure.[46] Rather than a desire to dive into the methodological debates between econometricians, the purpose of using two different estimation techniques here is to provide confirmation of the results. Hopefully, by arriving at a similiar model via two different routes, the validity of the argument will be strengthened.

Cointegration testing is still at an early stage, so the results must be treated as tentative, especially given the relatively small sample size. The small number of observations limits the degree to which alternative lag structures can be explored without causing problems with degrees of freedom. It will be several decades before most developing economies have sufficient reliable data to be able to estimate these types of models with confidence. In the interim, however,

---

[45] See Hendry and Richard, 1983 for a description of this methodology and Bean, 1981 for an application to investment in the United Kingdom.

[46] Jenkinson, 1987; Banerjee et al, 1987. The major problem with the Engle-Granger procedure is that the validity of the dynamic differenced results hinges crucially on the appropriateness of the first stage levels results, i.e. the equilibrium long run relationship hypothesized. With unrestricted dynamic modelling, the choice of explanatory variables is based on empirical significance. The limitation of unrestricted dynamic modelling is on the number of explanatory variables that can be included without losing degrees of freedom.

economic policy must be made and it seems unwise to do it without the benefit of better econometric techniques.

3.5. Engle and Granger's Two-Step Estimator

The first stage of the Engle and Granger procedure involves exploring the levels or equilibrium part of the error correction model to establish whether the variables cointegrate. Evidence of cointegration includes an R^2 that is close to unity at the levels stage, significant coefficients[47], a significantly non-zero Cointegrating Regression Durbin-Watson statistic, and significant Dickey-Fuller and Augmented Dickey-Fuller tests on the residuals from the levels regression. With cointegrating variables, the coefficient estimates from this levels regression can be interpreted as the long run multipliers. The second stage involves running regressions using stationary time series (in this case, first differences) and including the lagged residuals from the levels regressions as an explanatory variable. This lagged residual term, RES(-1), is intended to capture the error correction process as agents adjust for expectational errors about the equilibrium relationship in the previous period.

The first stage cointegrating levels regressions for investment are presented in Table 2. Equation 1 represents the simplest version of the model presented above with no explicit government policy variables. All of the variables are significant and appropriately signed and

---

[47] Note that because of autocorrelation of the residuals, the "t" statistics from the levels regression are biased upwards and therefore it is not possible to assess the true significance of the coefficient estimates. However, it is possible to accept the insignificance of coefficients at the levels stage since if a variable is insignificant when "t" statistics are upwardly bias, it will certainly be insignificant for the true value of the "t" statistics.

Table 2: COINTEGRATING VECTORS FOR INVESTMENT (LEVELS REGRESSIONS)

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	-32.54	-23.62	-29.88	-19.42	-9.05	-40.28	-32.66	-27.79
	(6.90)	(3.36)	(7.11)	(3.59)	(2.35)	(5.76)	(4.08)	(3.22)
GDP	4.16	2.79	4.02	2.70	1.26	5.02	4.29	2.97
	(8.18)	(3.03)	(9.05)	(3.88)	(2.97)	(6.56)	(5.07)	(2.62)
ICOSTS	-1.89	-1.14	-2.62	-1.94	-1.58	-2.19	-2.37	-1.79
	(3.54)	(1.57)	(4.96)	(3.29)	(2.43)	(3.03)	(3.41)	(2.40)
MARKUP	1.23	0.51	1.72	1.33		2.20	1.96	1.20
	(2.53)	(0.78)	(3.77)	(2.45)		(2.19)	(2.03)	(1.17)
R/W						1.14	-0.01	3.29
						(0.75)	(0.003)	(1.99)
GVIINF		0.54		0.36	0.71			1.06
		(1.79)		(1.53)	(3.39)			(2.50)
PVCRDY			0.93	1.35	1.00		0.76	
			(2.90)	(3.73)	(2.63)		(1.70)	
DBFGD								
GOVEX								
R2	0.95	0.94	0.97	0.97	0.95	0.94	0.95	0.94
R2(ADJ)	0.95	0.92	0.96	0.96	0.94	0.92	0.93	0.92
CRDW	1.53	1.40	1.47	1.80	1.24	1.27	1.23	1.25
F	151.90	64.96	152.71	94.17	89.75	65.52	58.78	35.98
DF	-3.95	-3.73	-4.06	-5.09	-3.85	-3.00	-3.02	-3.15
ADF(2)	-2.86	-2.08	-3.54	-4.17	-3.08	-2.33	-2.24	-2.06

the cointegration statistics are promising. Equation 2 considers the effect of government infrastructure investment and results in a significant coefficient as well as positive indications of cointegration. Similarly, the quantity of private credit which is included in equation 3 is significant and generates favorable cointegration statistics. This would seem to imply that there was some rationing in credit markets that served to crowd out private investment.

On the surface, this result would appear to be inconsistent with the survey findings and interviews with banks that credit markets were very liquid throughout much of the period, except after the imposition of credit ceilings by the Central Bank as part of a reform package negotiated with the International Monetary Fund in 1987. Established firms never complained about a shortage of credit prior to the imposition of ceilings, implying that government borrowing did not crowd out some of the private sector through the financial system. In fact, some firms complained that the banks put pressure on them to borrow more. Because real interest rates were negative throughout the period, established firms did tend to borrow heavily since credit was, in some sense, a "free good." However, credit was rationed at the margin, especially for new, poorly connected firms. Government borrowing may have crowded out these new borrowers but, given the conservatism of the financal system, it is not clear that the banks would have extended them loans anyway.

Other government spending variables, such as total government investment and non-infrastructure government investment, were also tried in all possible combinations and always appeared with an insignificant sign and generated no improvement in the cointegration

statistics.[48] Given that "t" statistics are biased upwards when positive autocorrelation exists, insignificant coefficients at the levels stage imply that these variables should be omitted.

The combined effects of government investment in infrastructure and rationing in credit markets are considered in equation 4. The resulting levels equation has the best cointegration statistics as evidenced by the highly significant DF, ADF, and CRDW tests. Equation 5 illustrates the importance of the markup variable by indicating the poor performance of an equation that does not include markups. The preferability of expressing the costs of capital as a function of the cost of investment goods (ICOSTS) and quantities of credit (PVCRDY) over the more conventional factor price variable, R/W, is evidenced by equations 6 and 7. Factor costs are insignificant when they are included with ICOSTS in equation 6 and with PVCRDY in equation 7. The only case where the more conventional neoclassical representation of the cost of capital is significant is in equation 8 where it appears with a positive sign. This is not surprising in a rationed credit market where a rise in the real interest rate generates a larger quantity of credit available to investors through the banking system. Consequently, the significance of R/W in equation 8 seems to be merely serving as a proxy for the quantity of credit variable, PVCRDY.

The preferred specifications from these levels results are equations 3 and 4 which include the quantity of private credit and government investment in infrastructure. The coefficients are significant and appropriately signed. The equations indicate that in the long run, the accelerator has the greatest effect on investment, followed by the cost variable (ICOSTS). The markup is also

---

[48] The insignificance of these other government spending variables also occurred when they were expressed in differences. The results are not reported here because, strictly speaking, if there is no long run relationship at the levels stage, one would not expect to find significant effects in the dynamics. This was consistently so for these variables.

important with a long run coefficient that is over one. The magnitude of the effect of the quantity of credit is greater than that for government infrastructure investment, but both are significant. The cointegration tests are favourable implying that the error is "white noise." As in the only other known application of the Engle and Granger procedure to investment by Henry and Minford for the United Kingdom, a fairly complex specification was necessary to find evidence of cointegration for investment.[49] This suggests that previous studies that relied on fairly simple models of the determinants of investment may have been misspecified. These preferred specifications will be used for the second stage of the Engle and Granger procedure to explore the dynamics of the investment process.

The differenced dynamic equations for investment are reported in Table 3. The residuals from the levels regressions are included in lagged form, (RES(-1)), to capture the process by which agents adjust to prediction errors in the last period. Ideally, it would be possible to include several lags of each differenced variable and to reparamaterize according to significance. However, in order to preserve degrees of freedom, only one lagged difference was included.

The results of running an unrestricted version of equation 3 from table 2 are reported in equation 1 of Table 3. Reparameterizations based on significance are reported in equations 2, 3, and 4. A similar exercise that includes government investment in infrastructure is repeated in equation 5 with reparamaterizations reported in equations 6, 7, and 8 of Table 3. The reparameterizations allow the alternative lag structures to be defined by the data. In general, the variables have significant and appropriate signs and the diagnostic statistics are good. In

---

[49] Henry and Minford, 1988.

Table 3: DYNAMIC EQUATIONS FOR INVESTMENT (DIFFERENCE REGRESSIONS)
(Dependent variable is the difference of the logarithm of real private investment)

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	0.08	0.09	0.08	0.04	0.05	0.06	0.01	-0.05
	(1.41)	(1.89)*	(1.42)	(0.61)	(0.49)	(1.16)	(0.08)	(0.86)
DGDP	1.97	1.39	1.34	1.55	1.90	1.61	1.88	2.65
	(2.44)**	(2.19)**	(2.03)**	(1.77)*	(1.37)	(2.14)**	(2.64)**	(3.26)**
DGDP(-1)	-0.72				-0.84			
	(0.88)				(0.96)			
DICOSTS	-2.00	-1.45	-1.44	-1.88	-1.75	-2.11	-2.20	-2.68
	(2.44)**	(1.96)*	(1.92)*	(2.08)**	(1.29)	(2.65)**	(2.97)**	(3.07)**
DICOSTS(-1)	0.79				1.32	1.17	0.87	
	(1.10)				(1.58)	(1.79)*	(1.39)	
DMARKUP	0.64		1.30	0.9	0.25			1.01
	(1.12)		(2.69)**	(1.64)	(0.32)			(0.61)
DMARKUP(-1)	0.86	1.36			0.91	1.11	1.05	
	(1.59)	(2.93)**			(1.44)	(2.37)**	(2.41)**	
DGVIINF					0.21			0.11
					(0.89)			(0.61)
DGVIINF(-1)					0.18	0.43	0.20	
					(0.47)	(1.82)*	(0.77)	
DPVCRDY	1.15	1.16	1.11	0.80	1.35	1.10	1.27	1.27
	(3.78)**	(3.95)**	(3.84)**	(2.78)**	(4.05)**	(3.62)**	(4.26)**	(4.81)**
DPVCRDY(-1)	0.44	0.62	0.56		0.27			
	(1.42)	(2.54)**	(2.00)**		(0.73)			
DPRIVI(-1)	0.19		0.11	0.37	0.22		0.33	0.50
	(0.86)		(0.53)	(1.76)*	(0.66)		(1.72)*	(3.11)**
RES(-1)	-0.61	-0.39	-0.43	-0.63	-0.72	-0.52	-0.85	-1.33
	(2.58)**	(2.23)**	(2.19)**	(2.60)**	(1.09)	(1.81)*	(2.60)**	(4.82)**
R2	0.64	0.56	0.56	0.42	0.86	0.73	0.78	0.76
R2(ADJ)	0.39	0.41	0.38	0.22	0.62	0.57	0.63	0.62
SE	0.17	0.17	0.17	0.19	0.14	0.15	0.14	0.15
DW	1.73	1.74	1.86	1.89	2.10	1.56	1.91	1.66
F	2.53	3.77	3.14	2.16	3.61	4.54	5.00	5.43
DF	-5.14	-4.65	-5.03	-4.65	-4.78	-3.46	-4.22	-3.63
ADF(2)	-4.21	-3.88	-4.19	-4.30	-4.06	-2.43	-3.39	-3.16
CHOW		0.31		1.21		5.10	10.78	

NOTES: -NUMBERS IN PARENTHESES ARE T STATISTICS. ONE ASTERISK IMPLIES SIGNIFICANCE AT THE 10% LEVEL. TWO ASTERISKS IMPLY SIGNIFICANCE AT THE 5% LEVEL.

differenced form, the coefficient on the ICOSTS variable has the greatest magnitude, followed by the accelerator (DGDP) and the markup. The coefficient on government infrastructure investment is smaller and significantly positive in equation 6. Given the long lead time on investment in infrastructure, it is not surprising that the effects on private investment are initially small in magnitude.

These results of the second stage of the Engle-Granger procedure provide strong evidence of the appropriateness of an error correction framework. The lagged residuals from the levels regressions, (RES(-1)), which represent the equilibrium error term, are always significant, implying that an error correction mechanism exists whereby agents adjust their expectations to unanticipated changes. This implies that the equations have a long run or equilibrium solution in the level of investment. The lagged private investment term is significant in equations 4, 7, and 8. Given the limited scope for exploring further lagged effects, it is likely that the coefficient on lagged private investment is capturing the effects of further lags of the right hand side variables that cannot be included separately in the regressions.

The overall fit of the equation is evidenced by the plot of the actual evolution of private investment and that predicted by equation 2 of Table 3 that appears in Figure 5.[50] The fitted values for private investment are very close to the actuals over the 1960-86 period. This is remarkable given the array of shocks during this period- two wars, two oil shocks, and a fundamental change in economic policy orientation. Chow tests for parameter stability were constructed for the best regressions in Table 3, equations 2, 4, 6 and 7, to test for a structural break with the introduction of the "open door policy" reforms in 1974. The results of the Chow

[50]Note that Figure 5 depicts private investment in first differences.

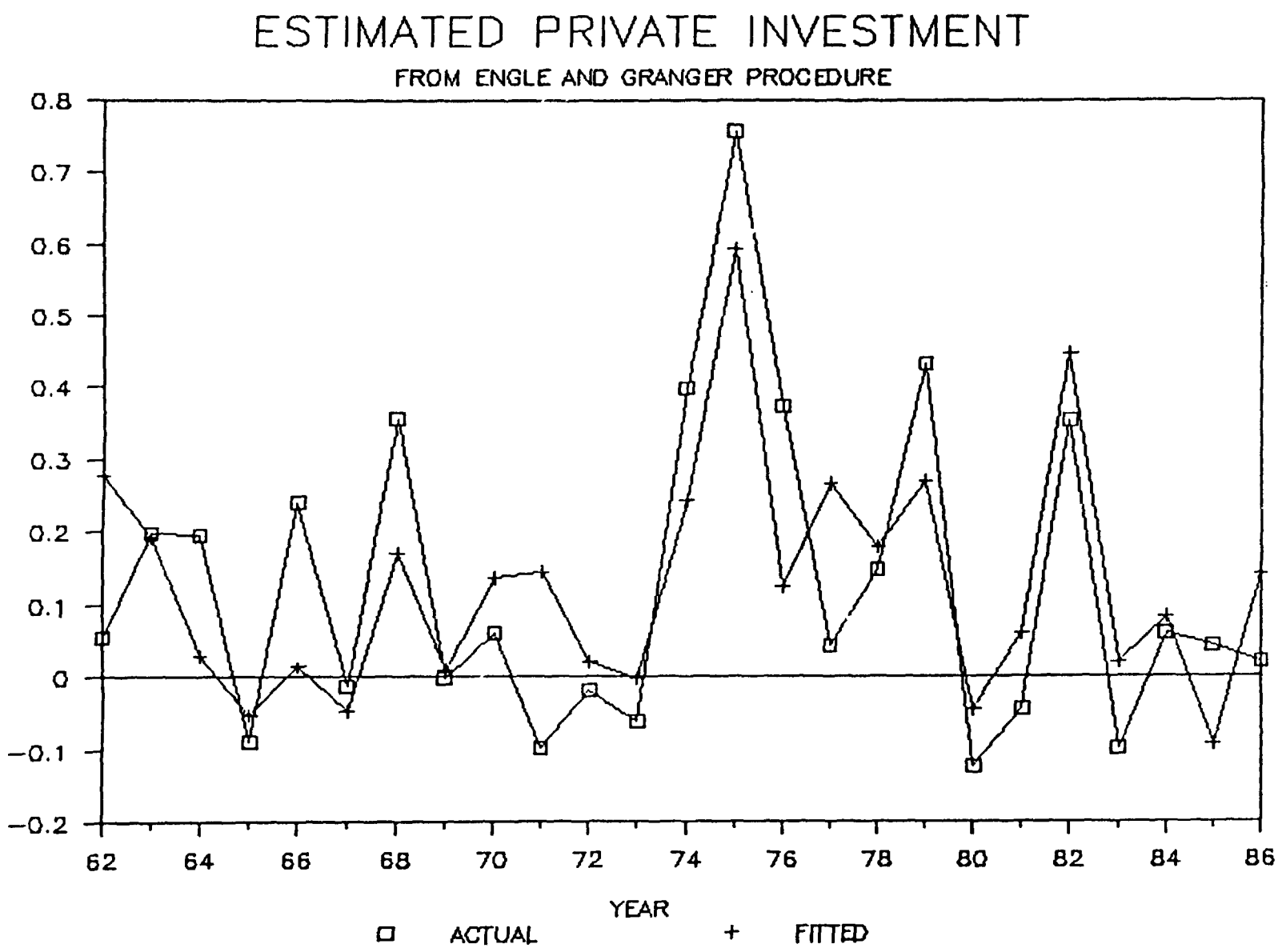


Figure 5: ESTIMATED PRIVATE INVESTMENT

tests, also reported in Table 3, show considerable parameter stability for equations 2 and 4 during the period. This implies that the coefficient estimates for equations 2 and 4 in table 3 were not significantly different in the 1962-74 period from those in the 1975-86 period. These Chow test results are encouraging since they indicate that the underlying determinants of investment in the economy, or "deep parameters," have been adequately captured. These results from the Engle-Granger procedure will be compared with those from general dynamic modelling below.

3.6. Unrestricted Dynamic Estimation

The results of the unrestricted dynamic equations are reported in Table 4. Again, because of the limited number of observations, it is not possible to include several lags of all of the variables.[51] Instead, one lagged difference of each variable was included along with a lagged error correction term that reflects the relationship in the levels:

$$ecm = (Y_t - \Sigma x_t)$$

[51] This may be an advantage of the Engle-Granger procedure when dealing with small samples. Engle and Granger suggest estimating the simplest error correction model initially and then considering the effects of lags. Such an approach does preserve degrees of freedom, although the validity of the results hinge on having the correct specification at the first stage. Engle and Granger, 1987.

Table 4: UNRESTRICTED DYNAMIC EQUATIONS
(Dependent variable is the difference of the logarithm of real private investment)

VARIABLE	(1)	(2)	(3)	(4)
C	-1.32	-2.10	-0.12	-0.10
	(0.73)	(2.26)**	(0.67)	(0.75)
DGDP	1.02	1.06	1.41	0.83
	(1.12)	(2.15)**	(1.63)	(1.43)
DGDP(-1)	-0.71		0.47	
	(0.65)		(0.53)	
DICOSTS	-0.29		-0.68	
	(0.32)		(0.74)	
DICOSTS(-1)	1.44	1.00	0.43	
	(1.69)	(1.92)*	(0.53)	
DMARKUP	-0.06		0.44	
	(0.08)		(0.68)	
DMARKUP(-1)	0.96	0.88	0.87	0.93
	(1.38)	(1.95)*	(1.36)	(1.86)*
DGVIINF	0.36	0.34		
	(1.57)	(2.16)**		
DGVIINF(-1)	0.41	0.33		
	(1.52)	(1.84)*		
DPVCRDY	1.12	1.05	1.07	1.10
	(3.64)**	(4.30)**	(3.08)**	(3.67)**
DPRVCRDY(-1)	0.66	0.74	0.87	0.81
	(1.87)*	(3.50)**	(2.16)**	(2.97)**
DGOVEX				
DGOVEX(-1)				
DNIGVEX				
DNIGVEX(-1)				
DGOVI				
DGOVI(-1)				
DPRIVI(-1)	-0.07		-0.10	
	(0.41)		(0.44)	
ECM(-1)	-0.16	-0.25	-0.08	-0.08
	(0.80)	(2.35)**	(1.38)	(1.77)*
R2	0.85	0.83	0.54	0.50
R2(ADJ)	0.60	0.71	0.21	0.34
SE	0.15	0.13	0.19	0.18
DW	1.64	1.66	1.59	1.87
F	3.33	6.75	1.62	3.51
DF	-4.1	-4.21	-4.73	-5.29
ADF(2)	-2.16	-2.31	-3.55	-4.11
CHOW		1.13		2.07

NOTE: THE ECM TERM IS DEFINED AS THE DIFFERENCE IN THE LEVELS OF THE LEFT HAND SIDE AND RIGHT HAND SIDE VARIABLES.

where Y_t is the left hand side variable and X_t are the right hand side variables.[52] Although not ideal, the lagged difference includes information from two years in the past, which coincides with the survey findings that the average lag between the conception and implementation of an investment project was two years. Consequently, although being able to include more lags would be desirable, given the constraint, the present approach is certainly adequate.

The results in equation 1 of Table 4 and the resulting reparameterization in equation 2 confirm the importance of government infrastructure investment and the quantity of credit. Equations were also estimated that consider the effects of non-investment government expenditure and total government investment which, like those from the Engle-Granger estimates, always generated insignificant coefficients. Equation 3 reports the results of including only the PVCRDY variable along with the core model. The reparameterization in equation 4 implies that only demand and internal funds variables, i.e. output, markups and credit, matter.

An interesting feature of the results in Table 4 is that the ICOSTS variable takes a positive sign in equation 2 that is significant at the 10% level. This may seem paradoxical since a rise in investment costs would usually be associated with a fall in investment. However, in a highly oligopolistic market, changes in costs may not matter in the short run since they can be passed on to consumers. In addition, a rise in investment costs may be reflecting, in part, increases in aggregate demand in the short run. However, the long run effect of a rise in investment costs on

---

[52] This formulation of the error correction term restricts the sum of the coefficients to unity. Ideally, the coefficients of the levels terms would be estimated directly and then could be included in a composite error correction term. However, given the restrictions on degrees of freedom, it was not possible to use this approach. The validity of the assumption that the coefficients sum to unity implied by this formulation was confirmed by the significance of the error correction term in the regressions reported in Table 4.

private capital formation is significantly negative as evidenced by the cointegrating vectors in Table 2.

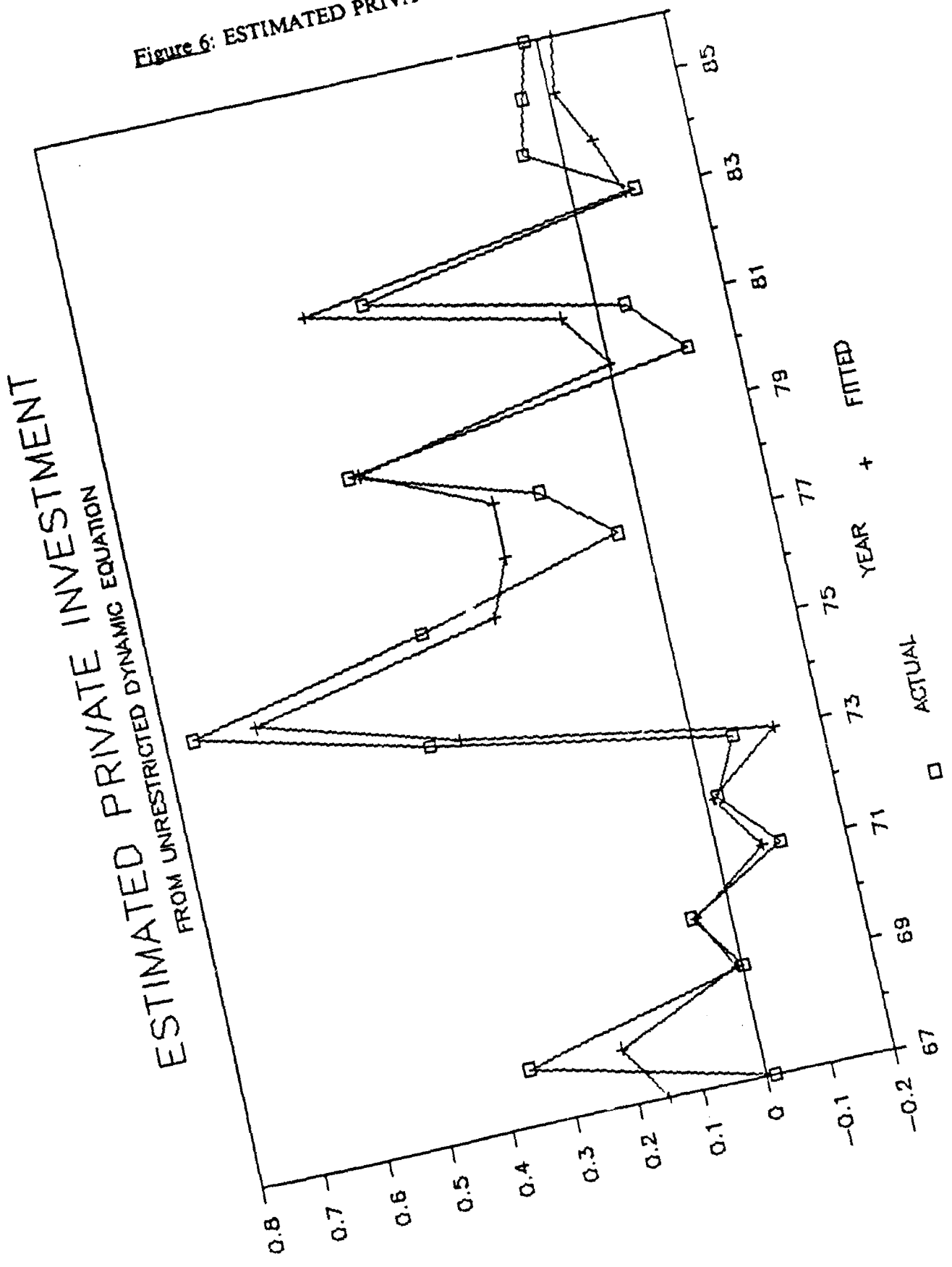
As with the previous results, the unrestricted equations indicate the importance of government infrastructure investment and quantities of private credit, as well as a positive role for government expenditure. The error correction term is significant in all of the reparameterizations, lending support to the model hypothesized as well as to this formulation of the error correction model. The lagged private investment term is never significant although its inclusion tends to improve the diagnostic statistics. As before, this may be because of lagged variables that had to be omitted to preserve degrees of freedom. Equations 2 and 4 perform particularly well with significant coefficients and cointegration tests that indicate white noise errors. Figure 6 plots the actual and fitted values for private investment using equation 2 from Table 4.[53] Once again, the model fits very well over the sample period. The Chow tests for a structural break in 1974 also indicate considerable parameter stability. Like the previous results from the Engle-Granger procedure, the parameter stability implied by the Chow tests is an indication that the consequences of the policy changes between the pre and post infitah periods have been captured through the economic determinants on the right hand side of the regressions.

3.7. An Evaluation of the Results

The best results from the Engle and Granger procedure are equation 2 in Table 3 and for the generalized dynamic modelling equation 2 in Table 4 perform particularly well. The diagnostic tests from both procedures are not markedly different, nor are the coefficient estimates. The plot

[53]Note that Figure 6 depicts private investment in first differences.

Figure 6: ESTIMATED PRIVATE INVESTMENT



of actual and fitted values for the unrestricted version is a slightly better representation of the data than that from the Engle-Granger procedure. Both estimates confirm the core model hypothesized above which identified the role of demand, markups, and costs in investment determination. The long run multipliers in Table 2 reveal that the accelerator has the largest impact on private capital formation, followed by investment costs and the markup. The cointegration tests indicate that these best equations resulted in approximately stationary error processes at the first stage and white noise errors in the second.

The two stage and the unrestricted dynamic modelling provide strong evidence on the crucial role of the quantity of credit. The interpretation of this PVCRDY is as an indication of rationing in credit markets where banks face administered interest rates and have imperfect information about borrowers. In Egypt this was particularly problematic because of widespread tax evasion. As a consequence, banks often had to make decisions about loans without access to the firm's true balance sheets. Although government borrowing did not crowd out established private sector firms who had access to abundant amounts of credit, there appears to have been some crowding out at the margin of less established firms and perhaps of potential firms. Ultimately, this reflected weaknesses in the financial system which operated with highly imperfect information and in a climate of considerable uncertainty.

The more Keynesian ICOSTS variable consistently outperformed the interest rate variables, R and R/W. This is because the ICOSTS variable takes into explicit account the interaction of demand and supply in the capital goods market and includes the important distinction between tradable and non-tradable capital goods, thereby providing a more realistic measure of the user cost of capital. The combination of the ICOSTS variable and PVCRDY provides a much better

measure of the cost of capital to the firm in a repressed financial system than the neoclassical interest rate.

The insignificant effect of interest rates on investment has been a common and often problematic finding in much empirical work in both developed and developing economies. A number of explanations have been proposed in the literature to explain why it is not possible to obtain a significant coefficient for the cost of funds when in theory the interest rate should be a crucial variable. These include uncertainty about internal rates of return, unsophisticated investment decision procedures, the long time frame of investment decisions compared to short run fluctuations in interest rates, and the possibility that changes in borrowing costs are overshadowed by variations in demand.[54]

In this model, the insignificance of the interest rate is justified by the existence of markup pricing, the preference for using internal funds for investment financing,[55] and the effects of "financial repression." In a rationed financial market, the allocation of credit has little to do with the price of borrowing and much more to do with the quantity. In the Egyptian case, the existence of rationing did not imply that credit was in short supply since the banks were highly liquid during much of the period. Rather, it meant that what credit there was available was allocated according to non-price criteria such as reputation.

---

[54] See Hay and Morris, 1979, pp. 393-394 for a discussion.

[55] In addition to firms preferring internal financing of investment, the banks avoid providing funds for longer term activities because they are not permitted under Central Bank regulations to charge higher interest rates on longer term loans. Instead, the banks prefer to roll over short term loans, which obviously adds greater uncertainty for the firm.

This is not to imply that the interest rate was not important, since its low level was a crucial factor determining the tendency of firms to become overindebted, as evidenced by the frequent overleveraging among the firms surveyed. Rather, it is argued that in a repressed financial system, the interest rate serves a different role than that of clearing the market for credit. Specifically, the rate of interest becomes a mechanism whereby the government taxes savers on behalf of itself and private sector borrowers.

Neither modelling procedure provided any evidence of crowding out as a result of government policy. None of the government spending variables had a significantly negative coefficient. Equation 2 in Table 4 provides strong evidence of the positive effects of government investment in infrastructure on private capital formation. The long run coefficient on GVIINF in equation 2 of Table 2 is also significantly positive. This implies that infrastructure investment is complementary to private activity by reducing costs to firms and therefore induces higher levels of private investment.

The error correction mechanism is consistently significant, whether as the lagged residual from the levels regression in the Engle and Granger procedure or as the lagged levels term in the unrestricted estimates, thereby confirming its appropriateness as a representation of the data. In general, the error correction model seems to be an appropriate means of capturing the process by which agents adapt to the highly complex environment in which investment decisions are made. The plots of the actual and fitted values from the two procedures indicate that the model has strong predictive content. Without having to rely on ad hoc dummy variables, it has been possible to identify the underlying economic processes that determined private investment.

Although the above econometric analysis lends considerable support to the model of investment determination hypothesized, it also highlights the limits of this type of analysis and the difficulties in assessing the impact of government policy. In theory, by estimating the signs and magnitudes of public policy multipliers it should be possible to respond to the long-running debate about crowding out versus crowding in.[56] However, at the aggregate level, it is virtually impossible to prove definitively whether crowding out or crowding in has occurred because of the problem of constructing the counterfactual.

In order to prove that crowding out occurred, for example, it would be necessary to show not only that the public sector expanded while the private sector contracted, but also that the private sector sought to expand and was displaced by the public sector. It would be easy to conclude that a negative multiplier on a government policy variable implied crowding out when in fact it may be reflecting a possibly wise countercyclical policy on the part of the state. What it is possible to conclude at the macroeconomic level, however, is what did not happen. For example, a positive public policy multiplier is a fair indication that crowding out did not occur as is a negative multiplier a reasonable basis for concluding that crowding in did not occur.

The results above for Egypt provide mixed evidence of crowding out at the macroeconomic level. The effects of government policy only operated through direct, non-price channels, such as rationing in credit markets and government investment. Indirect channels such as interest rates

[56] Buiter concludes from his theoretical survey about crowding out versus crowding in that ultimately the question is an empirical one that must be addressed through the estimation of public policy multipliers. Buiter, 1985.

and bond substitutability were not relevant. This is a particular feature of the crowding out versus crowding in debate in many developing countries.

The government did not crowd out established firms in the credit market and, by maintaining artificially low interest rates, implicitly subsidized the borrowing of these firms. At the margin, however, the government may have crowded out newer borrowers and thus contributed to a lower level of private investment. This may not have been a major economic loss since there is evidence that the efficiency of much of the private investment that was made was very low. On the other hand, greater access to credit for newer and smaller firms and the resulting competitive pressures might have contributed to a more efficient use of investment resources.

The economic results also lend some support to crowding in as a result of aggregate government expenditure and, in particular, to government investment in infrastructure. However, the positive coefficient on GVIINF may be reflecting a procyclical stance on the part of the state. Whether the results are capturing causality or simply the coincidence of government spending with private investment during a boom period is not clear.

4. Conclusions

This paper has attempted to address some of the weaknesses in the theoretical and empirical literature on investment. By integrating the microfoundations and macroeconomics of investment at the empirical level, it has been possible to provide a more realistic model of the causes of capital formation in a developing economy. Rather than simply hypothesizing a theoretical model of the determinants of aggregate investment, the macroeconomic specification

is based on detailed case studies of firm decision-making. Its application to the Egyptian experience generated a number of different determinants of investment that might be considered in other country case studies.

The microfoundations revealed the complex channels through which government policy can affect private activity. While it was not possible to test all of the transmission mechanisms empirically, the model provides a general framework for analyzing aspects that are relevant to particular economies. The econometric approach taken to test the model addressed many of the methodological weaknesses in the existing literature on investment. Thus, for example, the common problem of "spurious correlations" in investment functions was addressed by testing the time series for stationarity and insuring that the residuals from the econometric estimation were "white noise."

By using two different estimation techniques along with the microfoundations, the validity of the model hypothesized was confirmed further. The use of an error correction approach and the application of unrestricted dynamic modelling allowed for some of the effects of expectations and uncertainty on aggregate investment. A comparison of the actual and estimated values for private investment over the 1960-86 period revealed how well the model fit the data despite the considerable shocks to the economy over the period.

The limits of econometric testing of whether the government "crowds in" or "crowds out" private investment and the impossibility of constructing the counterfactual were also discussed. While it is not possible to conclude whether crowding out or in occurred at the macroeconomic level, i.e. to accept the alternative hypothesis, it is possible to draw conclusions about what did

not happen, i.e. to reject the null hypothesis. In addition, the model provided a framework for analyzing the effects of government policy by considering explicitly the role of a number of possible instruments such as the exchange rate, the quantity of credit available to the private sector, and the composition and financing of the government budget. Future research may choose to test other empirical proxies, such as protection, within the same framework.

The model of investment behavior that emerged had features in common with a number of different approaches in the literature as well as aspects that are particularly relevant to a developing economy. Firms' decisions about investment were outcomes of the oligopolistic structure of markets, putty-clay technology, the inelastic supply of non-traded capital goods and financial repression. The consequences of these factors for investment determination were an important role for mark ups, internal financing, demand, and the cost of investment goods defined, not as the interest rate, but as the price outcome from the interaction of supply and demand in the market for capital goods.

By constructing an index of the relative price of investment goods, it has been possible to provide a more meaningful indicator of the true cost of capital to the firm under a repressed financial system. In an economy with a well functioning credit market, the Keynesian equilibrium condition equating the marginal efficiency of investment with the interest rate is likely to hold. However, under financial repression or where credit markets are imperfect, the interest rate is not a true reflection of the cost of capital to the firm. Instead, a combination of the price of investment goods and the quantity of credit available to the private sector appears to be a more realistic proxy.

Further extensions of the model have interesting implications for a range of stabilization policies. For example, policies such as devaluation, credit ceilings and reductions in public investment, have negative effects on private capital formation. In the context of protection, putty-clay technology and inelastic demand for imports, the likely outcome of devaluation is a reduction in investment, at least in the short run until efficiency gains are achieved.[57] Similarly, credit ceilings imposed on a repressed financial system are likely to result in a worsening allocation of resources since those who possess borrowing power are often different from those whose projects have the highest returns. The model also provided evidence of the potential negative impact of fiscal austerity and cuts in public infrastructure investment on capital formation in the private sector.

Some of the fall in investment that results from such stabilization policies may be desirable if, for example, more efficient production results. However, the costs of this transition in factor efficiency may be high because firms are locked into their technological choices for long periods. An evaluation of the efficacy of stabilization policies cannot occur in an institutional vacuum and must take into account these differential effects of government policy over the short and long run. The question of how government stabilization policy can facilitate this transition to more efficient production could be an important extension of this research.

---

[57] See Chhibber and Shafik, 1990 for an analysis of the impact of devaluation for private investment in Indonesia that contrasts the short versus long run effects.

Appendix A: Data Sources and Derivations

Sources of Data

The data used in the econometrics came from a variety of sources. The sources are listed below with the variable(s) obtained from them. Note that when a variable is listed with more than one source, this means that different parts of the time series came from different sources or that series from a number of sources were cross referenced and reconciled. Note also that a "N" at the end of a variable's acronym indicates its nominal value. All indices use 1980 as the base year (1980=100).

For a general discussion of the sources of economic data in Egypt, see the statistical appendix in Mabro and Radwan.[58] For a discussion of the evolution of the measurement of capital formation in Egypt, see Radwan.[59] A more recent discussion of economic data in Egypt is available in Hansen.[60]

The sources used were the following:

Central Authority for Public Mobilization and Statistics, Statistical Yearbook, various issues.

- consumer price index, disaggregated (CPI)
- wholesale price index, disaggregated (WPI)
- WPI for domestic machinery (WPIDMACH)
- WPI for construction (WPIBLDG)
- WPI for transport equipment (WPITRANS)
- gross domestic product at factor costs (GDPN)

Central Authority for Public Mobilization and Statistics, Employment, Wages, and Hours of Work, various issues (1968-78).

- number of workers in the private sector

---

[58] Mabro, R. and S. Radwan, 1976, pp. 242-265.

[59] The commodity flow approach used to measure capital formation in Egypt is based on data for domestic production, imports, and exports of capital goods. See Radwan, 1974, pp. 74-81.

[60] Hansen, 1988.

Commander, S., The State and Agricultural Development in Egypt since 1973, London: Ithaca Press, 1987.

- average wages in agriculture (AVGWAG)

Ikram, K. Egypt: Economic Management in a Period of Transition, Baltimore: Johns Hopkins University Press, 1980.

- domestic bank financing of the government deficit (DBFGDN)
- government expenditure (GOVEX)

International Monetary Fund, International Financial Statistics, various issues.

- domestic credit claims on the private sector (PRVCRDN)
- discount rate, end of period (DISCR)
- consumer price index (CPI)
- GDP deflator (GDPDEF)
- London interbank interest rate (LIBOR)
- world wholesale price index (WWPI)

International Monetary Fund, "Arab Republic of Egypt - Recent Economic Developments," various issues.

- private investment (PRIVIN)
- government investment (GOVIN)
- government investment in infrastructure (GVIINFN)
- gross domestic product at factor prices (GDPN)

Mabro, R. and S. Radwan, The Industrialization of Egypt, 1939-73, London, 1976.

- gross domestic product at factor prices (GDPN)

Ministry of Planning, "Follow-up Report to the Five Year Plan," (in Arabic), various issues.

- private investment (PRIVIN)
- government investment (GOVIN)

Pick's, World Currency Yearbook, various issues.

- nominal parallel market price of foreign exchange (EBM)

Shura Council, "Investment Policy during the Period 1959/60-1982/83," Arab Republic of Egypt, unpublished report, 1985 (in Arabic).

- government investment by economic activity (GOVIN)
- private investment by economic activity (PRIVIN)[61]
- number of workers by economic activity (TOTLAB)
- wages by economic activity (TOTWAGN)
- final consumption at market prices by the public sector (GOVCONN)
- government investment in agriculture and irrigation (GVIAGN)
- government investment in electricity (GVIELECN)
- government investment in construction (GVICONN)
- government investment in transportation (GVITRNN)
- government investment in communications (GVICOMN)
- government investment in utilities (GVIUTILN)
- investment costs in machinery (ICMACHN)
- investment costs in buildings (ICBLDGN)
- investment costs in transport equipment (ICTRANSN)
- investment costs in other (ICOTHERN)
- gross domestic product at factor costs disaggregated by economic activity

World Bank, "Arab Republic of Egypt: Issues of Trade Strategy and Investment Planning," January 1983.

- gross domestic product at factor prices (GDPN)
- GDP from the petroleum sector (GDPPETRN)
- government deficit (GOVDEFN)
- domestic bank financing of the government deficit (DBFGDN)
- total government tax revenue (GVTXRVN)

World Bank, "Arab Republic of Egypt. Current Economic Situation and Economic Reform Program," July 1986.

- gross domestic product at factor prices (GDPN)
- GDP from the petroleum sector (GDPPETRN)
- government investment in infrastructure (GVIINFN)

World Bank, "Arab Republic of Egypt: Country Economic Memorandum," September 1988.

- gross domestic product at factor prices (GDPN)
- GDP from the petroleum sector (GDPPETRN)
- government investment in infrastructure (GVIINFN)
- government expenditure (GOVEX)

---

[61] The Shura Council data on private and government investment by economic activity were compared with the figures given in various issues of the Ministry of Planning's Follow-up Report to the Five Year Plan. The figures were generally consistent and discrepancies could usually be explained by differences in definitions and categories used.

United Nations, Yearbook of National Accounts Statistics, various issues.

- indirect taxes (INDTAXN)

United Nations, Monthly Bulletin of Statistics, various issues.

- export price index for machinery and equipment from the major industrialized countries (XUVKIMP)

Derivations

The derivations used for the variables included in the econometrics are as follows in alphabetical order:

AVGWAG	=	TOTWAGN/TOTLAB
GDP	=	log(GDPNO)
GDPNO	=	(GDPN-GDPPETRN)/GDPDEF
GOVI	=	log[GOVIN/IDEF]
GVEX	=	log[GVEXN/GDPDEF]
DBFGD	=	log[DBFGD/DBFGD]
GVINFN	=	GVIAGN+GVIELECN+GVICONN+GVITRNN+GVIUTILN
GVIINF	=	log[GVINFN/IDEF]
ICOSTS	=	log[IDEF/GDPDEF]
ICTOTN	=	ICMACHN+ICBLDGN+ICTRANSN
IDEF	=	(0.194*WMACH*WPIDMACH)+(0.0806*WMACH*IMACHI) +(WBLDG*WPIBLDG)+(WTRANS*WPITRANS) +(WOTHER*WPI)
IMACHI	=	XUVKIMP*EBM
INDTAX	=	INDTAXN/GDPDEF
KP	=	(1-0.043)KP(-1)+PRIVI
MARKUP	=	log[WPI/WAGEINDX]
NIGVEX	=	GOVEX-GOVI
PRIVI	=	log[PRIVIN/IDEF]
PROFIT	=	log(GDPNO-TOTWAG-INDTAX)
PVCRD	=	log[PRVCREDN/GDPDEF]
PVCRDY	=	log[PRVCREDN/GDPDEF/GDPNO]
R	=	log(1+DISCRATE)/(1+(WPI-WPI(-1))/WPI(-1))
R/W	=	log(1+R)/(1+AVGWAG)
TOTWAG	=	TOTWAGN/WPI
WBLDG	=	ICBLDGN/ICTOTN
WMACH	=	ICMACHN/ICTOTN
WOTHER	=	ICOTHERN/ICTOTN
WTRANS	=	ICTRANSN/ICTOTN

Notes

The investment deflator used above was constructed by using a weighted average of price indices that constitute investment costs. Since the weights based on the Shura Council data were only available for 1961-82, the shares of investment costs were assumed fixed before 1961 and after 1982.[62] The price index for domestic capital goods was the WPI for machinery and equipment which only includes indigenous capital goods. The indices for construction and transport were also obtained from the disaggregated WPI. The WPI was not available in disaggregated form before 1977, therefore the aggregate WPI had to be used. The only exception was the price index for construction for which a series was available from 1970.[63] A price index for machinery exports of the major industrial countries was used as an index of imported capital goods prices. This was multiplied by the nominal parallel market exchange rate to obtain an index of imported capital goods prices in Egypt. The parallel market exchange rate was used since it was the operative rate for much of the period and captures the opportunity cost of foreign exchange for the period of rationing prior to 1974. The relative shares of domestic versus imported machinery is assumed to be fixed. The weights are based on estimates from the World Bank that imported machinery constitutes 80.6% of total machinery inputs.[64] This is a fairly plausible figure given the small size of the domestic capital goods industry and the fact that indigenous and imported machinery are far from perfect substitutes.

The index of wages used to calculate the markup proxy is based on two sources. For 1960-1981, the series for average wages in the economy calculated from the Shura Council was used. However, after 1981, data on aggregate wages are scarce since the Central Authority for Public Mobilization and Statistics is several years behind in compiling the labour force surveys. Consequently, data on agricultural wages was used for 1981-1986 to construct the wage index.[65] This is not an implausible supposition since wages in the agricultural sector are fairly market-determined and would represent a close approximation to wages in the private sector.

---

[62] The weights used before 1961 were: machinery-0.35; building-0.41; transport-0.15; other-0.09. The weights used after 1982 were: machinery-0.40; building-0.38; transport-0.16; and other-0.05.

[63] Assaad constructs a Paasche index for labour, capital and materials in the construction sector. Assaad, 1989.

[64] World Bank, 1980.

[65] Commander, 1987, p. 92.

Bibliography

Anderson, C., 1981, "A New Approach to the Empirical Investigation of Investment Expenditures," Economic Journal.

Assaad, R., 1989, "A Construction Index for Egypt," mimeograph, Cairo.

Balassa, B., 1988, "Public Finance and Economic Development," PPR Working Paper Number 31, The World Bank.

Banerjee, A., J. Doaldo, D. Hendry and G. Smith, 1986, "Exploring Equilibrium Relationships in Econometrics Through Static Models: Some Monte Carlo Evidence," Oxford Bulletin of Economics and Statistics.

Bean, C., 1981, "An Econometric Model of Manufacturing Investment in the United Kingdom," Economic Journal.

Behrman, J., 1972, "Sectoral Investment Determination in Developing Economy," American Economic Review.

Bilsborrow, R., 1977, "The Determinants of Fixed Investment by Manufacturing Firms in a Developing Country," International Economic Review.

Blejer, M. and M. Khan, 1984, "Government Policy and Private Investment in Developing Countries," IMF Staff Papers.

Brown, E., R. Solow, A. Ando, and J. Kareken, 1963, "Lags in Fiscal and Monetary Policy," Commission on Money and Credit.

Brunker, D., 1985, "Empirical Studies of Investment Behavior: Abstracts," Australia Bureau of Industry Economics, Working Paper 34.

Buiter, W., 1985, "A Guide to Public Sector Debt and Deficits," Economic Policy.

Chhibber, A. and N. Shafik, 1990, "Does Devaluation Hurt Private Investment? The Indonesian Case," PRE Working Paper, The World Bank.

Chhibber, A. and S. van Wijnbergen, 1988, "Public Policy and Private Investment in Turkey," PPR Working Paper, World Bank.

Commander, S., 1987, The State and Agricultural Development in Egypt since 1973, London: Ithaca Press.

Currie, D., 1981,"Some Long Run Features of Dynamic Time Series Models," Economic Journal.

Dailami, M., 1987, "Expectation, Stock Market Volatility and Private Investment Behavior: Theory and Empirical Evidence for Brazil," mimeograph, The World Bank.

Dailami, M., 1989, "Policy Changes that Encourage Private Business Investment in Colombia," PPR Working Paper Number 266, The World Bank.

Dailami, M., 1990, "Stock Markets, Cost of Credit and Private Investment. The Korean Case," mimeograph, The World Bank.

Davidson, J., D. Hendry, F. Srba, and S. Yeo, 1978, "Econometric Modelling of the Aggregate Time Series Relationship between Consumer's Expenditure and Income in the United Kingdom," Economic Journal.

Dickey, D. and W. Fuller, 1979, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," Journal of American Statistical Association.

Dickey, D. and W. Fuller, 1981, "The Liklihood Ratio Statistics for Autoregressive Time Series with a Unit Root," Econometrica.

Dolado, J. and T. Jenkinson, 1987, "Cointegration: A Survey of Recent Developments," Oxford Applied Economics Discussion Paper number 39, Institute of Economics and Statistics, Oxford University.

Eisner, R., 1960, "A Distributed Lag Investment Function," Econometrica.

Eisner, R., 1967, "A Permanent Income Theory for Investment: Some Empirical Explorations," American Economic Review, volume 57.

Engle, R. and C. Granger, 1987, "Co-integration and Error Correction: Representation, Estimation and Testing," Econometrica.

Ersel, H. and G. Sak, "Public Borrowing and the Development of Financial Markets in Turkey," mimeograph, Capital Markets Board of Turkey, 1987.

Fazzari, S. and T. Mott, 1984, "The Investment Theories of Kalecki and Keynes: An Empirical Study of Firm Data, 1970-1982," Department of Economics Working Paper Series 75, Washington University.

Fazzari, S., R. Hubbard and B. Peterson, 1988a, "Financing Constraints and Corporate Investment," Brookings Papers on Economic Activity.

Fazzari, S., R. Hubbard and B. Peterson, 1988b, "Investment, Financing Decisions, and Tax Policy," American Economic Review.

Friedman, B., 1985, "Crowding Out or Crowding In? Evidence on Debt-Equity Substitutability," National Bureau of Economic Research Working Paper Series, Number 1965.

Friedman, B., 1978, "Crowding Out or Crowding in? Economic Consequences of Financing Government Deficits," Brookings Paper on Economic Acticity. Number 3.

Fry, M., 1980, "Saving, Investment, Growth and the Cost of Financial Repression," World Development.

Giovannetti, G., 1987, "The Purchasing Power Hypothesis in the Long Run: An Application of Cointegration," mimeograph, Faculty of Statistics, University of Rome.

Granger, C., 1983, "Co-integrating Variables and Error Correction Models," University of California, San Diego Discussion Paper number 83-13.

Granger, C., 1986, "Developments in the Study of Cointegrated Economic Variables," Oxford Bulletin of Economics and Statistics.

Granger, C. and P. Newbold, 1974, "Spurious Regressions in Econometrics," Journal of Econometrics.

Grossman, S.J. and O.D. Hart, 1982, "Corporate Financial Structure and Managerial Incentive," in J. McCall, editor, The Economics of Information and Uncertainty, Chicago: University of Chicago Press.

Haavelmo, T., 1960, A Study in the Theory of Investment, Chicago: Chicago University Press.

Hall, R. and D. Jorgenson, 1971, "Application of the Theory of Optimum Capital Accumulation," in G. Fromm, editor, Tax Incentives and Capital Spending, Washington, D.C.: The Brookings Institution.

Hall, S., 1986, "An Application of the Granger and Engle Two-Step Estimation Procedure to United Kingdom Aggregate Wage Data," Oxford Bulletin of Economics and Statistics.

Hansen, B., 1988, "The Political Economy of Poverty, Equity and Growth: Egypt," unpublished manuscript.

Hay, D. and D. Morris, 1979, Industrial Economics, Oxford: Oxford University Press.

Hayashi, F., 1982, "Tobin's Marginal q and average q: A Neoclassical Interpretation," Econometrica.

Helliwell, J., 1976, editor, Aggregate Investment, London: Penguin.

Henry, S. and M Minford, 1988, "United Kingdom Manufacturing Investment in the 1980s: Some Estimates using Error Correction Models," Discussion Paper number 137, National Institute of Economic Research.

Ikram, K., 1980, Egypt: Economic Management in a Period of Transition, Baltimore: Johns Hopkins Press.

Jenkinson, T., 1986, "Testing Neo-classical Theories of Labour Demand: An Application of Cointegration Techniques," Oxford Bulletin of Economics and Statistics.

Jensen, M. and W. Meckling, 1976, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," Journal of Financial Economics.

Jorgenson, D., 1963, "Capital Theory and Investment Behavior," American Economic Review, volume 53.

Jorgenson, D., 1967, "The Theory of Investment Behavior," in R. Ferber, editor, Determinants of Investment Behavior, New York: Columbia University Press.

Jorgenson, D. and C. Siebert, 1968, "Theories of Corporate Behavior," American Economic Review.

Kalecki, M., 1971, Selected Essays on the Dynamics of the Capitalist Economy, 1933-1970, Cambridge: Cambridge University Press.

King, M., 1977, Public Policy and the Corporations, London: Chapman and Hall.

Mabro, R. and S. Radwan, 1976, The Industrialization of Egypt, 1939-73, Oxford: Clarendon Press.

Malinvaud, E., 1980, Profitability and Unemployment, Cambridge: Cambridge University Press.

Malinvaud, E., 1982, "Wages and Unemployment," Economic Journal.

Marris, R., 1964, The Economic Theory of Managerial Capitalism, London: Macmillan.

Marris, R. and A. Wood, 1971, The Corporate Economy, London: Macmillan, 1971.

Meyer, J. and R. Glauber, 1964, Investment Decisions, Economic Forecasting and Public Policy, Boston: Harvard University Press.

Meyer, J. and E. Kuh, 1957, The Investment Decision, Cambridge: Harvard University Press.

Modigliani, F. and M. Miller, 1958, "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review.

Nickell, S., 1978, The Investment Decision of Firms, Welwyn: J. Nisbet and Company and Cambridge University Press.

Nickell, S., 1985, "Error Correction, Partial Adjustment and All That: An Expository Note," Oxford Bulletin of Economics and Statistics.

Nowshirvani, V., 1971, "A Modified Adaptive Expectations Model," American Journal of Agricultural Economics.

Oks, D., 1987, "Public Sector Deficits in Argentina: Measurement and Macroeconomic Effects," D.Phil. thesis, St. Antony's College, Oxford University.

Pick's, World Currency Yearbook, New York: International Currency Analysis, various issues.

Pinell-Siles, A., 1979, "Determinants of Private Industrial Investment in India," World Bank Staff Working Paper number 333.

Precious, M., 1987, Rational Expectations, Non-Market Clearing and Investment Theory, Oxford: Clarendon Press

Radwan, S., 1974, Capital Formation in Egyptian Industry and Agriculture, 1882-1967, London: Ithaca Press.

Rowley, J. and P. Trivedi, 1975, Econometrics of Investment, New York: John Wiley and Sons.

Salmon, M., 1982, "Error Correction Mechanisms," Economic Journal.

Samuelson, P., 1939, "Interaction between the Multiplier Analysis and the Principle of Acceleration," Review of Economics and Statistics.

Sargan, J. and A. Bhargava, 1983, "Testing Residuals from Least Squares Regression being Generated by the Gaussian Random Walk," Econometrica.

Serven, L. and A. Solimano, 1989, "Private Investment and Macroeconomic Adjustment: An Overview," PPR Working Paper 339, World Bank.

Shafik, N., 1989, "Private Investment and Public Policy in Egypt, 1960-1986," DPhil thesis, Oxford University.

Snessens, H., 1987, "Investment and the Inflation-Unemployment Trade-Off in a Macroeconomic Rationing Model with Monopolistic Competition," European Economic Review.

Solimano, A., 1989, "How Private Investment Reacts to Changing Macroeconomic Conditions: The Case of Chile in the 1980s," PPR Working Paper Number 212, The World Bank.

Sundararajan, V. and S. Thakur, 1980, "Public Investment, Crowding Out, and Growth: A Dynamic Model Applied to India and Korea," IMF Staff Papers.

Taylor, L., 1987, "Macro policy in the Tropics: How Sensible People Stand," World Development.

Tobin, J., 1967, Comment on Crockett-Friend and Jorgenson," in R. Ferber, editor, Determinants of Investment Behavior, New York: National Bureau of Economic Research.

Tobin, J., 1969, "A General Equilibrium Approach to Monetary Theory," Journal of Money, Credit and Banking.

Tobin, J. and W. Brainard, 1977, "Asset Markets and the Cost of Capital," in B. Balassa and R. Nelson, editors, Economic Progress, Private Values and Public Policy: Essays in Honor of William Fellner, Amsterdam: North Holland.

Tun Wai, U. and C. Wong, 1982, "Determinants of Private Investment in Developing Countries," Journal of Development Studies.

Waterson, M., 1984, Economic Theory of the Industry, Cambridge: Cambridge University Press.

Witte, J., 1963, "The Microfoundations of the Social Investment Function," Journal of Political Economy.

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS429	Ghana's Cocoa Pricing Policy	Merrill J. Bateman Alexander Meeraus David M. Newbery William Asenso Okyere Gerald T. O'Mara	June 1990	C. Spooner 30464
WPS430	Rural-Urban Growth Linkages in India	Peter B. Hazell Steven Haggblade	May 1990	C. Spooner 30464
WPS431	Recent Developments in Marketing and Pricing Systems for Agricultural Export Commodities in Sub-Saharan Africa	Panos Varangis Takamasa Akiyama Elton Thigpen	May 1990	D. Gustafson 33714
WPS432	Policy Choices in the Newly Industrializing Countries	Bela Balassa	May 1990	N. Campbell 33769
WPS433	India: Protection Structure and Competitiveness of Industry	Francois Ettori		
WPS434	Tax Sensitivity of Foreign Direct Investment: An Empirical Assessment	Anwar Shah Joel Slemrod	June 1990	A. Bhalla 37699
WPS435	Rational Expectations and Commodity Price Forecasts	Boum-Jong Choe	June 1990	S. Lipscomb 33718
WPS436	Commodity Price Forecasts and Futures Prices	Boum-Jong Choe	June 1990	S. Lipscomb 33718
WPS437	Institutional Development Work in the Bank: A Review of 84 Bank Projects	Cheryl W. Gray Lynn S. Khadiagala Richard J. Moore	June 1990	L. Lockyer 36969
WPS438	How Redistribution Hurts Productivity in a Socialist Economy (Yugoslavia)	Milan Vodopivec	June 990	J. Lutz 36970
WPS439	Indicative Planning in Developing Countries	Bela Balassa	May 1990	N. Campbell 33769
WPS440	Financial Sector Policy in Thailand: A Macroeconomic Perspective	William Easterly Patrick Honohan	June 1990	R. Luz 34303
WPS441	Inefficient Private Renegotiation of Sovereign Debt	Kenneth Kletzer		
WPS442	Indian Women, Health, and Productivity	Meera Chatterjee		

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS443	The Inflation-Stabilization Cycles in Argentina and Brazil	Miguel A. Kiguel Nissan Liviatan		
WPS444	The Political Economy of Inflation and Stabilization in Middle-Income Countries	Stephan Haggard Robert Kaufman	June 1990	A. Oropesa 39176
WPS445	Pricing, Cost Recovery, and Production Efficiency in Transport: A Critique	Rachel E. Kranton	June 1990	W. Wright 33744
WPS446	A Model of Crop and Livestock Markets in Mexico	Gerald T. O'Mara Merlinda Ingco		
WPS447	Analyzing the Effects of U.S. Agricultural Policy on Mexican Agricultural Markets using the MEXAGMKTS Model	Gerald T. O'Mara		
WPS448	A Model of U.S. Corn, Sorghum, and Soybean Markets and the Role of Government Programs (USAGMKTS)	Richard E. Just		
WPS449	Analysis of the Effects of U.S. Macroeconomic Policy on U.S. Agriculturre Using the USAGMKTS Model	Richard E. Just		
WPS450	Portfolio Effects of Debt-Equity Swaps and Debt Exchanges with Some Applications to Latin America	Daniel Oks		
WPS451	Productivity, Imperfect Competition and Trade Liberalization in the Côte d'Ivoire	Ann E. Harrison		
WPS452	Modeling Investment Behavior in Developing Countries: An Application to Egypt	Nemat Shafik	June 1990	J. Israel 31285
WPS453	Do Steel Prices Move Together? A Co-integration Test	Ying Qian		
WPS454	Asset and Liability Management in the Developing Countries: Modern Financial Techniques -- A Primer	Toshiya Masuoka	June 1990	S. Bertelsmeier 33767