ISSN 0265-8003

THE FISCAL AND MONETARY DYNAMICS OF ISRAELI INFLATION: A COINTEGRATED ANALYSIS 1970-1987

Michael Beenstock and Michael Ben-Gad

Discussion Paper No. 290
May 1989

Centre for Economic Policy Research
6 Duke of York Street
London SW1Y 6LA
Tel: (44 1) 930 2963

CEPR Discussion Paper No. 290

May 1989

ABSTRACT

The Fiscal and Monetary Dynamics of Israeli Inflation: A Cointegrated Analysis 1970-1987*

Using quarterly data from 1970-1987 we estimate a simple econometric model in which inflation and the money supply are jointly determined and in which expectations of inflation are rational, or forward-looking. The model is estimated using the recently developed 'cointegration' principle in econometrics. The main findings are that Israeli inflation reflected monetary growth which in turn reflected the fiscal deficit, and that the authorities have systematically accommodated inflationary shocks in the execution of monetary policy.

JEL classification: 301, 311, 321
Keywords: inflation, cointegration, Israel

Michael Beenstock and Michael Ben-Gad
Department of Economics
The Hebrew University
Mount Scopus
Jerusalem 91905
Israel

* This paper is part of a CEPR research programme on International Macroeconomics, supported by grants from the Ford Foundation (no. 890-0404) and the Alfred P Sloan Foundation (no. 88-4-23), whose help is gratefully acknowledged.

NON-TECHNICAL SUMMARY

During the 1970s inflation in Israel climbed towards 100% per annum. By the first half of 1985 the rate of inflation exceeded 500%. Now it is about 15%. In this paper we study the roles of fiscal and monetary phenomena in this inflationary process. We conclude that monetary growth has been the principal cause of the rise and decline of Israeli inflation, while the budget deficit has been the driving force behind the growth rate of the money supply.

Previous empirical research into Israeli inflation has failed to find a causal link between the money supply and inflation. It is widely held that the money supply has been a passive phenomenon in an inflationary environment. Inflation has reflected instead real phenomena such as excessive real wages or excessive real devaluation. According to this argument, inflation set off by such real forces leads to an increase in the demand for money, and the authorities allowed the supply of money to rise to meet the higher demand. We argue that while there may not have been a consensus on the causes of Israel's inflation, there has been a consensus that monetary growth was not among them. We challenge this view by integrating real and monetary theories of inflation and argue that the impetus to inflation was the fiscal deficit which triggered excessive monetary growth, although there were also times when inflation was purely a monetary phenomenon operating independently of fiscal policy.

To test this view, we estimate a two-equation model in which the money stock and the aggregate price level are endogenous variables. They are represented by the broadest definition of the money stock (M4) and the GDP deflator. The data are quarterly and run from 1970 through 1987. Stability tests reveal that the model did not break down following the Stabilization Programme launched in July 1985. In the model expected inflation is 'rational' in the sense that the public is assumed to form its expectations according to the estimated model itself. This property implies that inflation will tend to jump up or down prior to expected policy changes. For example, if fiscal policy is expected to be expansive next year in a way that will induce excessive monetary growth, inflation will accelerate now. It then appears that monetary growth was caused by inflation, when the truth is the converse. Controlling and testing for the presence of rational expectations is essential if the causal effects of monetary policy are to be isolated properly.

This approach addresses the 'Lucas Critique' directly. The econometric technique employed to estimate the model is cointegration, a powerful statistical method for estimating the dynamic interdependence between variables which are highly trended. In Israel prices and money are highly trended, so cointegration is particularly suitable.

Our analysis suggests that fiscal policy did not directly affect the rate of inflation. Instead, inflation depended on the rate of monetary growth and the net excess

supply of money. It also depended on expected inflation which, in the model, depends on expected monetary growth. This is a 'monetarist' account of inflation in the sense that only money appears to matter; fiscal policy does not appear to matter. Our analysis suggests that growth largely reflected the fiscal deficit; money was 'printed' in order to finance the deficit, which reached 15% of GDP by 1985. There was also a tendency for the authorities to accommodate inflationary shocks. This policy reinforced underlying inflationary tendencies both directly and indirectly via rational expectations.

The main policy conclusion we draw is that control of the fiscal deficit is vital if inflation is to be stabilized. Control of monetary growth is impossible if the fiscal deficit is not moderated, and monetary growth is the driving force behind inflation. Monetary growth must be reduced if inflation is to be reduced. There are two ways in which this may be carried out; either by announcing it in advance or by springing it as a surprise on an unsuspecting public. If expectations are indeed rational, the public will respond responsibly to credible policy pronouncements. This implies that inflation may be brought down by promulgating a 'Medium Term Financial Strategy' in which moderate fiscal deficits and consistent monetary growth targets are announced in advance. The alternative of reducing monetary growth on an unannounced basis will delay the reduction of inflation and may depress the economy unnecessarily.

It is implicit in this work that the exchange rate is determined by rather than a determinant of inflation. The paper does not, however, test the hypothesis that inappropriate exchange rate policies, in particular excessive devaluations, were an independent cause of inflation. A more authoritative answer on this issue will have to await the integration of the exchange rate as a third endogenous variable into the model.

I. Introduction

During the 1970's Israeli inflation breached single and then double digit levels. In the first half of 1985 it was approaching triple digits. Thereafter it rapidly fell to less than 20% p. a. In this paper we seek to investigate the monetary, fiscal, and related factors responsible for the rise and decline of Israeli inflation.

Econometric analysis of the relationship between money and inflation in Israel goes back many years. Kleiman and Ofir (1972 and 1975) concluded that for the period 1955-65, the supply of money was essentially demand- determined. Inflationary shocks which raised the demand for money were accommodated by the monetary authorities; the supply of money was a passive accomplice in an inflationary environment. Moreover, this perspective on the Israeli monetary system may be partly responsible for a series of econometric studies of the demand for money, e.g. Offenbacher (1985), in which it is assumed that the quantity of money is demand-determined. In addition, simple "causality" tests, e.g. Brezis et al (1983), tend to confirm that money has been passive rather than active in the Israeli inflation while Melnick (1988) presents evidence in favour of the hypothesis that price shocks were primarily responsible for Israel's inflation during 1970-1983. In short, the econometric evidence, such as it is, does not support the hypothesis that the money supply was a contributory factor in Israel's inflation. Nor for that matter does it support the hypothesis that the fiscal deficit was a contributing factor although fiscal orthodoxy is one of the centrepieces of the stabilization programme that was launched in July 1985, see Bruno and Piterman (1987).

The central objective in this paper is to attempt to unravel the two-way, dynamic interdependence between the money supply and prices in Israel. In this context we also seek to estimate the influence of the fiscal deficit and public sector borrowing on monetary growth. To these ends we estimate a dynamic model consisting of two behavioural simultaneous equations in money and prices respectively and an identity that relates the evolution of public sector debt to the fiscal deficit. Expected inflation plays an important part in the model and these expectations are hypothesized to be rational . The main implications of the model are as follows:

i) Public sector borrowing has been the fundamental determinant of the core rate of inflation over the period investigated (1970 QI - 1987 QI).

ii) However, monetary accommodation tended to reinforce inflationary shocks.

iii) Rational expectations of inflation - prone policies aggravated the rate of inflation.

iv) The inflation has been home - grown; external factors have played a negligible role.

v) Monetary growth was both a cause and a consequence of the inflationary process.

vi) Monetary growth has reflected the fiscal deficit and the public sector borrowing requirement (PSBR).

vii) It is difficult to distinguish between a "monetarist" model in which only money matters for inflation and a "Keynesian" model in which non-money assets also matter for inflation.

Perhaps the most novel result is the first, which others e. g. Liviatan and Piterman (1986) and Bruno and Fischer (1986) failed to find. Nevertheless, the theoretical specification which we adopt broadly mirrors that of Bruno and Fischer. However, our econometric treatment is very different. Liviatan and Piterman have tried to argue that Israeli inflation was fanned by inappropriate exchange rate policies. Balance of payments crises prompted over-reaction by the authorities, which resulted in excessive devaluations (especially in 1983). By trying to push the real exchange rate above its natural rate inflation became pandemic. According to this view the rapid monetary growth was on the whole a result of the inflation and not a cause.

Liviatan and Piterman did not implement formal econometric tests of their hypothesis. Nor do we in the present paper. Indeed we abstract from exchange rate (and labour market) considerations, which inevitably limits and qualifies our findings. The implication of this is that the exchange rate and the balance of payments were determinands rather than determinants and reflected the inflationary process instead of contributing to it. Beenstock and Kahanaman (1988) consider the dependent nature of the exchange rate and the balance of payments. However, a full analysis of the joint determination of the exchange rate and inflation lies beyond our present, less ambitious, terms of reference.

Our econometric efforts are based on the cointegration methods proposed by Engle and Granger (1987). Indeed the implementation of this technique, particularly in a simultaneous setting, is an important methodological component of the paper. The highly non-stationary character of Israeli data is particularly suited to the technique. Cointegration involves separate equations for the long run and short run elements of "error correction mechanisms". We show that money and prices feedback onto each other over time and that the second stage equations for money and prices are interdependent.

The remainder of the paper is organized as follows. In section II we present the theoretical context in which our econometric efforts are based. In section III we present our empirical findings. Section IV concludes.

II. Theory

Macroeconomic Framework

Except for a brief interval in the late 1970's, Israel has operated a fixed but adjustable exchange rate system. In principle, this implies that monetary conditions were dominated by external considerations since Israel is a small open economy. In practice, however, monetary aggregates appear to have been dominated by net domestic credit and the exchange rate was frequently devalued. The rate of inflation that surpassed 400% in 1985 was essentially a domestic phenomenon and it is assumed here (see section I) that the exchange rate by and large responded passively to domestic monetary developments.

We postulate a demand for money (M) which is linear homogeneous in prices (P) and varies inversely with the rate of inflation (π). In section III we consider the more general case in which the demand for money depends additionally on the rate of interest. We assume for present heuristic purposes that foresight is perfect and myopic:-

$$m^D = (M/P)^D = e^{\beta\pi} \qquad (\beta<0)$$

For expositional simplicity we assume that the "core" rate of inflation happens to be zero. Prices do not clear the product/money market instantaneously, hence,

$$\pi = \tau \ln(M/M^D) + V \qquad (1)$$

i.e. the rate of inflation depends on the excess demand for money. If the "core" rate of inflation is positive the change in the rate inflation will depend on excess money demand. The term V reflects other factors such as import costs that might affect inflation.

The money supply process contains two elements. First, the authorities are assumed to accommodate in part the demand for money. Secondly, the real fiscal deficit (G) has to be financed either by money issue or bond issue. Here we assume that the "unpleasant monetary arithmetic" suggested by Sargent and Wallace (1981) has already been realized in which case sustained bond-financed deficits are infeasable. These considerations suggest the following money supply process:

$$D\ln M = G/m + \mu \ln(M^D/M) \qquad (2)$$

where D = d/dt denotes the differential operator.

The second term represents the accommodating element of monetary policy where an excess demand for money induces monetary growth. The first term represents the effects of the fiscal deficit on monetary growth; the bigger the fiscal deficit the bigger the rate of monetary growth. However, this growth is proportionate to the rate of inflation reflecting inflation-tax considerations and the effects of inflation on the demand for real money balances, see e.g. Melnick and Sokoler (1984).

The model incorporates several dynamic features. First, the government budget constraint implies that inflation feeds back onto the money supply (if $G > 0$) which in turn feeds back onto the rate of inflation. But increases in expected inflation lower the demand for money which in turn raises prices. Secondly, if $\mu > 0$, inflationary shocks are accommodated and inflation will feedback onto itself. This in turn will affect expected inflation and thence prices. If, however, $\tau < \infty$, monetary disturbances will not be fully reflected in prices instantaneously and the inflationary process will be moderated. In the limit if $\tau = 0$ the link between money and prices is severed completely and the dynamic interaction between fiscal policy, monetary policy and prices disappears.

Unfortunately, the simple model that has been proposed is not amenable to analytical solution. However, its insights may be revealed analytically provided we consider its dynamic components separately. If we assume $\tau = \infty$ and $\mu = 0$ the model becomes

$$m = e^{\alpha\pi}$$

$$Dm + m\pi = G$$

i.e. prices are perfectly flexible and monetary policy reflects the budget deficit. Substituting the first equation into the second implies that the dynamics of inflation are governed by:

$$e^{\alpha\pi} (D + \beta^{-1})\pi = G/\beta$$

The particular solution is (see e.g. Sargent (1979, p. 37); -

$$\pi_t e^{\alpha\pi t} = G/\beta(D + \beta^{-1}) = \beta^{-1}\int_t^{\infty} e^{(s-t)/\beta}\, G(s)ds \quad (3)$$

i.e. current inflation depends on expectations of fiscal deficits over the entire future. Thus, even if the current fiscal deficit is relatively modest, current inflation will accelerate rapidly if expectations of future fiscal deficits are revised upwards.

The solution to the homogeneous component is independent of $e^{\alpha\pi}$ and implies that

$$\pi_t = Ae^{-\beta t}$$

where A is an arbitrary constant. Since $\beta < 0$ the root is unstable. The condition that inflation will not explode independently of the fiscal deficit implies that A = 0 in which case equation (3) is the solution. This implies that the fiscal deficit is the driving force behind inflation and that at the margin the effect of fiscal deficits on inflation tends to increase with the size of the fiscal deficit as illustrated on the diagram.

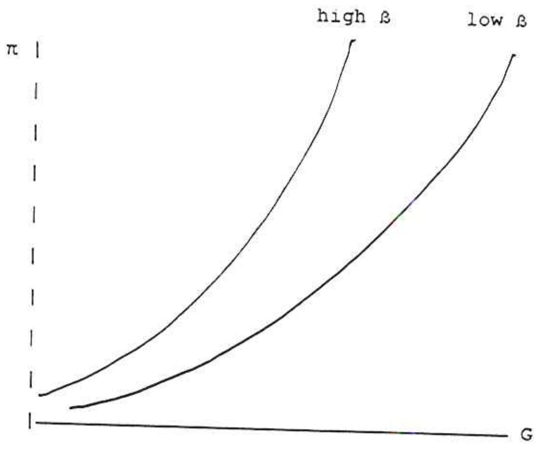

Fig. 1 Relationship between Fiscal Deficit and Inflation

Next we assume that $G = 0$, i.e. the budget is balanced and that $\tau < \infty$ and $\mu > 0$. This enables us to consider dynamic elements of the model that are independent of fiscal policy. Under these assumptions the model becomes:

$$([1+\tau\beta]D + \tau)\ln P - \tau \ln M = V$$
$$\mu(1 + \beta D)\ln P - (D + \mu)\ln M = 0$$

in which case the dynamic solution for inflation is:

$$(D + \Phi)\pi = V(D + \mu)/(1 + \tau\beta)$$

where $\Phi = (\tau + \mu)/(1 + \tau\beta)$

If $D + \Phi < 0$ the general solution for inflation is:

$$\pi_t = Ae^{-\Phi t} - (1 + \tau\beta)^{-1} \int_t^{\infty} e^{(s-t)/\Phi} (D + \mu)V(s)ds \qquad (4)$$

i.e. current inflation depends on expectations of the future exogeneous shocks that are likely to affect the rate of inflation. Since in the absence of such shocks the inflation rate would be expected to be stable it follows that $A = 0$. If e.g. V is expected to be constant the solution for inflation is:

$$\pi = V(\tau + \mu)/(1 + \tau\beta)^2$$

which implies that as monetary policy becomes more accommodating (i.e. as μ increases) inflationary impulses become more pronounced. As monetary policy becomes completely accommodating, (i.e. as μ tends to infinity) the rate of inflation becomes completely unstable.

If $D + \phi > 0$ it may be shown that instead of the forward-looking solution of equation (4) we obtain a backward-looking solution of the type

$$\pi_t = Ae^{-\phi t} + (1+\tau\beta)^{-1} \int_{-\infty}^{t} e^{(s-t)\phi} (D + \mu)V(s)ds$$

Provided prices are not extremely sticky and the demand for money is not too insensitive to expected inflation the forward-looking solution will be valid.

If expectations are rational stable fiscal deficits and stable rates of monetary accommodation imply stable rates of inflation. There is no inherent hyperinflationary logic unless of course fiscal deficits and/or monetary accommodation are expected to become more pronounced. Alternatively hyperinflation would tend to occur if, as suggested by Bruno (1987), β were positively related to inflation, i.e. at higher rates of inflation the demand for money becomes more sensitive to the rate of inflation. If instead expectations are irrational (e.g. they are adaptive) then almost anything can happen; inflation will tend to explode as the elasticity of expectations exceeds unity. However, such prognoses are arbitrary.

In equation (2) it was assumed for presentational purposes that fiscal deficits were monetized instantaneously, i.e. deficits were money-financed both in the short run and in the long run. Sargent and Wallace (1981) have suggested that in the long run the money supply will be driven by the fiscal deficit and Minford et al (1984) provide some empirical support for this view. In the short run, however, there are many reasons why the deficit might not be instantaneously monetized and why it might be bond-financed instead.

Therefore a more general specification of equation (2) is:

$$DlnM = \mu_0 + \mu_1(G/m) + \mu_2 \ln(M^D/M) + \mu_3 \ln(B/M) + \mu_4 \pi \qquad (5)$$

where $\mu_1<1$, $0<\mu_3<1$, $\mu_4<0$, and B denotes the stock of public sector debt, i.e. DB = GP. The first two restrictions imply that fiscal deficits may be temporarily bond-financed. The latter reflects the peculiarities of the Israeli financial system. Because public sector debt is largely indexed to inflation while monetary assets (except PATAM accounts) are not indexed, inflation is likely to raise the demand for public sector debt relative to the demand for money. This enables the authorities to bond-finance to a greater degree than otherwise would be the case. Equation (5) implies that the long run stock equilibrium (i.e. when G = 0) is:

$$\ln M = \mu_2/\mu_3 + \ln B + (\mu_4/\mu_3)\pi \tag{6}$$

In fig. 1 we plot B/M where it will be discerned that this ratio is broadly (but not exclusively) positively related to inflation as suggested by equation (6). The real rate of interest is likely to be a negative component of μ_0, however, in what follows we assume that it is constant in the long run. Other shift variables in μ_0 such as tax incentives to invest in public sector debt are also ignored. In section III we test the restriction in equation (6) that the quantity of money is homogeneous to degree one in public sector debt.

For presentational purposes we further assumed that G was exogenous. In Israel, and most probably in other inflation-prone countries, this is likely to be unrealistic especially in the short run. The so-called "Tanzi Effect" implies that the real fiscal deficit is positively related to inflation since most tax systems are less than perfectly index-linked and tax payments are usually paid in arrears. Inflation therefore erodes the real value of tax payments. This will give an extra twist to the instability of inflation. An increase in the underlying deficit which fuels inflation will induce a bigger deficit and yet more inflation. The opposite happens when the deficit is reduced. Indeed most probably a significant part of the fall in the deficit in Israel from 14 percent of GDP in 1983-1984 to the current level of about 3 percent is explained by the "Tanzi Effect" associated with the fall in inflation from over 400 percent per year to less than 20 percent.

Finally, another presentational simplification consisted of the assumption that the demand for money is interest inelastic. However, we defer discussion of this issue until section III.

Econometric Framework

If we seek to estimate equations such as (1) and (5) in an orderly fashion appropriate dynamic estimation techniques are required. We illustrate our arguments with respect to inflation. Inverting the demand for money function (in discrete time) implies that the long-run equilibrium price level is:

$$\ln P_t^* = \alpha_o + \alpha_1 \ln M_t + \alpha_2 Z_t + \alpha_3 \pi^e_{t+1} + u_t \qquad (7)$$

where homogeneity implies $\alpha_1 = 1$, Z is a vector of variables that affect the demand for money, $\pi^e_{t+1} = \ln P^e_{t+1} - \ln P_t$ denotes expected inflation and u is a stochastic term. Hendry and Mizon (1980) suggest that e.g. equation (1) may be estimated in the form of an "error correction mechanism" (ECM), from equation (7). They argue that serial correlation should be regarded as a diagnostic check on dynamic misspecification rather than as a nuisance that must be purged e.g. by GLS.

More recently Granger and Engle (1987) have suggested that under certain circumstances equation (7) may be estimated separately in a two stage procedure. In the first stage equation (7) is estimated without any dynamics. This is legitimate provided P is "cointegrated" with M,Z, and π. The latter variables constitute a cointegrating vector if the estimated residuals (u) are stationary and if P, M, Z, and π are jointly or severally integrated to the same degree (d). Although P,M,Z and π are unlikely to be individually stationary, it may be the case that some combination of them generates a variable (u) which is stationary. If this is so, it implies that the trend in P is explained by the trends in M,Z and π. This first stage equation may be regarded as the long run relationship that we seek to identify in the data. If in the long run we expect to be on the demand for money function estimates of equation (7) should generate stationary estimates of u.

We note that equation (7) may be written alternatively as:

$$\ln P_t = \frac{1}{1 + \alpha_3} (\alpha_0 + \alpha_1 \ln M_t + \alpha_2 Z_t + \alpha_3 \ln P^e_{t+1}) + u'_t \quad (7')$$

However, it is an empirical matter whether the specification of P^e in equation (7') instead of π^e in equation (7) provides a more reliable basis for cointegration.

Having generated a stationary series for u Granger and Engle suggest that the dynamics of the model can be estimated separately in an equation of the following type:

$$\Delta \ln P_t = F_1(L)\Delta \ln M_t + F_2(L)\Delta Z_t + F_3(L)\Delta \ln P_{t-1} + \lambda \pi^e_{t+1} + F_4(L)\Delta V_t + \Theta_1 u_{t-1} + v_t \tag{8}$$

where Θ_1 is expected to be negative, and $F_i(L)$ denotes polynomial functions in the lag operator L. The basic idea is that u may be regarded as an estimate of the deviation from equilibrium (P*) in which case equation (8) may be regarded as a first order ECM. $F_i(L)$ and Θ_1 represent derivative and proportionate error corrections respectively.

Provided P, M, Z and π^e (or P^e) are highly trended OLS estimates of α_i will be "super consistent" but not efficient because u is unlikely to be white noise, see Stock (1987). Thus, the `t' values for α_i have to be interpreted with caution. This effectively turns non-stationarity to advantage; the greater is d the more sensible it is to estimate equation (7). An advantage of Israeli data is that P and M are highly non-stationary (see Table 1).

Another characteristic of equation (7) is that if P, M, Z and π^e are cointegrated then e.g. M must "Granger cause" P and/or P must "Granger cause" M. Hence cointegration implies "Granger causality". If equation (8) can be estimated and Θ_1 is significant it implies that M "Granger causes" P. However, if equation (8) cannot be estimated it implies that P "Granger causes" M.

To explore the latter we suggest the following two stage procedure for the determination of the money stock that is implied by equation (5). In the first stage we represent equation (6) by:

$$\ln M_t = \beta_0 + \beta_1 \ln B_t + \beta_2 \pi^e_{t+1} + w_t \qquad (9)$$

where w is a disturbance term that is analogous to u in equation (7). The maintained hypothesis is that $\beta_1 = 1$ and $\beta_2 < 0$.

In the second stage we represent equation (5) by:

$$\Delta \ln M_t = F_1(L)\Delta \ln M_{t-1} + F_2(L)\Delta \ln P_t + F_3(L)\Delta Z_t + F_4(L)\Delta \ln B_t + \Theta_2 u_{t-1} - \Theta_3 w_{t-1} + e_t \qquad (10)$$

where $F_i(L)$ denote polynomial functions in the lag operator L. The coefficient Θ_3 reflects the ECM implied by equation (9) while Θ_2 reflects μ_2 in equation (5). If Θ_3 is statistically significant we may infer that B "Granger causes" M. If Θ_2 is statistically significant we may infer that P "Granger causes" M in a way that reflects monetary accommodation and is independent of fiscal influences on the supply of money. In principle M may be "Granger caused" by both B and P.

Clearly equations (8) and (10) must be estimated simultaneously, because M_t is endogenous in the former equation, while P_t and B_t are endogenous in the latter. A separate econometric issue concerns the specification of expected inflation in equations (7), (8), and (9). Since these expectations are hypothesized to be rational we apply the "errors in variables" method which has been proposed e. g. by Wickens (1982). While in principle this simpler method is less efficient than the "substitution method" proposed e.g. by Wallis (1980) we note with interest that in a practical comparison of the two methods West (1986) found the former superior to the latter.

It should be emphasized that this schema has nothing in common with the VAR model of Leiderman and Razin (1987). There are several differences. First, we attempt to estimate economic structure rather than a "black box". Secondly, we make use of data about the levels of variables and not just their first differences. In doing so we tend towards the school of Hendry, Engle, and Granger rather than the school of Sims and Litterman, and are able to test for various restrictions in levels as illustrated by equation (7).

III. Estimation

Data

Our observation period ranges from 1970Q1 - 1987Q1. The data are defined in the appendix, however, here we note particular data issues. We proxy the general level of prices by the GDP deflator on the grounds that this is the most general index of prices just as the GDP is the most general index of economic activity. We therefore do not distinguish between controlled and free prices or between consumer and other prices.

There are currently four official definitions of the money supply in Israel. M_1 denotes current account deposits and notes and coins held by the non-bank private sector. M_2 is M_1 plus deposit accounts. M_3 is M_2 plus accounts that are index-linked to the shekel-dollar exchange rate. Finally, M_4 is M_3 plus tradeable bonds that are either index-linked to the dollar or the CPI. We use the M_4 definition of the money supply for theoretical as well as statistical reasons. Until 1983 tradeable-linked bonds were effectively monetized and it turns out that a broader definition of the money supply lends greater statistical support to the theories that we investigate. However, since 1983 the monetary character of tradeable-linked bonds has diminished in principle and in practice we find that after 1983 the importance of M_3 began to increase. However, these results are not included here.

In fig. 2 we plot velocity for the different definitions. Not surprisingly, these suggest the the sensitivity of velocity to inflation increases with the narrowness of the definition of money. Melnick (1988) has provided a more detailed analysis of this phenomenon.

Our most serious data deficiency concerns the absence of quarterly data on the fiscal deficit (G). Fortunately, a quarterly time series has been recently constructed on the net domestic liabilities of the public sector (B) whose relationship with M_4 is plotted on Fig. 1. Details concerning this series (which includes commercial bank reserves) may be found in Elkayam, Tal and Yariv (1987). Since tradeable linked bonds (i.e. $M_4 - M_3$) are also a component of B there is inevitably some overlap between M and B. However, it is clear from fig. 1 that this overlap is relatively minor for otherwise the ratio between M and B could not have varied to the extent that it did.

In section II we assumed for presentational purposes the textbook case where $\Delta B = GP$. In this simple case we may impute $G = \Delta B/P$. However, in reality the case is considerably more complicated and the definitions of the change in the outstanding stock of public sector debt is:

$$\Delta B \equiv GP + N + R + I + F \tag{11}$$

where

N = net asset purchases by the government

R = revaluation effects

I = Indexation payments

F = Purchases of foreign exchange by the private sector

The inclusion of R reflects the measurement of B in terms of market rather than par values. The inclusion of I reflects the fact that much of the debt is index-linked as discussed above.Direct data are available for B, F, and P and indirect data are available for I. We compute the latter from data on the indexed components of the debt. This implies that we may infer GP + N from equation (11) but not G. However, this is not necessarily a shortcoming because GP + N = PSBR where PSBR denotes what in UK parlance is the Public Sector Borrowing Requirement. For example Minford et al (1984) argue that the PSBR is a more general measure of the financing requirement of the authorities than the fiscal deficit. On this basis the nationalization of assets will generate financing requirements similar to those generated by the fiscal deficit while privatization proceeds will reduce them. Unfortunately separate data for R are not available in which case we may only infer PSBR + R from equation (1).

On fig. 3 we plot as a percentage of nominal GDP, ΔB, F, I, and PSBR + R that are generated from equation (11). For comparative purposes we also plot the fiscal deficit on an annual basis.

In Table 1 we report the estimated order of integration (d) for the central variables in the model in terms of the Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) statistics based on the significance tables (at p = 0.05) reported by Engle and Yoo (1987). The ADF is based on a third order autoregressive process and is appropriate when the DF regression errors are autocorrelated. The table suggests that the order of integration is not unambigious and that DF and ADF can suggest different conclusions. However, we have asterisked the estimate of d on the basis of the autocorrelation properties of the DF regression. For example, we prefer the ADF statistic for B which suggests that d = 3 to the DF statistic which suggests d = 2 because the DF regression errors are autocorrelated.

Notice that all the variables in Table 1 are expressed as deviations from (semilogarithmic) deterministic time trends. We found that untransformed variables did not cointegrate or if they did the estimated ECMs failed various statistical tests. These problems were resolved by the transformed data. Because tests of cointegration require that all the variables be stochastic it was necessary to detrend the data before applying them. However, we note that the results were very similar whether or not we detrended the data.

The need to detrend requires some theoretical as well as statistical justification. It would have been preferable to specify stochastic variables of an appropriate order of integration in place of a time trend to achieve cointegration. However, we were unable to specify such stochastic variables and our resort to the use of a time trend is a popular, if unsatisfactory, default option. In the case of equation (7) it implies that the demand for money is time-trended, a common empirical finding that reflects technical innovation, while in the case of equation (9) it reflects a secular shift in asset preferences. Thus, henceforth, all the variables reported in the regression equations are detrended.

Cointegration requires that all the variables in the cointegrating vector be jointly or severally of the same order of integration. In our multivariate context the number of possible combinations is very large and we do not report them. However, in practice we found that it was possible to find several satisfactory combinations. Although we do not report them in Table 1 we present estimates of d for certain combinations of economic aggregates that may be of interest to the reader.

Results

We begin with illustrative estimates for the first stage equations in money and prices respectively, i.e. equations (9) and (7'). The latter specifies the expected future price level which is necessarily integrated to the same degree as the dependent variable. Accordingly we may assume that $P^e_{t+1} = P_{t+1}$ without any instrumentation provided the R^2 is high (which it is). The former specifies expected inflation which cannot be integrated to the same degree as the dependent variable. Accordingly we have taken the precaution of instrumenting π_{t+1} (see table 2) in estimating equation ($\hat{9}$). The choice of instruments includes the PSBR and lagged money supply because these variables play a central role in the estimated model.

Engle and Yoo (1987) suggest that unless the sample size is very large the Durbin-Watson statistic is an unreliable test for the absence of unit roots in w and u. We therefore report the Dickey-Fuller statistic (DF) and denote in parentheses their approximate critical values at $p = 0.05$. We found that augmentation of the Dickey-Fuller regressions was unnecessary.

Our estimate of equation (9) is:

$$\ln M_t = \underset{(0.243)}{-.003} + \underset{(64.5)}{1.1}\ln B_t + \underset{(3.01)}{0.77}\ln GDP_t - \underset{(5.07)}{0.82}\pi^e_{t+1}$$

$+ w_t$ (9̂)

$R^2 = 0.988$ DF(4.11) = 3.45 OP = 1970Q4 - 1987Q1

The very high R^2 suggests that the parameter estimates are likely to be "super consistent". Although their estimated standard errors are biased we nevertheless report 't' values in parentheses. Equation (9̂) implies that in the long run the quantity of money rises slightly more than proportionately with the stock of debt thereby supporting the view that the growth of debt generated by the PSBR and the growth of the money stock are related. We defer issues of causality to the discussion of equation (1̂0). GDP raises the quantity of money relative to debt because it forces the authorities into a greater degree of monetization via upward pressure on interest rates. The opposite happens when expected inflation increases; because it is indexed the demand for debt rises which enables the authorities to engage in less monetization than otherwise would have been the case. Finally the implicit time trend suggests that there has been a secular tendency for the relative portfolio demand for public sector debt to rise by about 4.3 percent per quarter which is apparent from fig. 1.

In short, equation (9̂) represents a long run policy reaction function of the quantity of money to the quantity of public sector debt such that its real rate of interest remains stable over the long term. The elements of the cointegrating vector constitute factors that influence the public's demand for interest bearing public sector debt. The greater this demand the less is the deficit monetization in which the authorities are required to engage in order to guarantee a stable real rate of interest.

The DF statistic is somewhat below its critical value suggesting that the variables in equation $(\hat{9})$ might not cointegrate. However, the autocorrelation function for w decays to within a standard deviation of zero. We therefore proceed under the assumption that equation $(\hat{9})$ is cointegrated.

Our illustrative estimate of equation (7') is:

$$\ln P_t = \underset{(0.73)}{0.005} + \underset{(8.74)}{0.371}\ln P_{t-1} + \underset{(14.6)}{0.604}\ln M_t - \underset{(9.45)}{1.43}\ln GDP_t + u_t \qquad (\tilde{7}')$$

$R^2 = 0.9967$ DF(4.11) = 4.26 OP = 1970Q2 - 1987Q1

In this case the DF test is passed. The implicit estimates of α_1 and α_3 are 0.96 and 0.79 respectively. The former implies that the long-run homogeneity condition is almost satisfied. The latter implies that the demand for money is quite sensitive to expected inflation. This is true despite the fact that part of M_4 is index-linked. Equation $(\hat{7}')$ further implies that the real income elasticity of the demand for money is greater than unity. The implicit time trend implies that there has been a secular tendency for the demand for money to fall by about 1.7 percent per quarter. The latter may be interpreted as reflecting technological improvements in cash management etc.

Equation $(\hat{8})$ illustrates the estimation of equation (8) based on equation $(\hat{7}')$:

$$\pi_t = \underset{(1.12)}{0.01} + \underset{(3.5)}{0.522}\pi^e_{t+1} + \underset{(3.26)}{0.466}\Delta \ln \hat{M}_t - \underset{(11.8)}{1.21}\Delta \ln GDP_t - \underset{(4.59)}{0.426}u_{t-1} \qquad (\hat{8})$$

$R^2 = 0.904$, $\sigma = 0.042$, $LMF_8(2.17) = 1.61$, $S(21.03) = 16.5$

$ARCH(9.49) = 4.02$, $W(9.49) = 7.59$, $Z(2.2) = 1.02$

σ denotes the standard error of estimate. LMF_j denotes the lagrange multiplier portmanteau (F version) test for j order autocorrelation in the residuals where the auxiliary regression is appropriately instrumented. S denotes a chi square test for instrument validity proposed by Sargan (1958). ARCH denotes the test statistic for autoregressive conditional heteroscedasticity, Engle (1982), and W denotes the test for heteroscedasticity proposed by White (1980). These test statistics are also chi square. Finally Z denotes the predictive test due to Salkever (1976) over the period since the implementation of the

Stabilization Programme in 1985. It has the dimension of an F test. Critical values are indicated in parentheses, i.e. if the calculated value exceeds this critical value at $p = 0.05$ there is evidence of misspecification.

Equation $(\hat{8})$ passes all of these tests independently although as the number of autocorrelations is reduced LMF begins to become significant. Perhaps of particular interest is the ease with which the predictive test is passed suggesting that the same model applies both before and after the launch of the Stabilization Programme. Also of particular interest is the significant negative coefficient on u_{t-1} suggesting that money "Granger causes" prices. However, the size of this coefficient suggests that the speed of adjustment is very rapid. In addition the equation suggests that inflationary expectations have a large effect on actual inflation. Details about the instrumentation of equation $(\hat{8})$ are reported in table 2.

Equation $(\hat{8})$ does not include any explanatory variables that represent the cost-push variables (V) that were mentioned in equation (1). We could not represent V by wage rates or the exchange rate, as e.g. in Melnick (1988), because these variables are clearly endogenous in the framework that we propose. Therefore we tried instead to represent V by exogenous components of costs e.g. by world inflation, the prices of imported raw materials and by oil prices. However, we failed to discover any significant role for these variables. Melnick suggests the specification of controlled prices as an exogenous inflationary component, but it is doubtful whether this variable is weakly exogenous since inflation forced the authorities to adjust these controlled prices at frequent intervals. Therefore, equation $(\hat{8})$ suggests that Israeli inflation was dominated by monetary variables and that perhaps the sheer pace of the inflation prevents successful estimation of cost-push phenomena.

Equation $(\hat{10})$ illustrates the estimation of equation (10):

$$\Delta \ln M_t = \underset{(0.54)}{-0.004} + \underset{(5.66)}{0.373}\Delta \ln M_{t-1} + \underset{(1.73)}{0.162}\Delta \ln \hat{B}_t + \underset{(3.78)}{0.487}\Delta \ln(\hat{PGDP})_t + \underset{(2.32)}{0.0776}(u_{t-3} - \hat{w}_{t-4}) \qquad (10)$$

$R^2 = 0.907$, $\sigma = 0.035$, $LMF_4(2.57) = 1.22$, $S(23.68) = 8.25$

$ARCH(9.49) = 2.65$, $W(9.49) = 4.18$, $Z(2.2) = 0.81$

Here too the various specification tests are passed with ease. The coefficient on lagged w (ϕ_3 in equation (10)) should be negative if B "Granger causes" M. The coefficient on lagged u (ϕ_2 in equation (10)) should be positive if there is monetary accommodation according to which P "Granger causes" M. We found that ϕ_3 and ϕ_2 were equal and opposite to one another at lags four and three respectively. There is no inherent reason why these lags should be first order and the lag correlation in equation $(\hat{10})$ reflects goodness-of-fit criteria. This suggests that both B and P "Granger cause" M while from equation $(\hat{7'})$ M also "Granger causes" P.

Finally, we draw attention to the fact that equations $(\hat{8})$ and $(\hat{10})$ are estimated in first differences despite Table 1 which suggests that the degree of integration of M and P might be 2 or 3. The latter suggest that the ECMs might be estimated in terms of second or even third differences instead of first differences. While this would have guaranteed that all the variables in the ECM were stationary it would have restricted the dynamic form of the ECM in a way that might not have been desirable or intended. Faced with a similar dilemma Hall (1986) chose to estimate the ECM in first differences despite the fact that d = 2. We followed this precedent. Indeed, when the ECM was forced to include stationary transformations of all the variables (e.g. $\Delta^3 lnM$, $\Delta^2 lnP$, $\Delta lnGDP$ and $\Delta^3 lnB$) the results were unsatisfactory. Either the latter implies that the ECM hypothesis is rejected or equations $(\hat{8})$ and $(\hat{10})$ corroborate the first difference representation of the ECM. We prefer the second interpretation to the first. However, the moral seems to be that when variables are integrated to a relatively high degree the empirical testing of ECM is more hazardous than in the "standard" case where variables are assumed to be I(1).

Testing "Monetarism"

Equations ($\hat{7}'$) and ($\hat{8}$) are "monetarist" in the technical sense that only monetary variables directly affect the price level in both the short and long terms. Fiscal variables indirectly affect the price level through the link between fiscal policy and the money supply and via rational expectations that are implied by this linkage. However, fiscal variables, such as B, do not directly affect inflation in equations ($\hat{7}'$) and ($\hat{8}$).

Beenstock and Longbottom (1982) proposed a test of "monetarism" based on exclusion restrictions with regard to B in an ECM in prices. They showed that in the long run (i.e. when output and interest rates are at their equilibrium values) the general solution for the aggregate price level is of the form:

$$\ln P = \lambda_0 + \lambda_1 \ln M + (1-\lambda_1)\ln B + \lambda_2 \pi^e \tag{12}$$

In a "monetarist" model $\lambda_1 = 1$, i.e. only the money supply matters. More generally in a "Keynesian" model where $\lambda_1 = 1$ both money and bonds (and thereby fiscal policy) matter. Control of the money stock alone is not enough to control the price level. The proposed test therefore consists of testing for $\lambda_1 = 1$.

This test is closely related to the test proposed by Stein (1976). However, it is more general in the sense that if, as Barro (1974) suggests, government bonds are not part of net wealth we should find that $1-\lambda_1 = 0$. In this section we consider tests based on equation (12) within a cointegrated setting. The basic question is whether B is a valid element of the cointegrating vector for P, i.e. in addition to M in equation (7). The matter cannot be decided directly by adding a term in lnB to equation (7') because although "super consistent" the variance-covariance matrix is biassed. Drobney and Hall (1986) have proposed a nested test to decide the matter in the second stage rather than first stage.

They suggest the following procedure:

i) Re-run equation ($\hat{7}$') with the addition of $\ln B_t$ as a regressor. This equation is the equivalent of equation (12). Compute the residuals from this equation and call them v.

ii) Re-run equation ($\hat{8}$) with ($v_{t-1} - u_{t-1}$) as an additional regressor. If this additional term is significant we may conclude that B improves the ECM. If it is not significant we may conclude that $\lambda_1 = 1$ and the "monetarist" model is corroborated.

The first and second stage results from this exercise are as follows:

$$\ln P_t = \underset{(0.286)}{0.002} + \underset{(3.61)}{0.173\ln P_{t+1}} + \underset{(16.1)}{0.842\ln B_t} + \underset{(6.57)}{0.354\ln(M/B)_t}$$

$$- \underset{(10.93)}{1.343\ln GDP_t} + v_t \qquad (13)$$

$R^2 = 0.997 \quad DF(4.35) = 5.21$

$$\pi_t = \underset{(0.64)}{0.006} + \underset{(3.58)}{0.535\pi^e_{t+1}} + \underset{(3.36)}{0.476\Delta\ln \hat{M}_t} - \underset{(11.76)}{1.2\Delta\ln GDP_t}$$

$$- \underset{(4.97)}{0.542u_{t-1}} + \underset{(1.93)}{0.359(u_{t-1} - v_{t-1})} \qquad (14)$$

$R^2 = 0.909 \quad \sigma = 0.042 \quad LMF_4(2.57) = 2.14$

Equation (14) reveals that $(u_{t-1} - v_{t-1})$ is just significant at p = 0.05, suggesting from equation (13) that lnP is homogeneous to degree one in lnM and lnB and that $\lambda_1 = 0.428$.

This rejection of "monetarism" assumes that the two hypotheses are nested. This is true if all that is involved is the addition of lnB to the cointegrating regression and the addition of $(v_{t-1} - u_{t-1})$ to the second equation. An alternative procedure which is non-nested, compares a "monetarist" model with a "Keynesian" alternative. The latter is exemplified by equation (15):

$$\pi_t = \underset{(0.65)}{0.006} + \underset{(3.15)}{0.478\pi^e_{t+1}} + \underset{(2.31)}{0.397\Delta\ln(\hat{M}/B)} + \underset{(3.77)}{0.524\Delta\ln \hat{B}_t}$$

$$- \underset{(12.02)}{1.205\Delta\ln GDP_t} - \underset{(5.07)}{0.543v_{t-1}} \qquad (15)$$

$R^2 = 0.908 \quad \sigma = 0.0407 \quad LMF_8(2.18) = 2.38 \quad S(21.03) = 9.44$

Equations (15) and ($\hat{8}$) are non-nested since the former is based on v and the latter is based on u. In addition the derivative error correction terms are different. Godfrey (1984) has usefully reviewed the available methodologies for testing non-nested hypotheses, while Mizon and Richard (1986) have related non-nested tests to the Encompassing Principle. Here we seek to determine whether the "monetarist" model encompasses its "Keynesian" rival, whether the opposite applies or whether neither model encompasses the other.

Broadly speaking there are two groups of non-nested tests based on OLS and IV respectively. In the former case Godfrey recommends a Wald (W) test in preference to the alternative J, JA, and F tests. The JA-test is a 't' test on the fitted values from the alternative hypothesis as an explanatory variable in the maintained hypothesis. The F procedure is an F test on the explanatory variables from the alternative hypothesis as explanatory variables in the maintained hypothesis. The W test is based on a comparison of the error variance from the alternative hypothesis and the error variance based on a regression of the fitted values from the maintained hypothesis on the explanatory variables from the alternative hypothesis. Monte Carlo studies suggest that the Wald test is the most reliable of these tests.

Although equations (15) and ($\hat{8}$) are based on IV rather than

OLS we nevertheless report JA, F, and W tests. Non-nested tests for IV have been suggested by Gallant and Jorgenson (1979) and by Godfrey (1984). The former is based on a comparison of the sum of squared predicted values generated by the auxiliary regression proposed by Sargan (1958) for the residuals of the maintained hypothesis and the unrestricted hypothesis. The latter is based on a test of independence between the residuals from the maintained hypothesis and the instrumented explanatory variables from the rival hypothesis. Details of all of these tests are provided by Godfrey (1984).

Results for these non-nested tests are reported in Table 3 where in colunm A the "monetarist" hypothesis is tested against the "Keynesian" alternative while in column B the "Keynesian" hypothesis is tested against the "monetarist" alternative. The first test implied that the "Keynesian" model does not encompass its "monetarist" rival but nor does the "monetarist" model encompass the "Keynesian" model. A similar conclusion (but less strongly) is implied by the JA test. The Wald test suggests a different picture in which both theories encompass each other in which case neither is likely to be valid.

Tests 4 and 5 are IV tests and as such failure implies either that the hypothesis is invalid and/or that the instruments are invalid. Test 4 suggests that the "monetarist" model is encompassed by its "Keynesian" rival. However, we were unable to apply the GJ test to the "Keynesian" model since the computed value of Chi-squared turned out to be negative. In our view this may arise when the instruments are particularly invalid in the restricted model while the opposite applies in the case of the unrestricted model. Indeed the S tests reported below equations ($\hat{8}$) and (15) respectively suggest that this may be at issue. Finally, the test proposed by Godfrey (1984, p. 79) implies that neither hypothesis encompasses the other. In this context it is worth noting that the test turns out to be very sensitive to the generalized matrix inversion algorithm with SAS providing more accurate test values than TSP.

The results in table 2 reject the notion that one hypothesis encompasses the other. However, equation (15) fails the LMF test suggesting perhaps that the decision (if one has to be made) should go in favour of the "monetarist" model. However, our focus here has been more concerned with the application of different non-nested tests in a cointegrated setting rather than with the search for an unambiguous explanation of Israeli inflation.

IV. Conclusion

We have already drawn attention to policy conclusions in section I. Here we address our attention to certain econometric issues arising out of the paper. In contrast to previous efforts at cointegration we sought to work with a model (albeit a simple one) rather than within a single equation context. Although the price equation was clearly cointegrated (after detrending) the money supply equation proved more difficult. This raises the question of stationarity tests for systems of equations rather than single equations. However, such tests are currently not available. Nevertheless, we found that the technique of cointegration proved useful in tackling the data especially in Israel were they are so highly non-stationary. We also found that it made very little difference whether the variables in the cointegrating vector were first detrended (as reported) or whether they were left in their original state (as not reported) but with an added time-trend in the cointegrating regression.

A shortcoming of cointegration concerns hypothesis testing of the cointegrating vector. Such tests cannot be carried out directly because the cointegrating regression is not efficient even if it may be "super consistent". The tests therefore have to be carried out indirectly thereby creating substantial difficulties. Indeed whatever the benefits of cointegration may be a disadvantage consists of the inherent awkwardness in comparing different hypotheses.

Finally, in the ideal case the variables in the cointegrating vector are all I(1), or at least meaningful combinations of them are I(1). In this case all the variables included in the ECM must be I(0). If, in practice, the variables in the cointegrating vector are greater than I(1), as they were in our case, the investigator is confronted by two related dilemmas. The first is whether or not to apply restrictions in the cointegrating regression that force the transformed data to be I(1). For example, if lnM and lnP happen to be I(2) while lnM-lnP turns out to be I(1), should linear homogeneity between M and P be imposed on the data to make life easier or should homogeneity be tested? In our case we opted for the hard life.

The second dilemma relates to the estimation of the ECM. Having opted for the hard life does one then restrict all the variables in the ECM to be I(0) forcing possibly undesirable restrictions in the process in order to exploit the advantages of stationary regressors, or does one relax these restrictions at the cost of introducing nonstationary regressors into the ECM? Here, we resolved these dilemmas by following the precedent of Hall (1986) in opting for the hard life but avoiding its consequences.

RATIO OF INTERNAL DEBT TO M4

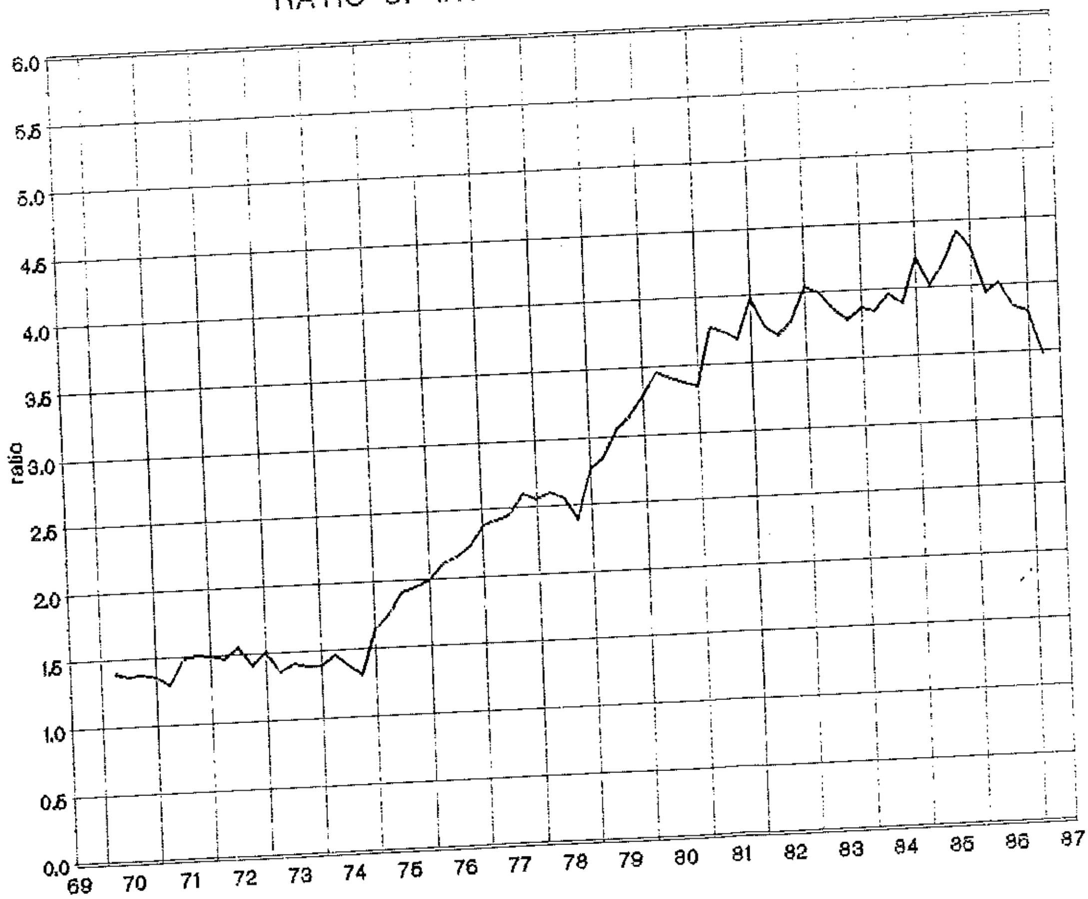

FIGURE 1

MONEY VELOCITIES 1970-1987

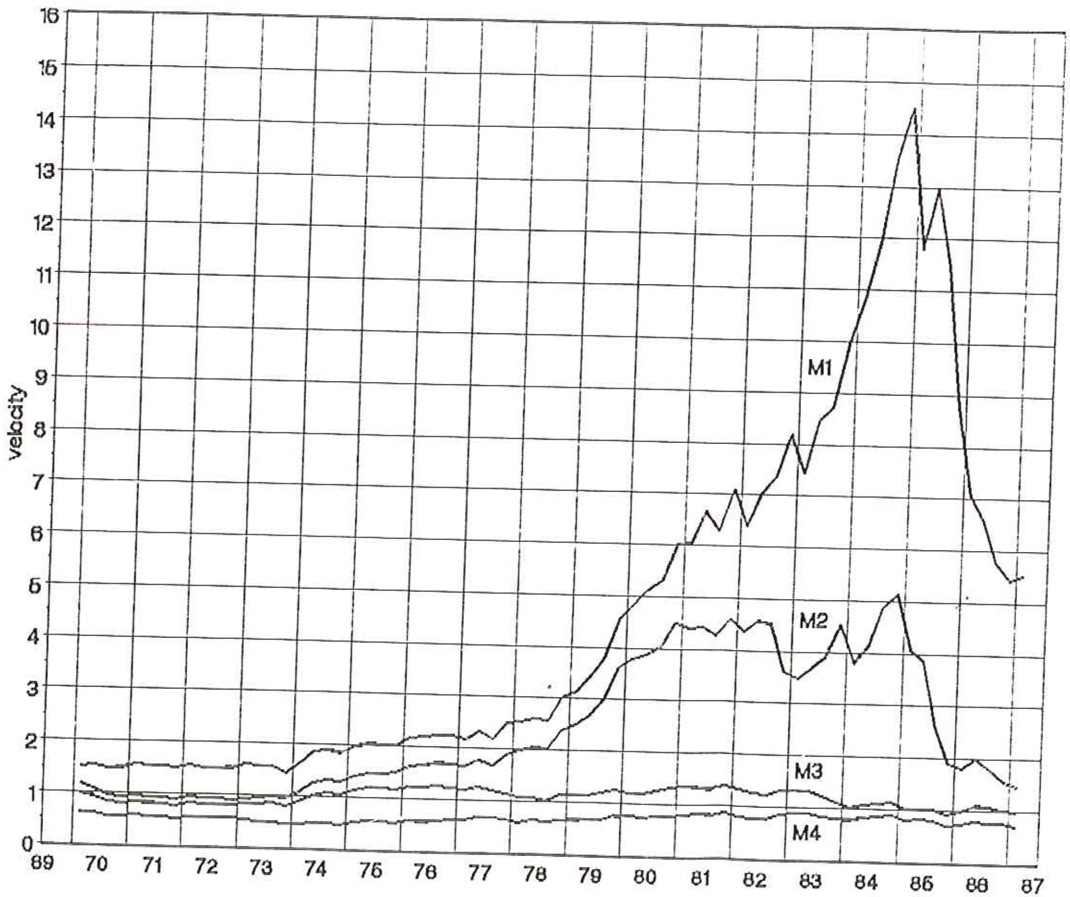

FIGURE 2

INTERNAL DEBT AND THE PSBR 1971-1986

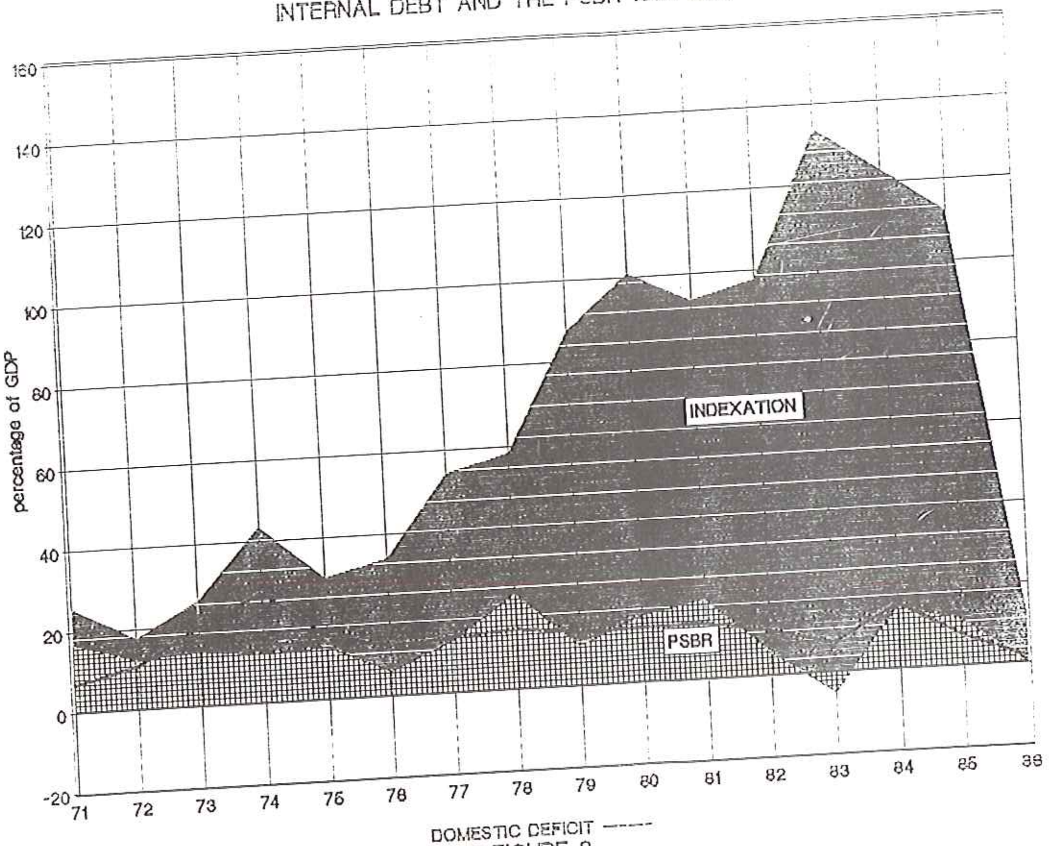

FIGURE 3

DOMESTIC AND TOTAL DEFICIT 1970-1987

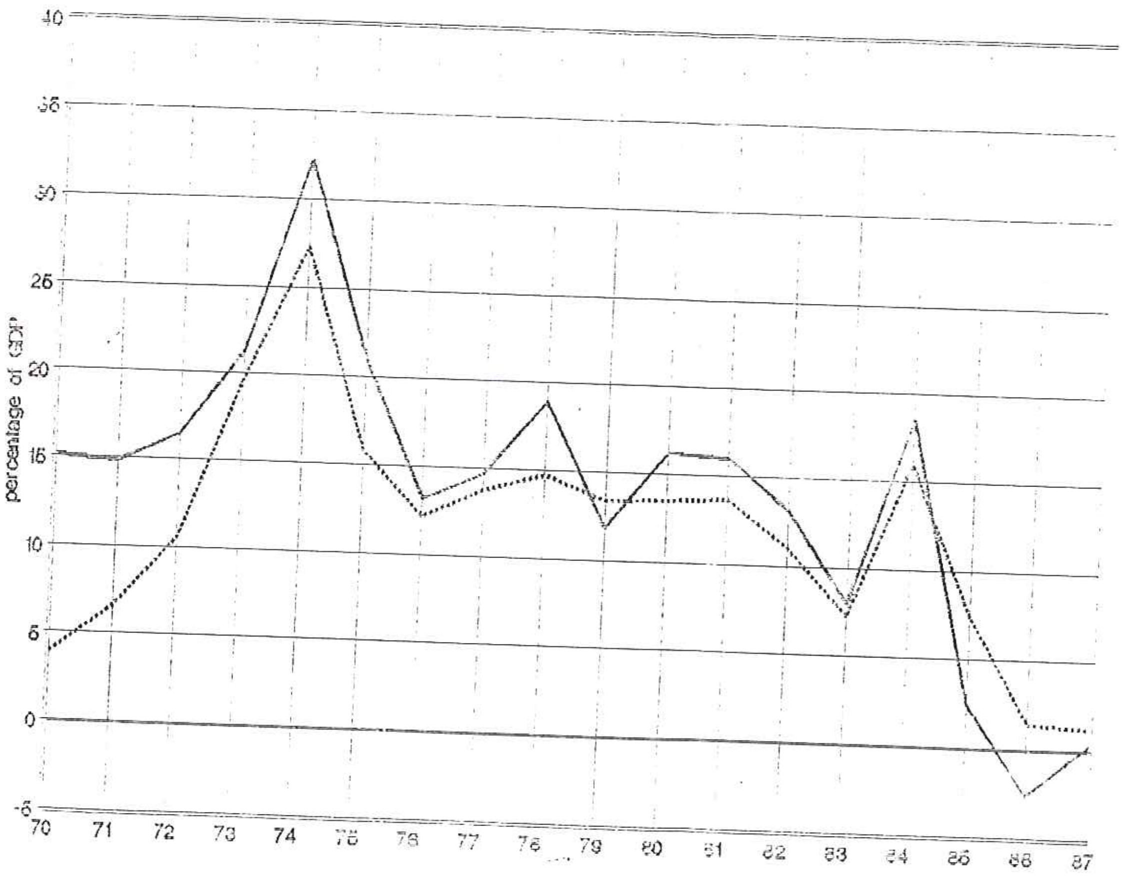

FIGURE 4

Table 1: Orders of Integration

	DF	ADF
lnP	2*	3
lnM	3	3
lnB	2	3*
lnY	1*	2
ln(P/M)	1	2
ln(YP/M)	2	2
ln(B/M)	2	2

Notes: ADF is assumed to be third order. In first four rows variables are expressed as deviations from semi-logarithmic time trends.
* denotes suggested value of d based on autocorrelation properties of DF regression.

Table 2: Instrument List (lag order)

Endogenous Variables/Equations

Instruments	$\ln M_t$/8, 14 $\ln B_t$/15 $\ln(M/B)_t$/15	$\ln B_t$/10 $\ln(PGDP)_t$/10	π^e_{t+1}/ 9, 8, 14, 15
(PSBR + R)/PGDP	0	0	0
ΔlnM			0
ΔlnPOIL	0, 1, 2	0, 1, 2	1
π^*	0, 1	0, 1	1
lnGDP	0, 1	0, 1	
ΔlnM*	0, 1	0, 1	
u	3	2, 3	
w	2	1, 2	

Notes: POIL = world oil price \$, π^* = inflation in industrialized countries, M* = world money stock. E.g. u_{t-3} is an instrumental variable in equations (8) and (12) while u_{t-2} and u_{t-3} are instrumental variables in equation (10). The choice of instrumentation is based on the Sargan (1958) test for instrument validity.

Table 3

Non-Nested Tests

Maintained Hypothesis

Test	A "Monetarism"	B "Keynesian"
1. F (F)	1.44 (2.37)	1.51 (2.53)
2. JA ('t')	1.80 (2.00)	1.78 (2.00)
3. Wald (Chi^2)	12.86 (3.84)	10.02 (3.84)
4. Gallant & Jorgensen (Chi^2)	7.21	-
5. Godfrey (Chi^2)	0.31 (11.07)	0.68 (9.49)

Note: Critical values at p = 0.05 are indicated in parentheses. If the calculated value exceeds the critical value the hypothesis is rejected.

Data Appendix

M M_4, average of end months, NIS millions, Monthly Bulletin of Statistics (MBS)

P GDP deflator at market prices, 1980=100, MBS

GDP GDP at constant market prices, 1980=100, MBS

B Internal debt, MIS millions, unpublished Bank of Israel, See Elkayam, Tal and Yariv (1987)

POIL Price of oil, Es Sidra, $/bl, International Financial Statistics (IFS)

M* World Money Stock, local currency, 1980=100, IFS

F Purchase of foreign currency by the private sector, NIS millions, MBS

π^* Inflation (CPI) in industrialized Countries, percent p.a., IFS

Note: The relationship between internal debt (B) and total debt (D) may be understood as follows. The overall fiscal deficit (DEF) is equal to the domestic deficit (DEF_D) plus the external fiscal deficit (DEF_E). The latter is defined as external procurment minus intergovernment transfers which in Israel are substantial. Hence

$$DEF = DEF_D + DEF_E$$

The financing counterpart of the external deficit which must be in foreign currency is:

$$DEF_E = \Delta(L - R) - F$$

where

L = external liabilities of the Israeli government

R = gold and foreign exchange reserves

F = purchases of foreign exchange by the private sector

The financing courterpart of the domestic fiscal deficit is

$$DEF_D - F = \Delta B$$

Here for clarity we assume that N = R = I = 0 in equation (11). On this basis it follows that:

$$DEF = \Delta(L - R + B)$$

and

$$D = L - R + B$$

Since in the text we use data for B rather than D it follows that our results reflect the domestic rather than the overall fiscal deficit. On fig. 4 we plot annual data for the overall deficit and the domestic deficit. The external deficit affects the real exchange rate as suggested by Beenstock and Kahanaman (1988). The internal deficit matters for inflation along the lines suggested in the present paper.

REFERENCES

Barro, R., "Are Government Bonds Net Wealth?", Journal of Political Economy, 1974.

Beenstock, M. and M, Kahanaman, "The Trade Balance and the Real Exchange Rate in Israel, 1955-1986", Bank of Israel, July 1988.

Beenstock, M. and A. Longbottom, "Money, Bonds, and Prices in the United Kingdom", Economica, November 1982.

Brezis, E. et al, "The Interaction between Inflation and Monetary Aggregates in Israel" Bank of Israel Economic Review, November, 1983.

Bruno, M. "Israel's Stabilization : The End of the "Lost Decade"? The Economic Quarterly, February 1987 (Hebrew).

Bruno M. and S. Fischer, "The Inflationary Process: Shocks and Accomodation" cap 17 in Y. Ben-Porath (ed.), The Israeli Economy: Maturing Through Crisis, Havard University Press, 1986.

Bruno, M. and S. Piterman, "Israel's Stabilization: A Two Year Review", Working Paper 2413, N.B.E.R., 1987.

Drobney A. and S. G. Hall, "A Suggested Procedure for Testing Equilibrium Specifications in the Granger and Engle Two Step Estimation Framework", National Institute of Economic and Social Research, London, 1986.

Elkayam, D., Y. Tal, and D. Yariv, "The Effect of Internal and External Debt on Consumer Expenditure in Israel: 1971-1984", Bank of Israel Economic Review, December 1987.

Engle, R. F., "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation:, Econometrica, pp. 987-1008, 1982.

Engle, R. F. and C. W. J. Granger, "Cointegration and Error Correction: Representation, Estimation and Testing, Econometrica, pp. 251-276, 1987.

Engle, R. F. and B. S. Yoo, "Forecasting and Testing in Cointegrated Systems", Journal of Econometrics, pp. 143-159, 1987.

Gallant A. R. and D. W. Jorgensen, "Statistical Inference for a System of Non-linear Implicit Equations in the Context of Instrumental Variable Estimation", Journal of Econometrics, pp. 275-302, 1979.

Godfrey, L., "On the Uses of Misspecification Checks and Tests of Non-Nested Hypotheses in Empirical Econometrics", Economic Journal, Supplement, 1984.

Hall, S. G., "An Application of the Granger and Engle Two-Step Estimation Procedure to UK Aggregate Wage Data", Oxford Bulletin of Economics and Statistics, pp. 229-239, 1986.

Kleiman, E. and T. Ofir, "The Adjustment of the Quantity of Money to Changes in the Price Level in Israel, 1955-1965", Bank of Israel Economic Review, August 1972.

Kleiman, E. and T. Ofir, "The Effects of Changes in the Quantity of Money on Prices in Israel", Bank of Israel Economic Review, January, 1975.

Leiderman, L. and A. Razin, "Government Policies and the Dynamics of Inflation and Consumption: Israel 1980-1985", Economic Quarterly, February, 1987 (Hebrew).

Liviatan, N. and S. Piterman, "Accelerating Inflation and Balance of Payment Crises: Israel 1973-1984 in Y. Ben Porath (ed) op cit 1986.

Melnick, R. "Prices, Wages and Import Prices in Israel: 1970-1983", Journal of Applied Econometrics, pp. 53-67, 1988.

Melnick, R. "The Demand for Liquid Assets in Israel: 1970-1985", Bank of Israel, April 1988.

Melnick, R. and M. Sokoler, "The Government's Revenues for Monetary Creation and the Inflationary Effects of a Decline in the Rate of Growth of GNP", Journal of Monetary Economics, pp. 225-236, 1984.

Minford, A. P. L. and A. A. Walters, "Modelling the Role of Government Deficits in Developing Countries", World Bank, Mimeo, 1987.

Minford P., et al, "The Liverpool Macroeconomic Model of the United Kingdom", Economic Modelling, January, 1984.

Mizon, G. E. and D. F. Hendry, "An Empirical Application and Monte Carlo Analysis of Tests of Dynamic Specification", Review of Economic Studies, January, 1980.

Mizon, G. E. and J. F. Richard, "The Encompassing Principle and Its Application to Testing Non-Nested Hypotheses", Econometrica, pp. 657-678, May, 1986.

Offenbacher, A. "Introduction to Empirical Research on the Demand for Money in Israel", Bank of Israel Economic Review, November, 1985.

Salkever, D. S., "The Use of Dummy Variables to Compute Prediction, Prediction Errors and Confidence Intervals", Journal of Econometrics, pp. 393-397, 1976.

Sargan, J. D., "The Estimation of Economic Relationships Using Instrumental Variables", Econometrica, pp. 393-415, 1958.

Sargent, T. S., "Macroeconomic Theory", Academic Press, 1979.

Sargent, T. S. and N. Wallace, "Some Unpleasant Monetarist Arithmetic", Quarterly Review, Federal Reserve Bank of Minneapolis, Fall, 1981.

Stock, J. "Asymptotic Properties of Least Squares Estimations of Cointegrated Vectors", Econometrica, pp. 1,035-1,056, 1987.

Wallis, K. F., "Econometric Implications of the Rational Expectations Hypothesis", Econometrica, pp. 49-73, 1980.

West, K. D., "Full Versus Limited Information Estimation of a Rational Expectations Model: Some Numerical comparisons", Journal of Econometrics, pp. 367-386, 1986.

Wickens, M., "The Efficient Estimation of Economic Models With Rational Expectations", Review of Economic Studies, pp. 55-67, 1982.