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ECONOMETRICS AND THE DESIGN OF ECONOMIC REFORM

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ABSTRACT

The concept of Economic Reform is described as a planned shift from one, Pareto inefficient, but quasi-stable, equilibrium (or 'trap') to a new Pareto superior equilibrium which is, or is designed to become, stable too. The concept is applied to recent 'shock' stabilization programs, with special reference to Israel, where the economy was credibly shifted from a 3-digit inflationary process with considerable inertia, to relative price stability with higher real growth, at only small adjustment costs, by means of a 'heterodox' plan. This two-pronged stabilization program consisted of a substantial correction of budget and external account 'fundamentals' together with a synchronized, wage-price-exchange rate freeze. The idea is theoretically rationalized within a simple dual equilibrium inflation model, for which some econometric estimates are also given.

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Econometrics and the Design of Economic Reform*

Implementation of a plan of economic action often precedes systematic theoretical rationalization of it. Given the problem to be attacked the policy planner may think of an idea based on some a priori 'sensible' theoretical arguments that have not yet been fully worked out. A set of numbers may be attached (by methods which might horrify many statistical econometrician members of this Society). The idea may then become a program of action to be adopted by a government, after being massaged, if not mutilated, by the political process. And then, lo and behold, the program sometimes works in practice. Only later may a body of systematic theory and quantitative empirical testing develop to which the program and its implementation can be subjected ex-post and may be improved upon for future reapplication. Like in other areas of applied economic theory, the field of enquiry within which this Address is embedded, that of Economic Policy Design often has to deal with ad-hoc programs or rules of action which evolved through practice and only later received a seal of approval of proper science.

The general area of my choice is one that has fascinated me ever since I became a member of this learned society about thirty years ago and was actively involved, at that time, in trying to design programs for long-term development planning as well as short-term national budgeting in my own country. I asked myself

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At this point I would like to remind you of the definition of the scope of Econometrics and of our Society as originally stated by its founders in 1930. It is definitely not statistical econometrics in the narrow sense of the word but "Any activity which promises ultimately to further unification of theoretical and factual studies in economics shall be within the sphere of interest of the society". Ragnar Frisch in the early years of the Society stated (1933) "Experience has shown that each of these three view-points of statistics, economic theory and mathematics is a necessary, but not by itself a sufficient condition for a real understanding of the quantitative relations in modern economic life. It is the unification of all three that is powerful and...that constitutes econometrics."

Thus the development of input-output analysis and that of static and dynamic linear programming models in development planning in the 1960's comes under a broader definition of econometrics, as applied to policy design. There were parallel developments in decision theory under uncertainty that have greatly contributed to the broadening of the scope of this general field. Two of my illustrious predecessors devoted their presidential addresses to some of the most pertinent issues - Arrow in 1956 ("Statistics and Economic Theory") and Dreze in 1970 ("Econometrics and Decision Theory").

By the end of the 1970's the whole area of economic policy design had certainly reached a much more sophisticated phase (at least in its theoretical approach, less so in empirical implementability) than was originally set out by Tinbergen a quarter of a century earlier. However, it had one major drawback. The policy maker in most of policy designs was an omnipotent government much like the control theory vision of the economy as a dumb machine planned and run by a clever engineer to achieve a well defined objective.

The major agents in the economy, as we all know, talk back to the government. Unlike the dumb machine they can incorporate anticipated government action into their rules of behaviour, a fact that a policy designer has to take into account. Tinbergen in his writings of the 1950's was well aware of the problem of policy design when "there is more than one policy maker" and even analyzed an example of government versus the trade unions in a game-like situation to which we shall come back in our subsequent discussion (see "Centralization and Decentralization in Government Policy", 1954). This line, however, was not seriously and systematically followed up until very recently when game theory made its successful entry into macroeconomics (after staging its re-entry, this time successful, into the mainstream of economic theory).

Another parallel development, that of the literature based on the rational expectations approach (having its origins in Muth (1961) brought up a critique of the use of conventional backward-looking econometrically estimated coefficients when applied to forward-looking policy designs. This is the so-called Lucas (1976) critique. A very relevant example in the present context would be a misguided attempt to plan the sharp reduction of inflation within a model based on time series equations of past inflationary behaviour. Here is a case in which a back-of-an-envelope calculation based on simple input-output wage and import coefficients can give (and has been shown to give, at least in our recent experience) much better guidance than a backward looking model based on inflationary inertia.

The same new approach to economic policy design also brought up the issue of **dynamic inconsistency** (Kydland and Prescott, 1977) and led to the discussion of **rules versus discretion** in policy design (Barro and Gordon, 1983) and systematically tackled the issue of **government credibility and reputation** all of which also have a repeated game theory grounding (Kreps and Wilson, 1982, Backus and Driffill, 1985).

II. Equilibrium Trap and Economic Reform

It is in the spirit of both of these later developments that I would now like to take up one sub-class of policy designs - that of economic reforms. Let me again turn back to Tinbergen for definitions. He distinguished among three types of policy changes varying by the degree of change in the underlying policy structure. First, **quantitative** policy constitutes a quantitative change in given instruments of policy (e.g., changes in tax rates). Next comes his definition of a **qualitative** policy change, which is a change in structure keeping the foundation intact (e.g., a change in the type of taxes implemented). Finally there is **economic reform**, "being equivalent to changes in foundations" . Again using Tinbergen's words (1956) "changes in more fundamental features of social organizations are the most far-reaching types of policy". What is sometimes called a 'regime change' also falls under the same heading.

One conventional, or 'orthodox', element in these programs was an attempted reduction in the government deficit (coupled with an initial devaluation and a monetary squeeze) which is a correction of 'fundamentals'. In the case of Israel the deficit came down from 12-15 percent of GNP throughout the preceding decade to a virtually balanced budget. A conventional flex-price market clearing approach would say that the correction of fundamentals is all that the government should have been required to do, implying that the market would do the rest of the adjustment to a lower inflation rate. Yet in all three cases there was another major, though less conventional, element (and one that had earned these episodes the term 'heterodox' programs) - an attempt at a synchronized exchange rate, wage and price freeze. In the case of Israel it took the form of an explicit social contract between the three major parties to an incomes policy package - the trade unions, the employers' association and the government. What is the theoretical rationale for such a step? Judging from our own experience it is a case in which intuition and some hand-waving arguments have preceded systematic theory[3] - some vague ideas about affecting the public's expectations, establishing government credibility and the need for initial synchronization of nominal magnitudes, under inflationary inertia.

To convince oneself of the rationality of applying a certain policy design and moreover, to convince one's colleagues in the profession, there is obvious need for a more firm theoretical grounding. This is particularly true when controversial policy measures such as a wage and price freeze (including temporary price controls) are involved. While I am not certain that the following will eventually prove an adequate (let alone the only) way of going about the theoretical problem, I will here attempt a sketch of the basic idea, which is an offshoot of work that I have been doing jointly with Stanley Fischer of MIT. It still requires a more thorough working out.

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3) I had proposed a very similar idea at an earlier stage (Bruno, 1981), with an attempt to adapt the lessons of historical hyperinflation experience (see Sargent, 1981) to the different local scene.

III. Multiple Inflationary Equilibria and Their Stability

The design of a stabilization program that we are discussing here involves two major components - the removal of the source of inflationary finance on the budget deficit side and the simultaneous synchronization or 'freeze' of nominal price variables on a new low level of inflation. Two important questions immediately arise - first, can one rationalize theoretically how and when both elements of the program are absolutely indispensable for rapid disinflation? Secondly, can a new low equilibrium level of the inflation rate be sustained and what are the conditions for its stability?

In order to tackle both these questions I will extend an analytical framework based on deficit finance by money and bonds which Stanley Fischer and I have used in an earlier empirical paper (1986) and whose theoretical properties were developed in other papers (1984, 1987).

The underlying idea, which in itself is not new, is that a given amount of seigniorage revenue can be collected at either high or low rates of inflation [see Sargent and Wallace (1984), and Liviatan (1984)]. The dual equilibria - a reflection of the Laffer curve - imply that an economy may be stuck in a high inflation equilibrium when, with the same relative budget deficit, it could be at a lower inflation rate. Which is the relevant equilibrium depends on how economic agents form expectations and adjust prices and other nominal magnitudes (wages, money and/or exchange rates) while learning about the system. It is known that under adaptive expectations (with sufficiently low coefficient of adaptation) the low inflation rate will be stable and the upper one unstable while the roles are reversed for the case of rapid adaptation or fully rational expectations [see Aurenheimer (1973); Evans and Yarrow (1981); and Bruno and Fischer (1984)]. The novel and more interesting model to be suggested here, however, is the empirically relevant non-linear case in which adjustment of a key variable like the exchange rate (and therefore wages and prices) is adaptive with coefficient of adjustment that itself rises with the rate of inflation. In this case both equilibria could turn out to be stable for some parameter values. This has interesting implications for the nature of stabilization policy. We shall skip technical detail here and consider only those features which are essential for the empirical applications that follow (for some additional detail see the Appendix to this paper).

The first point to note is that fiscal policy considerations may determine the average growth rate of money through the government budget constraint. Considerting first the closed economy, thus leaving aside foreign finance (see below), we can write the government budget constraint as:

(1) $G - T = d\,Y = \dot{H}/P + \dot{B},$

where G is government expenditure, T are taxes, Y is real GDP, d is the ratio of the deficit to GDP, H is base money, B are real indexed bonds, and the dot indicates the change in a variable.[4] Interest payments on bonds are included in G.

In steady state, the ratios H/(PY) and B/Y are constant. Accordingly in steady state the growth rate of high-powered money, Θ, or $\dot{H}/H$, is equal to the inflation rate (π) plus the growth rate of output (n):

(2) $\Theta = \pi + n.$

Similarly, in steady state, the growth rate of bonds is equal to the growth rate of output (n). Accordingly, in steady state the government budget constraint becomes

(3) $d = (\pi + n)h + nb,$

where h denotes the ratio of the stock of real high-powered money to nominal GNP (H/PY), and b the ratio of bonds to GNP (B/Y). Let v be the ratio of net wealth to GNP, where $v = h + b$. Then,

(4) $\pi = (d - nv)/h.$

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4. We here suppress the difference between bonds indexed to the domestic price level and to the exchange rate, and omit direct government sales of foreign exchange, which can be added separately (see below).

The use of the government budget constraint (1)or (4) does not necessarily imply that the government consciously decides on a particular growth rate of high-powered money as a means of financing its budget deficit. Rather, in the present context it is more realistic to assume that the government turned to printing money as its last resort in budget-financing. First it decided what it needed to spend and how much it could raise through taxes (and in the open economy - how much it could borrow abroad); then it sold as many bonds as it could at the existing real interest rate and financed the rest by printing money. As we shall see relatively small changes in the deficit could be consistent in the long run with major changes in the growth rate of H and thus of inflation. However, high real costs of transition from high inflation to low inflation could inhibit such a change.

Equation (4) gives one approach to analyzing the determinants of growth rate of the monetary base and thus, in steady state, of the inflation rate.[5] The term nv in the numerator of (4) is the amount of the deficit that can be financed by the government through the sale of bonds and printing of money without increasing their respective ratios to GNP. The more rapid the growth rate of output, the greater the share of the deficit that can be financed in a non-inflationary way. The larger the government deficit, d, the higher the inflation rate in the steady state. And the larger the monetary base, the lower the inflation rate need be.

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5) It can be shown that out of the steady state the analogous equation is $\pi = (d - vn - \dot{v})/h$, where $\dot{v}$ is the time change of the net wealth ratio (v).

In the open economy the same equation holds, providing it is reinterpreted to represent the ratio of domestic government finance to GNP.[6] It is in this sense that equation (4) will be applied to the Israeli data in Section III (see Table 4).

To embed equation (4) into a behavioural model we have to add assumptions pertaining to the demand for money and bonds. Assume, for simplicity, that consumption and savings depend on net wealth and the real rate of interest, and that the latter is fixed exogenously (by world markets or by government intervention in the market for bonds, not an unrealistic assumption in the Israeli case). This means that net injection to the money base $d_1 = (d - vn)$ can be considered as depending mainly on policy variables. However, the amount that the public wishes to hold in the form of base money (h) will depend on expected inflation, (π_e).

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6) In the open economy the budget constraint (1) has to be extended to include both the domestic and foreign deficits. Say d_h is the domestic deficit ratio to GNP, d_f is the ratio to GNP of the foreign deficit (net of unilateral transfers) and $\dot{B}_f$ is the change in net government debt (net of the change in exchange reserves and including interest payments). We have

$$(1a) \quad (d_h + d_f)Y = \frac{\dot{H}}{P} + \dot{B} + \frac{E\dot{B}_f}{P}$$

where E is the exchange rate. Thus,

$$(1b) \quad d_hY = \frac{\dot{H}}{P} + \dot{B} + [\frac{E\dot{B}_f}{P} - d_fY]$$

Equation (1b) now says that the domestic deficit (d_hY) is financed not only by domestic finance (money and bonds) but by net sales of foreign exchange by the government to the public sector (the term in square brackets).

Thus equation (1) continues to hold providing we reinterpret d' to be the 'domestic finance ratio' $(\dot{H}/P + \dot{B})/Y$, which according to equation - (1b) is the difference between the domestic deficit ratio d_h and the part that is financed by net foreign exchange sales to the public ($E\dot{B}_f/PY - d_f$).

Assume that the demand for unit real base money h (H/PY) depends negatively on expectated inflation (π_e) (again suppressing the real rate of interest, for simplicity) and we shall choose an empirically tested semi-logarithmic (Cagan) demand function:

5) $$h = \exp(-\alpha\pi_e).$$

Figure A depicts equations (4) and (5) in the space of H and π (or π_e).[7] Curve d, a simple hyperbola, asymptotic to the axes, shows the combinations of money demand and steady state inflation consistent with a given net deficit injection ratio d_1. Curve h shows the demand for money as a function of inflationary expectations.

In steady state inflationary expectations are the same as actual inflation and equilibrium may thus, in principle, take place at two intersection points A or B. If the lower intersection is stable, then an increase in d_1 (i.e. a rise in the domestically financed deficit, d_1 or a fall in the rate of growth, n) showing in Figure A as a shift from the d curve to the d' curve will involve an upward shift in steady state inflation to point A'.

If there is an exogenous downward shift in the demand schedule for money (due to the introduction of money substitutes, e.g,. foreign exchange-linked bank deposits)[8] this will show as a leftward shift in the h curve to h' and a further increase in long run inflation to C'. However, points such as A, A' or C'

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7) This is the framework originally employed by Liviatan (1984). In joint work with Stanley Fischer we have mainly carried out the analysis in the space of π_e and Θ (growth rate of nominal money) or π_e and π.(See Appendix).

8) This was a practical reality in the case of Israel and an old tradition in inflationary situations leading to hyper-inflation [(see post-Second World War Hungary (Bomberger and Makinen, 1983)].

are low inflation equilibria having respective dual high inflation equilibria B, B' or D' which are consistent with the same deficit injection ratio (d for A, B and d' for A',B' or C',D', respectively). The upper equilibria are inefficient (i.e., on the 'back' side of the Laffer curve) in the sense that the elasticity of demand for money at those points is above unity and inflation could be reduced by an <u>increase</u> in the deficit. For example. starting from equilibrium at point B' on h and d' a further rightward shift of the curve d' to d* will reduce inflation to the point A* at which the inflation tax is optimal [Friedman (1971)]. A further increase in the deficit will imply no intersection at all and inflation may rise ad infinitum.

The above discussion brings us to the question of dynamics of adjustment from one equilibrium, when there is an outside disturbance, to a new equilibrium. Suppose expectations are adaptive:

(6) $\dot{\pi}_e = \beta(\pi - \pi_e)$.

Time differentiation of equation (5) gives

(7a) $\Theta - \pi - n = -\alpha\dot{\pi}_e$.

Substituting for π from equation (6) gives the equation of motion for π_e:

(8) $\dot{\pi}_e = (1 - \alpha\beta)^{-1} \beta (\Theta - n - \pi_e)$

where $\Theta = d \exp(\alpha\pi_e)$

As is shown in the Appendix, and can be seen from equation (8), the stability of the low inflation equilibrium (A) depends on the product of α (the semi- elasticity of demand for money) and β (the adaptation coefficient) being less than 1. If $\alpha \cdot \beta > 1$ the low level equilibrium becomes unstable and the high inflation equilibrium (B) becomes the stable one [this, at the limit, is also the case for fully rational expectations, as Sargent and Wallace (1987), have shown].

It is important to point out that the only rationale for the gradual adjustment rule given in (6) is to introduce friction in the adjustment of some nominal variable. The adaptive expectation assumption on prices is thus only given for illustration purposes. Very similar results are obtained on the assumption of rational expectations when friction comes from lagged adjustment of money balances (see Bruno and Fischer, 1987) or from the fiscal lag (see Kiguel, 1987). Below we turn to an open economy application with gradual exchange rate adjustment performing that very same role. These examples show that stability or instability of an inflationary equilibrium may be endogenous to the choice of an operating rule for policy.

Let us now return to our simple model in which the argument has so far been entirely abstract. A further alteration of this model and a particular interpretation of the variable π_e turn it into one which is both applicable for policy and particularly relevant for the process of high inflation and a disinflation program such as the Israeli one (or, for that matter, the recent Argentinean or Brazilian programs).

First consider the case in which the ß coefficient is itself positively dependent on inflation or inflationary expectations. What this means is that $\alpha \cdot \beta$ may be below 1 at low inflation rates and eventually rise above 1 for high inflation rates. Say there is a critical inflation rate of π^* such that $\beta(\pi^*) = 1/\alpha$. Then we have the following possibilities:

(a) $\pi_A < \pi_B < \pi^*$ A stable, B unstable.

(b) $\pi^* < \pi_A < \pi_B$ A unstable, B stable

(c) $\pi_A < \pi^* < \pi_B$ Both A and B are stable.

Case (c) is the one shown in Figure A for the smaller budget deficit d while for the upper curve d' both equilibria lie above π^* and thus correspond to case (b). Suppose for some reason the economy is stuck at the high deficit and high inflation equilibrium point B' which is stable. The point B' is a real trap. A mere cut in the deficit will eventually lead the economy to a high inflation equilibrium B (which, of course, is even less efficient than having stayed at B'). On the other hand, keeping fiscal policy invariant (namely a fixed injection ratio d_1) but attempting a freeze on prices so as to jump back to the low inflation point A' will not work either as long as A' is an unstable equilibrium (being above the critical π^* rate). Only a combined budget cut and price freeze will get us down to the low inflation equilibrium A which will be stable if $\pi_A < \pi^*$.

IV. Dynamics of Inflation in the Open Economy

To make the argument of the previous section applicable to the case at hand let us reinterpret π_e for an open economy to be represented by the rate of devaluation ($\varepsilon = \dot{e}$), on the assumption that the actual adjustment of the exchange rate by the authorities, which is also the rationally expected rate of devaluation, follows a crawling peg rule, in which the rate of devaluation is adjusted (other than through shocks - see below) to the lag between the rate of wage inflation (w) and the rate of devaluation:

$$(9) \qquad \dot{\varepsilon} = \beta_1 (w - \varepsilon).$$

The rationale for this adjustment rule comes from supply of exports (or import substitutes) in the current account. Whenever the real (foreign-exchange deflated) wage departs from an equilibrium rate, the loss (or gain) in competitive power will induce an adjustment in the rate of devaluation. This adjustment is not instantaneous because the signals on wages are not immediately obvious. There may be information lags between the time wages are paid and the exchange rate is adjusted (a few months in most cases) and too frequent adjustment of the exchange rate in face of variable wage behavior may be costly. At the same time it makes sense to assume that the coefficient of adjustment β_1 will rise with ε, since the cost of error in terms of foreign exchange losses (or gains) mounts with the rate of expected inflation (represented by ε).

Next assume, for analytical convenience, that wage adjustment follows the simple rule

$$(10) \qquad w = \Phi\pi + (1 - \Phi)\varepsilon.$$

Equation (10) implies that wages are indexed partly to actual inflation (π) and partly to the exchange rate.[9]

If we take the time unit over which rates of change (w, π, ε) are defined as discrete but small, say a quarter, then the wage indexation coefficient (Φ) will itself depend on the formal indexation lag, which we know tends to get shorter and shorter in the process of high inflation (see next section for evidence). Thus Φ itself will rise with inflation and we may assume $\Phi'(\varepsilon) > 0$.

From (10) we get $w - \varepsilon = \Phi(\pi - \varepsilon)$. Substituting into equation (9) we have

(11) $\dot{\varepsilon} = \beta(\varepsilon)(\pi - \varepsilon)$,

where $\beta = \Phi \cdot \beta_1 = \beta(\varepsilon)$. and $\beta' > 0$

The adjustment rule (11) could also be derived directly [without going through (9) and (10)] from an alternative tradable/non-tradable goods model. In that case, however, a separate wage-inflation rate link would have to be written down, for a discussion of the wage/exchange rate policy game (see below). In our empirical illustration we consider both the components as well as a direct estimation of (11).

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9) The rationale for equation (10) can be based on the argument that ε, in a high inflation context, comes close to representing inflationary expectations. Alternatively (10) will be relevant in a context in which π represents prices of home goods and ε those of importables. Under the latter interpretation, however, there is no reason why the Φ coefficient should rise with inflation. The role of unemployment in wage adjustment is ignored here.

Equation (11) is the same as (6) with ε replacing π_e. We can likewise replace π_e by ε in the demand function for money (5), on the assumption that money and foreign exchange holdings are close substitutes in the open economy.

Thus the adaptive expectations mechanism of the previous simple model has been reinterpreted for an open economy in terms of the dynamics of exchange rate adjustment with a coefficient of adjustment (β) that rises with the rate of inflation. The stability of low or high inflation will thus very much depend on whether the Cagan condition $\alpha \cdot \beta(\varepsilon)$ < or > 1 holds for the relevant rate of inflation (or devaluation). In particular we may underline the point made earlier. An attempt to stabilize the economy from an initial high inflation trap requires not only a cut in the deficit by a permanent move of ε below ε^* (analogous to π^*). But to be able to do this it is not enough to slow down the rate of devaluation (through a reduction of the β_1 coefficient). Wage indexation must be brought down to the level commensurate with slow price adjustment so that $\beta < 1/\alpha$ at the lower devaluation (and inflation) rate, π_A. Otherwise the now low inflation equilibrium (at A) will not be stable and the system will eventually end up at the higher inflation rate π_B.

This analysis is incomplete in a number of ways. First of all the complete underlying model involving domestic and foreign assets has not been spelt out. This can be done, but will not be carried out here. There is one more important aspect, however, having to do with the dynamics of the inflationary process, under inertia and the possibility of jumps in the rate of inflation, that has to be discussed further in the present context.

Equation (11) describes a smooth exchange rate adjustment process, with no speculative attacks, in which no discrete devaluation of the exchange rate can take place. To add this very realistic possibility we rewrite equation (11) as a difference equation and add a discrete jump variable J_t to it:

(11a) $\varepsilon_t - \varepsilon_{t-1} = \beta(\pi_{t-1} - \varepsilon_{t-1}) + J_t$
with $\beta < 1$

where $\varepsilon_t = e_t - e_{t-1}$ $\quad \pi_t = p_t - p_{t-1}$

e = log of exchange rate $\quad$ p = log of price level.

A discrete upward shift of the exchange rate by Δe_t at time τ will show as $J_\tau = \Delta e_\tau$ at $t = \tau$ and $J_{\tau+1} = -\Delta e_\tau$ at $t = \tau + 1$. J_t may be a function of the foreign exchange exposure of the country and thus depend on the variable B_f in equation (1a) and the cumulative budget deficits as well as other exogenous shocks (such as an oil shock). J_t will here be taken to be exogenous.

Next, for the short-run dynamics of inflation, when there is inertia, we can write the following simplified equation:

$$(12) \quad \pi_t = \delta\pi_{t-1} + (1-\delta)\varepsilon_t - a_t$$

This equation may be derived from a conventional aggregate supply (AS) and aggregate demand (AD) framework with some simplifying assumptions.[10]

The degree of inflationary inertia (δ) may come from price indexation of wages while ε_t comes from the cost of imports. The shift factor a_t may reflect productivity shocks as well as planned intervention in the inflationary process by wage and price controls.

Equation (12) can be rewritten in the form

$$(12') \quad \pi_t - \pi_{t-1} = \delta^{-1}(1-\delta)(\varepsilon_t - \pi_t) - \delta^{-1} a_t$$

while (11a), using (12'), can be rewritten as

$$(13) \quad \varepsilon_t - \pi_t = \delta(1-\beta)(\varepsilon_{t-1} - \pi_{t-1}) + a_t + \delta J_t$$

substituting back into (12') we finally get the following equation:

$$(14) \quad \pi_t - \pi_{t-1} = -a_t + (1-\delta) J_t + (1-\delta)(1-\beta)\sum_{i=1}^{\infty}[\delta(1-\beta)]^{i-1}[\delta J_{t-i} - a_{t-i}]$$

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10) This cost-based equation can be rationalized on the assumption that under the circumstances the AS schedule is relatively flat while the AD curve is relatively steep [See Bruno and Fischer, 1986]. Thus AD mainly determines output and employment while cost-push (AS) determines prices (unemployment feedbacks on wages are here ignored). This type of equation (with more lags and including other exogenous variables) works well empirically.

Equation (14) expresses discrete changes in the inflation rate as a function of all present and past disturbance or jump variables weighted by geometrically declining coefficients. When $(1 - \delta)(1-\beta)$ is small (e.g., when inflationary inertia δ is high and/or when the price adjustment coefficient β is high) a devaluation today (J_t) will translate into an immediate upward jump in the inflation rate (rather than the price level). Likewise wage and/or price controls (a_t) will cause a downward pull on π_t. Equation (14) may thus be used to rationalize an upward pull on π_t when there are speculative pressures on the exchange rate (e.g., from an unbalanced budget, erosion of competitive power, loss of confidence, etc.) causing an expected exchange rate level devaluation (J_t). It also incorporates the possibility of discrete downward jumps in π_t as a result of direct controls imposed on wage and price formation when a stabilization effort is undertaken.

Note that when there is no inertia [$\delta=0$ in equation (12)] and no discrete jumps ($a_t= J_t= 0$), equation (11a) is the same as (11) and equation (12) degenerates to the equilibrium condition $\varepsilon_t = \pi_t$, in which case we are in the smooth world of the laws of motion derived from monetary finance as described in section III.

The law of motion of ε_t is then given from equation (8) with ε replacing π_e. In difference-equation form we have:

(8') $\varepsilon_{t+1} - \varepsilon_t = (1-\alpha\beta)^{-1} \beta[d \exp(\alpha\varepsilon_t) -n - \varepsilon_{t-1}]$

For π_t we have, from analogously rewriting (7):

(7') $\pi_t = d \exp(\alpha\varepsilon_t) + \alpha(\varepsilon_{t+1} - \varepsilon_t) - n$

Using (8') this can also be rewritten as

(15) $\pi_t = (1-\alpha\beta)^{-1} [d \exp(\alpha\varepsilon_t) - n - \alpha\beta\varepsilon_{t-1}]$

How can one combine the long-run money-determined smooth path of π_t as given by (15) with the short-run shock-and-inertia determination of the random walk (14)? We may assume that the actual path of π_t is determined by whichever gives a higher acceleration number $(\pi_t - \pi_{t-1})$. Whenever a shock from (14) dominates this means that the money-determined equation (7') will be in temporary disequilibrium.[11)]

For actual application of this framework one may assume that the shocks J_t and a_t are rather rare occurrences (J_t representing step devaluations and a_t wage and price controls). Thus the dynamic system represented by (8') and (15) could be used to simulate the dynamic stability and instability around equilibrium points with the occasional shocks marking the jumps in new initial conditions on π_t and ε_t. This way of looking at the inflationary process is useful in the present context because it helps to explain:

a) why equilibria, even if stable, are only temporary equilibria (until a new shock sets in).

b) Why equal upward and downward shifts may not be symmetrical in their effects[12)].

c) Why inflation may jump up across the "sound barrier" π^* under an exogenous shock (J_t) or down across the barrier when wage and price controls ($-a_t$) are imposed.

While the theoretical discussion given here is not formally a complete account it does provide sufficient theoretical basis for the empirical analysis that follows. We first return to an application of the accounting framework for deficit finance given in Section III.

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11) The ad-hoc assumption still has to be justified within a fully-fledged asset model. It does, however, make intuitive sense for the present example. Here it would imply that real money balances fall by more than expected and the real interest rate rises to equilibrate excess money demand (or excess supply of real bonds). For some empirical support see below p. .

12) Consider the case of a step devaluation ε_t at line $t = \tau$. We have from equation (14) applied at $t = \tau$ and $\tau + 1$ that

$$\pi_{\tau+1} - \pi_{\tau-1} = (\pi_{\tau+1} - \pi_\tau) + (\pi_\tau - \pi_{\tau-1}) = (1-\delta)\ \varepsilon_t - (1-\delta)(1-\beta)\alpha\ \Delta\varepsilon_t = \varepsilon_\tau(1-\delta)[1-\delta(1-\beta)]$$

This is positive and rising with β (which itself rises with π_τ). If the general thrust of π_τ is upward (to a higher stable equilibrium at B, say), a devaluation will thus accentuate the inflationary acceleration.

V. Deficit Finance and Equilibrium Inflation Rates, 1965-1986

We now apply the accounting framework presented in Section III to the Israeli inflation data,[13] in an attempt to account for the main components of the stepwise shifts in the inflation rate into and out of the high inflation period. The issue of stability will be taken up in the next section.

Table 2 gives figures on the budget deficit and its finance by the three major categories (money, domestic debt and the sale of foreign exchange) during the period 1981-1986. A few major changes stand out for the period after 1983. One is the sharp rise in the deficit in 1984, after a temporary drop in 1983, both fluctuations to be traced primarily to the tax revenue side. Secondly we note the sharp drop in the share of finance from the domestic debt issue since 1983 and its replacement by foreign exchange sales, evidence of the loss of confidence after the bank share crisis of 1983, with a partial rebound in the first half of 1985 (mainly sales of a foreign exchange linked domestic asset, PATAM, as part of the speculative move into a foreign exchange linked hedge, in addition to straight foreign exchange outflow). Third and last we note again the sharp drop in the deficit in the course of 1985 (already noted in Table 1) and the very marked change in the composition of finance, mainly between money and debt, a reflection of the rise in the demand for money with the reduction in (expected) inflation.

Table 3 applies the framework of equation (4) to the inflation profile and budget finance data over a 20 year period in which inflation increased in stepwise fashion from 5 to 400 percent per annum. This is a comparative dynamics exercise. For each sub-period we calculate the difference between the deficit ratio (d) and the part of the growth in domestic financial assets that individuals would be willing to hold as GNP increases [nv = n(h+b)]. The ratio of the resulting net injection to the money base (line 7) is then compared for consistency with the underlying inflation rate (line 8), under a hypothetical steady state assumption, as was shown in equation (4) of section III.

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13) This is done along the lines given in an earlier analysis [Bruno and Fischer(1986)], that was confined to the period up to 1983.

As indicated in a previous study [Bruno and Fischer (1986)] the shift from one phase to another could be related, during the high inflation period, to three important developments: the rise in the deficit (d) between the wars (1968-73), the fall in the growth rate (n) after the 1973-74 crisis [see Melnik and Sokoler (1984)], and the probable drop in the demand for money schedule [h( )] after 1977[14]. Also noted was the marked discrepancy between the injection ratio and actual inflation during 1981-83, anticipating the sharp subsequent jump in inflation at the end of 1983, which looked consistent with the underlying budget finance data. We note in hindsight that in the subsequent period (1984-84:2) the reverse relationship held, with actual inflation far exceeding the underlying government injection ratio, which was already consistent with the eventual lowering of the inflation rate (we return to this point below).

Line (9) in Table 3 gives hypothetical numbers of the supply of real money balances (h) that would equate lines (7) and (8), i.e., the numbers are derived from the ratio $(d- vn)/\pi$. Thus, in the period '81-'83 the data are consisent with a disequilibrium in the direction of 'excess money supply' (monetary expansion) while in 84-85:2 it is consistent with a converse 'excess money demand' (monetary contraction) situation.[15]

In the post stabilization period (1985:3-86, column 7) h rose dramatically, the deficit ratio continued to fall, and the lower net injection ratio (30 percent) is quite consistent with the new low inflation rate (25 percent during the first 18 months

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14) This is linked to the liberalization of foreign exchange markets of October 1977, in which a new liquid, foreign exchange linked, asset was introduced (PATAM, see above) - close substitute for conventional money.

15) Real interest rate behavior is indeed consistent with this characterization (see respective Bank of Israel Annual Reports for 1983-1985).

of the program, in annual terms).[16] Finally, column 8 in Table 3 gives a hypothetical set of numbers for zero inflation which is consistent with a 4 percent growth, a further growth in the money base ratio to 8 percent, say, and a government domestic deficit finance ratio of 4 percent (implying a surplus of 1-2 percent when interest payments are excluded).

We first reexamine this table using the model of Section II, by assessing the applicability of the demand function for money. A number of empiricial studies have been conducted at the Bank of Israel in recent years (see symposium in Bank of Israel, Bulletin 60, November 1985), mainly centering on the semi-logarithmic form of equation (5). Estimates by Melnik and by Ben-Bassat and Marom (see above symposium and introduction by Offenbacher) put the α coefficient for quarterly data at about 5 (strictly speaking, the estimate is 4.75). This figure implies that the elasticity of demand for money ($\alpha \cdot \pi$) turns unitary when the monthly inflation rate exceeds 6.5 percent (or 115 percent in annual terms). Let us look at the implied α estimate as we move from one sub-period to the next, in Table 3, namely, we calculate the proportional rate of change of h (from line 2) and divide it by the change in the rate of inflation between respective periods (translated into quarterly data). The following set of numbers is obtained for the relevant high-inflation period:

to period	Implied α
1974-77	4.4
1978-80	4.8
1981-83	8.0
1984-85:2	0.9
1985:3-86	4.4

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16) The 1 percent GNP growth rate for this period is an average between a drop in the second half of 1985 and a 2 percent increase in 1986. With 2 percent GNP growth rate the net injection ratio would drop to 10 percent. Obviously the estimates are sensitive to small changes in the underlying parameters and should only be regarded as a very rough guide.

Thus the first two observations and the last seem quite consistent with the estimate suggested, while the third and fourth very high inflation periods diverge substantially up or down, respectively (on average, interestingly, they do fit...). The very high figure for the early 1980s has given rise to the argument that there was a shift in the demand for money schedule on account of PATAM and other money substitutes that became very widespread during this period, thus illustrating the analysis of section III (shift from curve h to h' and from point A' to C' in Figure A). How could one then rationalize the very low figure for 1984-1985:2? One possible explanation for the back- shift in the demand for base money could be the decision to pay higher interest on commercial bank deposits with the Bank of Israel, evidence for which can be found in line 9 of Table 6 in the years 1983 and 1985:(1+2). But this would require deeper analysis. It is interesting to point out, however, that the tripling of h in the post-stabilization period is entirely consistent with an inflation semi-elasticity that was estimated econometrically for the earlier highly inflationary era.

How could one account for the large discrepancies in the bottom lines of Table 3 during the high inflation plateau (1980-83) and the period of runaway inflation (1984-85:2)?

I believe a potential explanation lies with the theory of dual inflationary equilibria and the possibility that in those years the economy was on the move to an inefficient, high inflation equilibrium of the type B' (Figure A). First we note that with an annual inflation rate of 141 percent (7 percent monthly) the elasticity of demand for money may have passed the unitary, 'optimal', inflation point, or was very close to it. If the net injection ratio of 219 is any indication of the long-run equilibrium inflation at that time, it certainly satisfied the high level equilibrium characteristics (the inflation rate certainly did in the subsequent period). We shall argue below that the stability properties of the high inflation equilibrium were also consistent with such an argument.

The more interesting discrepancy came in the next period (1984-85:2), however. We note that by then the net injection ratio had already come back to the 1968-73 level (!), i.e., the d' curve had shifted back to d, and yet the net injection ratio (and even more so the runaway inflation) were placed in a very different environment. First of all, it gives the best illustration of the multiple equilibrium nature of the system.

Even if we correct for a possible shift in the h( ) function in the intervening years, there is no doubt that the pair 18 and 119 (in line 7) or 11 and 385 (in line 8) together with the pair 13.4 and 2.1 for h (line 2) can be consistent with the same net injection ratio only under a multiple equilibria interpretation. But if at that point the economy was at a high inflation equilibrium, and if, in fact, that was a potentially stable equilibrium, then it is no wonder that a fall in the budget deficit, without any accompanying measures that would make for synchronization of nominal magnitudes at a credible low rate of devaluation and wage-price inflation, could shift the economy to an even higher rate of inflation (e.g., from B' to B). This in fact took place as a result of a balance-of-payments-induced price shock (i.e., a large devaluation), making for a jump in the inflation rate (see section IV).

The same argument holds with no less force for the shift into the actual stabilization period. Note that under the present interpretation the further fall in the domestically financed deficit ratio (and even more so in the net injection ratio) was only marginal, yet the fall in the inflation rate was dramatic. It can only be explained as a shift back from a high inflation equilibrium trap to its dual low-inflation equilibrium, along the lines of dynamic adjustment given in Section IV, to which we shall return below.

Figure B is an attempt to give numerical content to Figure A, using the data of Table 3 (observations are numbered by the columns of Table 3). Curves $d_{5.0}$ and $d_{2.5}$ represent the hyperbolae $h \cdot \pi = d$ for the two injection ratios 5% and 2.5% respectively. Curves m and m' represent money demand schedules before and after the shift caused by the introduction of money substitutes. For each of the problematic periods 1982-83 (col. 5) and 84-85:2 (col. 6) two observations were introduced, the original one and one based on the hypothetical h as given in line 9 of Table 3.

According to this analysis the hypothetical upper inflationary equilibrium before stabilization was situated at an annual rate of about 700 percent (actual inflation being about 400 percent, was thus "on the way" to 700), while the lower inflationary equilibrium was around 50 percent (observation 7, which represents the post-program inflation rate is at an intersection of curve m' with a constant injection curve $d_{1.8}$ which is not marked on the diagram). Point 8 represents a hypothetical 'bliss' of zero inflationary equilibrium (intersection of m' with the curve $d_{0.0}$ which is the pair of co-ordinates).

Two questions immediately arise: First, if the change in the relevant part of deficit finance was so marginal why is so much emphasis placed on the dramatic cut in the deficit (see Table 2)? Secondly, if the economy actually shifted to a low level equilibrium, what would guarantee its stability?

The answer to the first question hinges on the important link between the budget and the balance of payments which removed an important source of pressure on the exchange rate. The cut in the budget deficit helped bring about an almost equivalent cut in the current account deficit of the balance of payments (commensurate with the dramatic drop in foreign exchange sales to the public, see line 8 in Table 2) which, together with the step devaluation, made the exchange rate 'freeze' credible. In the terminology of section IV we would say that the expectation of another jump in ε and π due to the J-term was sharply reduced.

For the answer to the second question, on the stability of the new low level equilibrium, we turn back to the analysis of dynamics and the stability of multiple equilibria.

VI. Dynamic Adjustment and the Stability of the High and Low Level Inflation Rates[17]

We now return to the analysis of the dynamics of adjustment (see Section IV) and in particular, to an attempt to give the dynamic adjustment equations (9)-(11) [or, rather, (11a)] empirical content.

Consider first the COLA adjustment of wages. I have run two kinds of regressions of wages on present and lagged inflation rates, one based on quarterly data, the other on monthly data, aggregating the results to a three-month equivalent coefficient of adjustment (Φ). If we consider quarterly data for the period 1965-1985 and break the period down into three sub-periods (each with roughly 20 observations) the implied adjustment coefficient

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17)Research assistance for this section was ably provided by Eran Yashiv.

comes out as follows:[18]

1965:1-72:4	0.40
1973:1-78:4	0.57
1979:1-85:4	0.79

This confirms, in broad outline, the claim that the within-quarter adjustment coefficient has risen, and in fact doubled in the course of the inflationary process. Let us remember that in 1980 the frequency of adjustment of the COLA increased from a six to a three months lag and the rate of indexation increased from 70 percent to 80 percent. More recently, in October 1983, the agreement switched to a monthly adjustment formula, a 12 percent threshold and an 80-90 percent indexation coefficient.

To obtain a finer sub-period breakdown we have to use monthly regressions for wage adjustment. Table 4 gives the resulting estimated coefficients for the wage equation (Φ, line 2) and the exchange rate adjustment equation (β_1, lines 3 and 4) for sub-periods starting with the introduction of the crawling peg (the observations run starting 1975:1)[19]. The exchange rate adjustment coefficients listed include both quarterly and monthly based regressions, with the resulting calculated product ($\beta = \beta_1 \cdot \Phi$) given in lines 5 and 6, respectively. Finally, lines 7 and 8 introduce estimated coefficients for equation (11a) run directly on consumer and wholesale prices, respectively.

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18) The regression was run for each sub-period separately in the form

$$w_t - \pi_t = a_1(\pi_t - \pi_{t-1}) + a_2(\pi_{t-1} - \pi_{t-2}) + a_3(\pi_{t-2} - \pi_{t-3})$$

$(1 + a_1)$ is taken as the coefficient for the quarterly regressions and $(1 + a_3)$ as the one in the monthly regressions.

19) The exchange rate regression was run as in (9), adding a correction for U.S. wholesale prices within the brackets. For each regression dummy variables were included in the relevant periods in which step devaluations took place (since these are rate of change regressions, the dummies were introduced in two consecutive periods each time.).

From the various series of estimates it seems that the β coefficient that we were looking for did indeed behave monotonically over the four sub-periods. Given the fact that the α coefficient of the demand for money equation is of the order of 4-5, any β that exceeds 0.20-0.25 would be consistent with the Cagan condition of stability being violated. Given the above tentative results one could thus argue that up to 1977:2 stability was probably still maintained only at the low inflation rate of around 40 percent per annum. During the subsequent two periods it may have been slightly above or on the borderline of stability, while during the last high inflation period (84-85) stability has certainly also characterized the high level equilibrium point B or B', thus substantiating the argument made in the preceding section, with the low level inflation rate becoming unstable at the going wage and exchange rate adjustment mechanisms.

An alternative, more direct, way of testing whether the β adjustment coefficient is itself inflation-dependent is to specify a linear relation $\beta = \beta_1 + \beta_2\pi$, estimate equation (11a) directly by non-linear methods and test whether $\beta_2 > 0$.

The following difference equation was estimated over the above sample of 123 monthly observations (1975-85):

(11b) $$\varepsilon_t - \varepsilon_{t-1} = \beta_o + (\beta_1 + \beta_2\pi_{t-1})(\pi_{t-1} - \pi^{vs}{}_{t-1} - \varepsilon_{t-1}) + J_t$$

Here ε_t = rate of devaluation
π_t = rate of inflation
$\pi^{us}{}_t$ = U.S. rate of inflation
J_t = Dummy variables for discrete devaluations of 1975(IX-X), 1977(XI-XII) and 1983 (X-XI)

The equation was estimated once for π in term of the consumer price index (COL) and once for the wholesale price index of manufacturing goods (WHP). The resulting coefficients and threshold inflation ratio (π^*) are:

	β_1	β_2	π^* monthly	π^* annual
COL	-0.29	9.33	5.8	97
	[0.99]	[3.73]		
WHP	-0.43	12.74	4.8	76
	[1.39]	[4.97]		

Figures in square brackets are t- values. Estimates are corrected for serial correlation.

The threshold inflation rate (π^*) has been estimated from the condition $\beta = \beta_1 + \beta_2 \pi^* = (1 + \alpha)^{-1}$ which is the difference equation analog of the Cagan stability threshold condition $\alpha\beta=1$. The implication is that as long as the inflation rate is less than 5.8 (or 4.8) percent a month (97 or 76 percent in annual terms, respectively), inflation will adjust to the lower inflation equilibrium (since then $\alpha\beta<1$) while starting from a higher inflation rate it will diverge to the upper equilibrium. Obviously these results depend on equation (11b) being the maintained rule of crawling exchange rate peg adjustment under accelerating inflation, barring special events (e.g., balance of payments crisis) for which one time adjustments of the exchange rate (represented by J_t) are being made.

We note that the above estimate of a critical monthly inflation rate of about 5 percent (the 'sound barrier' above which the process diverges) conforms to one's intuitive hunch as to what the "danger zone" in this type of stabilization program may be (both Brazil and Argentina, for example, have, at some stage, overshot this rate and their programs started getting into very serious difficulty).

It is important to point out that the estimated equation (11b) is an exercise in ex-post interpretation of historical data in terms of a hypothesized policy adjustment rule. Policy rules are man-made and can be changed and obviously the numerical estimates should not be read as necessarily strictly applicable at the tail end to which the stabilization program was directed. Part of the program design can in fact be interpreted as an attempt to make a new low level inflation stable. A discussion of a number of ingredients in the program and its evolution should clarify this point.

A major component of the program was a government preannounced commitment to exchange rate stability on condition that the trade unions take care of wage stability. With price controls added on and a fiscal cum monetary squeeze it is an extreme application of equations (9), (11) or (11a) with $\varepsilon = w = \pi = 0$ and the fiscal and monetary squeeze (as well as adequate extra foreign finance) guaranteeing $J_t = 0$. Viewed as a (differential) game played by the unions and the government[20] the stability of the equilibrium depends on government's credibility and reputation building. The first few months of the program's implementation provided such a credibility test. When wages in the business sector overshot in the expectation, based on past experience, that the government would accomodate with an exchange rate devaluation (so as to keep export profitability from falling), such devaluation did not take place, causing a temporary profit squeeze and a downward correction of wages in some manufacturing industries. Eventually, only a year later (in January, 1987) was another step devaluation of 10% undertaken, again coupled with an agreed COLA suspension and a tax compensation to employers. This became part of a new, this time more credible, precommitment to an exchange rate stabilization policy.

In terms of the model presented in section IV, this is a case in which the coefficient $\beta=0$ and a step devaluation (J_t) is coupled with an incomes policy ($-a_t$) at the same time so as to neutralize the shock to ($\pi_t - \pi_{t-1}$) [see equation (14)] and thereby confine inflation to the vicinity of the low level equilibrium point.

Next, the COLA itself was corrected in the course of 1986 to conform to a lower inflation rate (moving up the threshold for wage compensation from 4 to 7 percent cumulative price increase and a reduction of the compensation rate to 70 percent). The result of both of these steps and the smaller price increase prevented the need for actual COLA payments for almost a year.

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20) A relevant bargaining model was analyzed by Horn and Persson (1986). In their model, however, the trade-off is between inflation and unemployment (in the export industry). More relevant in the present context is the trade-off between the current account (supplying foreign exchange relief) and inflation.

The imposition of initial price controls was a part of the social contract demanded by the unions. While those controls were not effective during the initial stages of the program they did help in signalling the government's serious intentions. Their gradual removal in the course of the subsequent two-year period without any clear signs of repressed inflation emerging added another element of credibility. The best test of the public belief in the success of the program, which in turn helped keep the exchange rate stable, was a large inflow of capital.[21]

VII. Concluding Remarks

In our empirical application we have naturally concentrated on the Israeli example. An interesting line of further research would be to cast the simultaneous experience of other countries, like that of Argentina or Brazil (and more recently, Mexico), into the same analytical mould. This has, to the best of our knowledge, not yet been done. It could, however, be observed that the reason for a less successful outcome in Argentina and Brazil probably lies with both parts of the heterodox package. In the case of Argentina, for example, which was the first and also more serious attempt at stabilization, the initial correction of fundamentals appears to have been insufficient - the fiscal squeeze had temporary more than permanent elements in it, and the external adjustment problem appeared more serious than Israel's, making an exchange rate freeze less credible and more short-lived. But the initially synchronized wage-price freeze also appeared to be more shaky on account of a trade union movement that was politically less collaborative than its Israeli counterpart. It

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21) Another element making for stability of a new 'equilibrium' is the bureaucratic feed-back mechanism by which mistakes in policy or unanticipated disturbances are quickly detected and reacted upon by corrective measures. In the Israeli case this role was at least in part played by a follow-up committee of bureaucrats with direct access to the Minister of Finance and the Prime Minister. In this sense the post-reform decision making mechanism should be part of the design for economic reform, since it affects the stability properties of the new equilibrium.

is hard to make a more concrete assessment of the differences between the countries without an analogous detailed empirical comparison.[22] Let us now turn back to more general remarks.

We have used the example of a recent 'shock' stabilization program to illustrate the way the concept of economic reform can be placed within acceptable theoretical and empirically testable frameworks. Even our particular example still has to be worked out more fully. For our present purpose, however, it illustrates a principle. The underlying idea is the existence of multiple stable equilibria for the economy and given a clear preference ordering over these equilibria, a reform program consists of a shift from one stable or quasi-stable equilibrium, which is inferior (or a point on the way to such equilibrium) to another, superior, equilibrium (or a process by which such equilibrium can be reached), which can be made stable by a suitable reform design.

We note the rather eclectic role of 'econometrics' in our exercise. Statistical econometrics can be used for various fragments or building stones of the jigsaw puzzle, as was indeed done here, but probably not as a complete estimable model structure. The conservative nature of backward looking time series modelling limits the use of the larger econometric models for this purpose because the extrapolation of the past under a regime change is fraught with difficulties. At the same time there are other, complementary ways, of bringing the past historical experience (sometimes not even quantifiable) to bear on the understanding of the potential ingredients of an economic reform. It requires a marriage of different subfields all of which constitute 'econometrics' as practiced by the members of our Society. Of all required components I would put the greatest emphasis on the need for one unifying analytical framework or 'theory' which can then be filled with smaller sub-models and missing facts. Facts alone, even if ordered or analyzed correctly from a purely 'statistical' point of view, can never be a good basis for policy, if there is no attempt to understand how the system to be guided actually 'ticks'.

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22) For the separate country studies see Bruno, Di Tella, Dornbusch, and Fischer (1988).

In a lecture on experimental economics given at the last World Congress of our Society I heard Alvin Roth mention four types of experiments in economics: The first one is 'speaking to theorists'. The second is 'searching for meaning'. The third is 'searching for facts' and the fourth and last is 'whispering in the ears of princes', which I take to be the politicians.

Speaking of politicians, I would like to end with a quote from Joseph Schumpeter who, believe it or not, happened to be one of the founding fathers of our Society. (Here is an interesting question - would he be elected Fellow of the Econometric Society to-day? Or else, would he be interested in being elected, given the highly technical segmentation of our discipline ?)[23] In the 1933 issue of Econometrica that I have already mentioned an article of his, entitled "The Common Sense of Econometrics", ends in a paragraph which runs as follows:

"The only way to a position in which our science might give positive advice on a large scale to politicians and business men, leads through quantitative work. For as long as we are unable to put our arguments into figures, the voice of our science, although occasionally it may help to dispel gross errors, will never be heard by practical men. They are, by instinct, econometricians all of them, in their distrust of anything not amenable to exact proof."

Princes in Schumpeter's days may have been a special breed. I am not sure whether I would buy this statement of Schumpeter's as far as to-day's politicians' optimal menu is concerned, at least not those in whose ears I have recently been whispering. I do, however, subscribe to the contents of a preceding paragraph in the same article having to do with the mix of 'speaking to theorists' and 'searching for facts' which is as relevant to-day as it seemed 55 years ago:

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23) A reader of a previous draft of this paper quipped at this point:" Or would he be Schumpeter to-day?". I hope he could.

"Theoretic and 'factual' research will of themselves find their right proportions, and we may not unreasonably expect to agree in the end on the right kind of theory and right kind of fact and the methods of treating them, not postulating anything about them by program, but evolving them, let us hope, by positive achievement."

I hope this discussion will be a small contribution towards further evolution of theory and fact in the continued 'search for meaning' of how policies ought to be rationalized. Princes and politicians come and go, some of them more receptive to our whispers than others. It befalls on us in the profession, in the meantime, to improve our basic understanding of how and what menus to prepare for future plans of action and reform.

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Figure A. Government Finance, Base Money and Equilibrium Inflation

d-line: (4) $h\pi = d_1 = d - nv$

h-line: (5) $h = \exp(-\alpha\pi_e)$

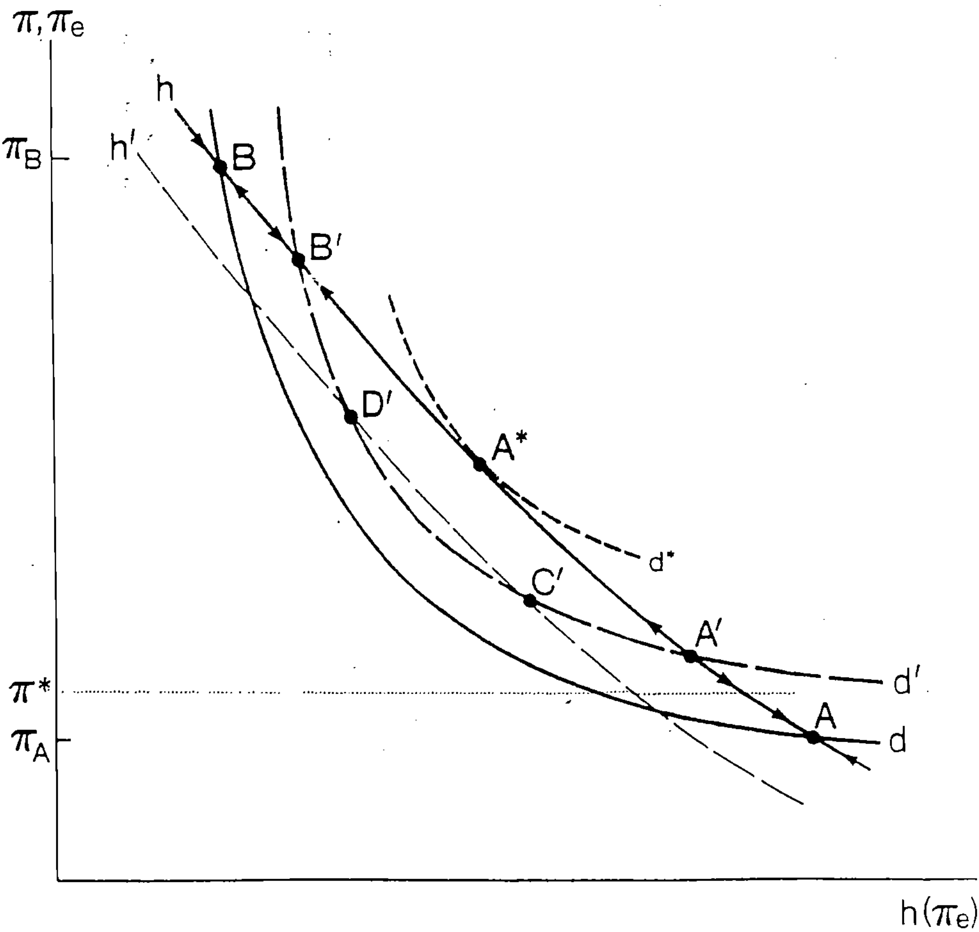

Figure 8. Deficit, Money Base, and Inflation: 1965 - 1986

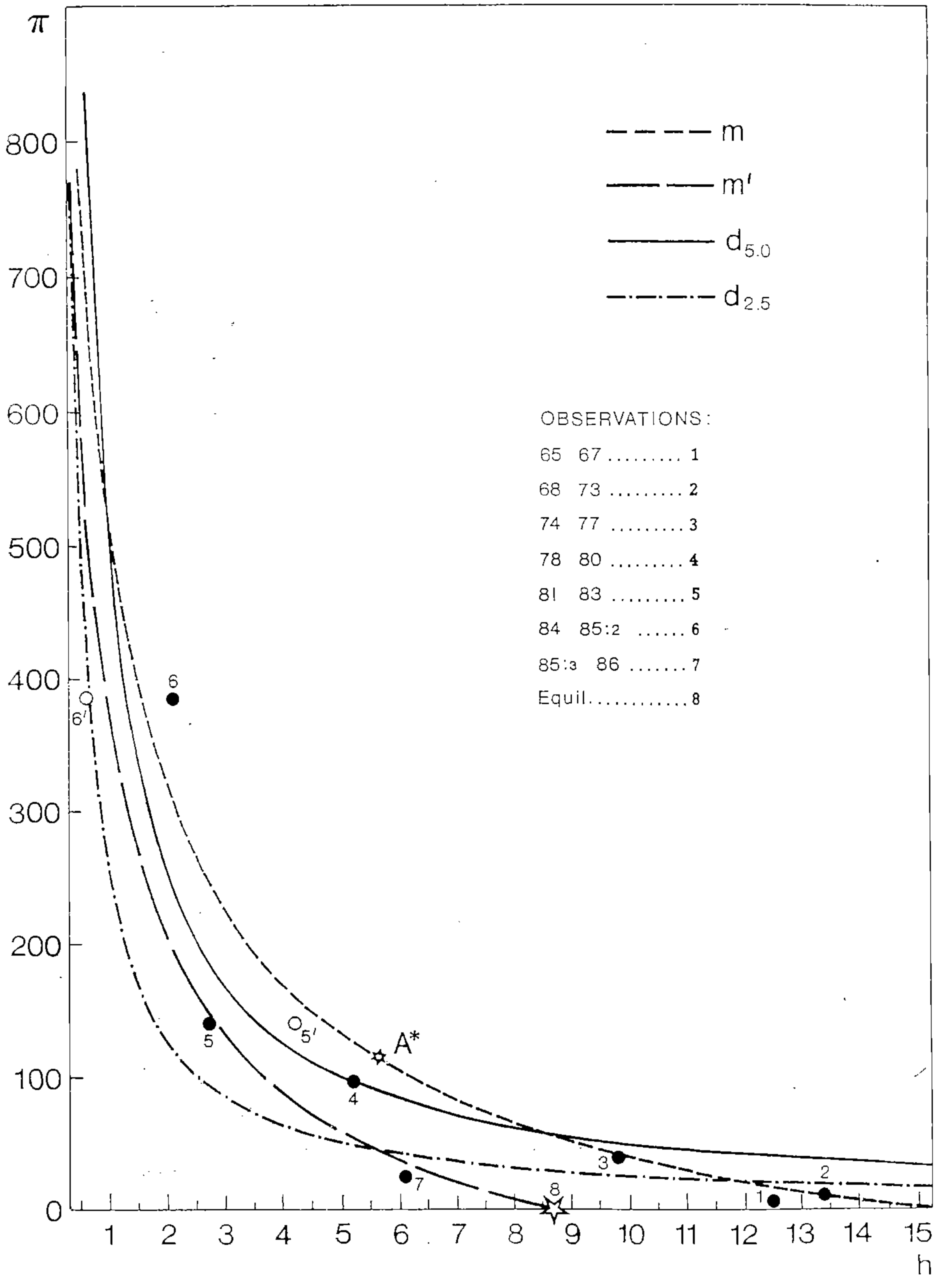

TABLE 1 - Economic Indicators

	Mean 1980-1984	1984 (during year)	1985 Jan.-July	1985 Aug.-Sept.	1985 Oct.-Dec.	1986 Jan.-March	1986 April-June	1986 July-Sept.	1986 Oct.-Dec.	1987 Jan.-March	1987 April-June
A. Prices, exchange rates and wages (monthly percentage change rates)											
1. Consumer prices	8.7	15.2	14.0	3.5	2.1	0.6	2.1	1.0	2.2	1.5	1.3
2. Wholesale prices	9.1	15.2	12.4	1.8	2.4	1.2	1.7	0.9	1.0	2.4	1.1
3. $ Exchange rate	8.8	15.9	13.6	0.2	-0.1	0.0	0.0	0.0	0.0	2.8[g]	-0.3
4. 5-currency basket exch. rate	7.5	15.3	15.3	0.7	2.0	1.5	0.5	0.0[f]	0.0	3.8[g]	-0.1
5. Nominal wage	9.0	16.5	11.0	0.3	4.5	6.4	4.3	-1.7	3.0	0.6	4.9
B. Money and credit (monthly percentage rates)											
1. Total bank credit	8.6	16.1	13.0	4.8	1.7	2.9	2.4	3.7	3.3	4.6	3.1
2. Quasi-money (M_3)[e]	10.7	15.9	13.0	3.5	1.9	2.3	-1.0	3.2	3.3	4.3	1.5
3. Means of payment (M_1)	8.0	13.4	11.8	16.2	6.7	15.7	0.9	7.0	4.2	2.4	0.5
4. Interest rate (end-of-period level)		16.1	21.0	14.1	7.2	4.0	3.6	3.5	4.0	4.9	4.1
C. Relative price levels (1980=100)											
Real exchange rate (new basket)[a]	94	92	103	110	105	103	98	96	93	98	95
Real wage (gross)	108[b]	116	116[c]	95	95	108	113	114	117	115	127
Real wage (after tax)	109[b]	114	116[c]	99	103	117	120	121	124	123	-
D. Budget deficit (%GDP)	10.2[b]	15.0	12.0[c]	5[d]	4	3	1	3	0	0	2
E. Unemployment rate (%)	4.9[b]	5.9	6.0[c]	7.8[d]	6.6	7.2	7.9	6.8	6.6	5.7	5.9
F. Balance of payments basic balance (uncorrected) (b.$)	-0.2[b]	-0.3	-0.7[c]	0.6[f]	1.2	-0.1	0.0	0.3	1.3	-0.2	

a. Relative wholesale prices of major trading partners (new basket of 5).
b. Mean, 1980-83.
c. Mean, Jan.-June 1985.
d. Mean, July-Sept. 1985.
e. Money and liquid assets, includes foreign-currency demand deposits.
f. Data for Aug.-Sept. On August 1, 1986 a new basket was adopted. (The figure for July was 2.0.)
g. In Jan. the N.I.S. was devalued by 11 percent relative to the 5 currency basket.

Table 2: DOMESTIC PUBLIC SECTOR DEFICIT (INCLUDING BANK OF ISRAEL) AND ITS FINANCING, 1980-1986

(Percent of GDP)

	1981	1982	1983	1984	1985 Total	1985 Jan.-June	1985 July-Dec.	1986
A. Components of Deficit								
1. Domestic expenditure	59.9	59.0	56.1	52.9	55.4	56.8	54	53.4
2. Taxes	50.5	52.7	52.8	44.6	52.4	50.5***	54.2***	56.0
3. Deficit (excl. interest)	9.4	6.3	3.3	8.3	3.0	6.2	-0.2	-2.6
4. Interest (adjusted)	2.2	3.6	2.8	3.8	5.9	5.9	5.9	5.3
5. Domestic deficit (3. + 4.)	11.6	10.0	6.0	12.1	9.0	12.3	5.7	2.6
B. Financing of Deficit								
6. Base money creation	2.0	1.7	2.3	2.9	6.5	2.4	10.6	1.9
7. Net domestic debt*	8.1	6.2	-1.0	0.8	-1.2	3.7	-6.1	-0.4
8. Foreign currency sales	1.9	2.6	6.3	8.6	4.8	7.4	2.2	2.5
9. Net effect of monetary policy**	-0.4	-0.6	-1.6	-0.2	-1.1	-1.2	-1.0	-1.4

* Financial asset formation (including PATAM) net of public credit to private sector.

**Interest on the money base, plus the fiscal burden of discount-window lending, less penalties for liquidity deficits.

***Estimate.

Source: Bank of Israel, Annual Report 1985, Table H-6.
1986 - Bank of Israel estimate.

Table 3. Government Injection to Money Base and the Rate of Inflation, 1965-1986

(Percentages)

	1965-1967 (1)	1968-1973 (2)	1974-1977 (3)	1978-1980 (4)	1981-1983 (5)	1984-1985:2 (6)	1985:3-1986 (7)	Hypo-thetical equi-librium (8)
1. Financial asset ratio (h ÷ b)100	(0.5)	0.6	1.0	1.1	1.3	1.2	1.3	1
2. Percentage money base to GNP (h)	12.5	13.4	9.8	5.2	2.7	2.1	6.1	8
3. GNP growth (n)	3.2	10.3	2.6	3.5	2.3	2.0	1.0	4
4. Domestic government finance ratio (d)	2.2	8.6	7.3	9.3	8.9	4.9	3.1	4
5. Of which: Growth factor (1. x 3.)	1.6	6.2	2.6	3.9	3.0	2.4	1.3	4
6. Net injection (4. - 5.)	0.6	2.4	4.7	5.4	5.9	2.5	1.8	0
7. Net injection money base (6./2.)	5	18	48	104	219	119	30	0
8. Inflation rate	5	11	40	97	141	385	25	0
9. Hypotetical money supply (h^s) [(4)-(5)]/(8)	12.5	21.9	11.8	5.6	4.2	0.7	7.3	8

Note : This table is an extension of Bruno and Fischer (1986), Table 4, which only covered the period up to 1983 [columns (1) -(5)]. All numbers are in percentages except for line 1 which is a simple rati

Sources: Line 1 - Yariv (1982) plus update 1965-67 figure assumed same as 1970 1968-1973 is the average for 1970-73. Line 2 - Bank of Israel, Annual Reports. Line 3 - CBS. Line 4 - Meridor (1985) plus update. Line 8 - CBS.

Table 4. Estimated Dynamic Price Adjustment Coefficients, 1975-1985

	1975:1-1977:2	1977:2-1979:4	1979:4-1983:3	1983:3-1985:3
1. No. of monthly observations	24	31	46	24
2. Wage adjustment coeff. (Φ)	0.44	0.53	0.87	0.77
Exchange rate adjustment (β_1):				
3. Quarterly	0.57	0.63	0.36	0.75
4. Monthly	-0.04*	0.12*	0.34	0.88
Price adjustment coefficients				
Calculated ($\Phi \cdot \beta_1$)				
5. = 2. · 3.	0.25	0.33	0.31	0.58
6. = 2. · 4.	-0.02*	0.06*	0.30	0.68
Estimated (β)				
7. Consumer	0.27*	0.32	0.41	1.02
8. Wholesale	0.13*	0.30	0.70	1.54
9. Exchange rate dummies	IX-X 1975	XI-XII 1977	-	X-XI 1983

* Coefficient insignificantly different from zero at 5 percent level.

Sources: Line 2 - Coefficient $(1 + a_3)$ in monthly wage adj. equation (6).
Line 3 - Quarterly exchange rate adjustment equation (9), without dummies.
Line 4 - Sum of 3 first coefficients in lagged monthly exchange rate adjustment equation (9), with dummies for periods given in Line 9.
Line 7 - Based on monthly regressions with $\dot{w}$ replaced by π (for consumer prices).
Line 8 - As in Line 7, with π representing wholesale prices.

TECHNICAL APPENDIX

High Inflation Traps and Rapid Disinflation

1. The Basic Model (see section III)

We here detail the model of Section III only for the case of no bonds, i.e., $v = h$. When the real rate of interest is exogenous, generalization to the money and bonds case is straightforward.[1] Assume a semi-logarithmic demand function for money (π_e = expected inflation),

(A1) $$H/PY \equiv h = \exp(-\alpha\pi_e) .$$

This is equation (5) in the text. Now assume deficit finance by money-base creation,

(A2) $$\dot{H}/PY = (\dot{H}/H)h = d .$$

This is equation (1) in the text for the case $\dot{B} = 0$.

From (A1) and (A2)

(A3) $$d = \theta h = \theta \exp(-\alpha\pi_e) ,$$

where $\theta = \dot{H}/H$ is the growth rate of high-powered money. This shows as curve GG in Figure A1.

Differentiating (A1) with respect to time we obtain

---

1 This Appendix is partly based on Bruno and Fischer (1984,1987). The case where the real interest rate is endogenous is technically messier (It is worked out in the above 1987 paper). Here our emphasis is an illustration of the case of dual stable equilibria which was not taken up in the above papers.

APPENDIX, p. 2

(A1') $$\theta - \pi - n = -\alpha\dot{\pi}_e ,$$

where π is actual inflation and n is the growth rate of GNP.

In steady state, $\dot{\pi}_e = 0$, and we have

(A4) $$\pi_e = \pi = \theta - n .$$

This is equation (2) in the text, and shows as the 45° line with intercept n in Figure A1. There are two possible steady states (at most), A and B, with A the low-inflation and B the high-inflation equilibrium. As d increases, GG shifts to GG', the low-inflation steady state rises from A to A', while the high-inflation steady state shifts leftward from B to B', with the inflation rate falling. Maximum seignorage is obtained when $d = \alpha^{-1}\exp(\alpha n^{-1})$ and $\dot{\pi} = 1/\alpha - n$ [Friedman (1971)].

Now consider adaptive expectations (for an alternative interpretation in terms of exchange rate adjustment see section IV):

(A5) $$\dot{\pi}_e = \beta(\pi - \pi_e) .$$

This is equation (6) in the text. Substituting for π from (A1') we get

(A6) $$\dot{\pi}_e = (1 - \alpha\beta)^{-1}\beta(\theta - n - \pi_e) ,$$

where $\theta = d\exp(\alpha\pi_e)$, from (A3). This is equation (8) in the text.

For slow expectations adjustment ($\beta < 1/\alpha$), $\dot{\pi}_e > 0$ for $\pi_e < \theta - n$, i.e., below the 45° line, and $\dot{\pi}_e < 0$ for $\pi_e > \theta - n$ (see Figure A1). Thus for the case $\alpha\beta < 1$, A, the lower inflation equilibrium in Figure A (if it exists) is stable, and the higher inflation rate at B is unstable. These roles are reversed when $\alpha\beta > 1$ (see Figure B1). This will also be the case for rational expectations, which can be represented as the limiting case $\beta \longrightarrow \infty$ or $\pi = \pi_e$ always.

The two cases can equivalently be represented in $\pi_e - \pi$ space, when the GG and GG' curves are no longer independent of the process of adjustment (see Figures A2, B2, respectively).

2. Variable Adjustment Coefficient

Consider now the case in which the adjustment coefficient in equation (A5) becomes inflation-dependent and we have

$$\text{(A5')} \qquad \dot{\pi}_e = \beta(\pi_e)(\pi - \pi_e) \; ,$$

where $\beta' > 0$, and assume $\beta(0) < 1/\alpha$.

The interpretation is that as inflation rises it becomes lier to make mistakes and therefore the response to unanticipated shocks will be more rapid. In the text (section IV) we replace this model and its interpretation with one based on exchange rate adjustment.

Since $\beta' > 0$, there exists a critical value, π_e^*, at which $\beta(\pi_e) = 1/\alpha$ (see Figure C1). It now becomes of crucial importance as to how the A and B intersections of the GG curve with the $\dot{\pi}_e = 0$ line relate to the point D at which $\pi_e = \pi_e^*$ on the GG line (D is a singularity point). We have the following cases:

(a)	$\pi_A < \pi_B < \pi_e^*$	A stable, B unstable
(b)	$\pi_e^* < \pi_A < \pi_B$	A unstable, B stable
(c)	$\pi_A < \pi_e^* < \pi_B$	<u>Both</u> A and B are stable.

APPENDIX, p. 4

Case (c) is clearly of special interest because it gives rise to multiple stable equilibria and therefore to a rationale for a discrete step in stabilization policy involving more than just a cut in the government deficit.

The analysis in terms of Figures A or C1 is of necessity incomplete because we have said nothing about actual inflation. As it turns out, the threshold expectation level, π_e^*, here causes some special dichotomy in inflation behavior. Let us consider case (c), where $\pi_A < \pi_e^* < \pi_B$. This is shown in Figure C2.

From equations (A5') and (A6) we know that except at π_e^* we have

(A7) $$\pi = \frac{-\alpha\beta(\pi_e)\pi_e + d\ \exp(\alpha\pi_e) - n}{1 - \alpha\beta(\pi_e)} \qquad \text{for} \quad \alpha\beta \neq 1$$

while for $\dot{\pi}_e$ we have

(A6') $$\dot{\pi}_e = \beta(\pi - \pi_e) = \frac{\beta[d\cdot\exp(\alpha\pi_e) - n - \pi_e]}{1 - \alpha\beta(\pi_e)} .$$

Differentiating (A7) with respect to π_e we get, for the slope of the GG curve in π-π_e space,

(A8) $$\frac{d\pi}{d\pi_e} = \frac{\alpha[\beta'(\pi - \pi_e) - \beta(\pi_e) + d\ \exp(\alpha\pi_e)]}{1 - \alpha\beta(\pi_e)} .$$

It follows that at the points A and B, where $\pi = \pi_e$, $d\pi/d\pi_e$ is the same as for the constant β case [since the β' term in (8) vanishes].[2]

Consider now the range $\pi_A < \pi_e < \pi_e^*$. Here $\alpha\beta < 1$ and $\dot{\pi}_e < 0$

---

[2] At

$$\pi = \pi e = \pi_A, \quad \frac{d\pi}{d\pi_e} = \frac{\alpha(\pi + n) - \alpha\beta}{1 - \alpha\beta} < 1, \qquad \text{since} \quad \alpha(\pi + n) < 1 ,$$

while at

$$\pi = \pi_e = \pi_B, \quad \frac{d\pi}{d\pi_e} = \frac{\alpha\beta - \alpha(\pi + n)}{\alpha\beta - 1} < 1, \qquad \text{since} \quad \alpha(\pi + n) > 1 .$$

since $\pi < \pi_e$ to the left of the $\dot{\pi}_e = 0$ line. Therefore the numerator on the right hand side of equation (A6') must be negative. But this means that close to the π_e^* level, when $\alpha\beta \sim 1$, the numerator of equation (A7) must also become negative, namely, the GG curve in that branch must eventually cross the π_e axis and $\pi \to \infty$ as $\pi_e \to \pi_e^*$ (from below).

For a similar reason it follows that in the range $\pi_e^* < \pi_e < \pi_B$, $(\alpha\beta - 1) > 0$ and the numerator of (A7) must be negative and π positive, with $\pi \to +\infty$ as $\pi_e \to \pi_e^*$ (from above).

Here a shift to a higher deficit ratio will show in the corresponding shift of the two branches (to the right in the lower region and to the left in the upper region). Figure C2 also includes a case where a higher deficit ratio gives a curve GG^1 for which both equilibria are in the upper region, now the lower one (A') being unstable and for low enough π becoming asymptotic to the π_e^* line from above.

Repeating the experiment, previously discussed, of moving from the initial point B' to a lower deficit together with an incomes policy that pulls π_e credibly below π_e^*, we first move to the point E, say, on the lower branch of GG, which is enough to get us eventually to the point A. Note that for this case the <u>actual</u> inflation rate falls at first by more than π_e, while the adjustment process from E to A will involve a further fall in π_e as π rises to the new equilibrium at A.[3]

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[3] We have also marked the point E on Figure C1. Note that θ behaves monotonically during the transition, the growth rate of money falling (with the fall in expectations) while inflation must rise - the numerator in (A7) rising by more than the denominator.

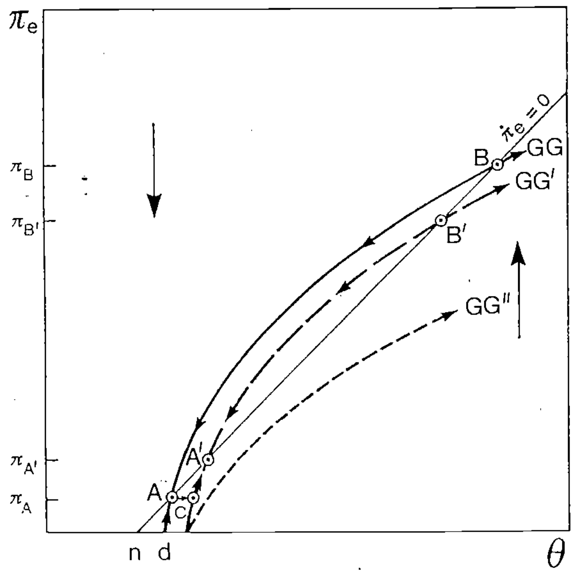

Fig. A1. Money growth

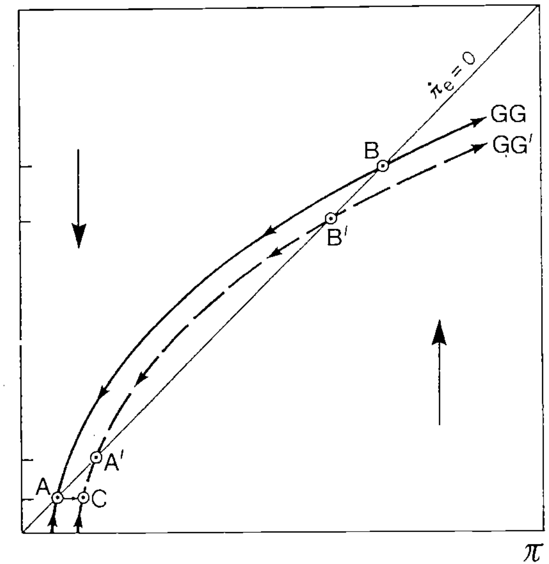

Fig. A2. Inflation

Depicts the case $\beta < 1/\alpha$.

A, A' stable; B, B' unstable.

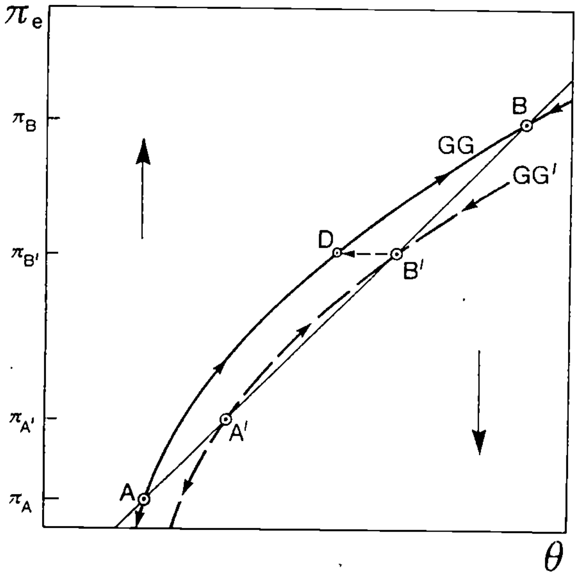

Fig. B1. Money growth

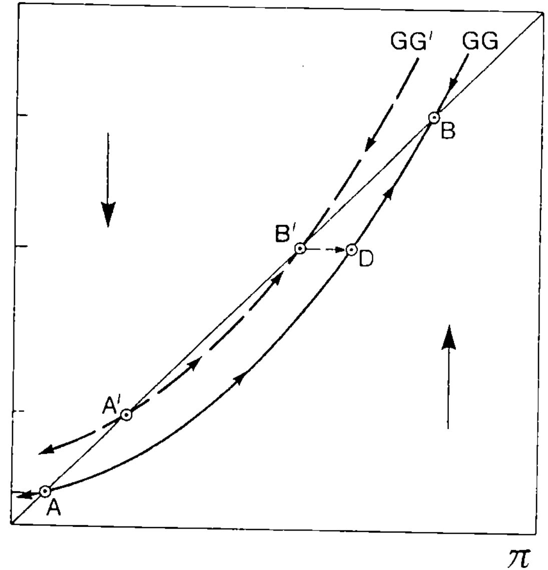

Fig. B2. Inflation

Depicts the case $\beta > 1/\alpha$.

A, A' unstable; B, B' stable.

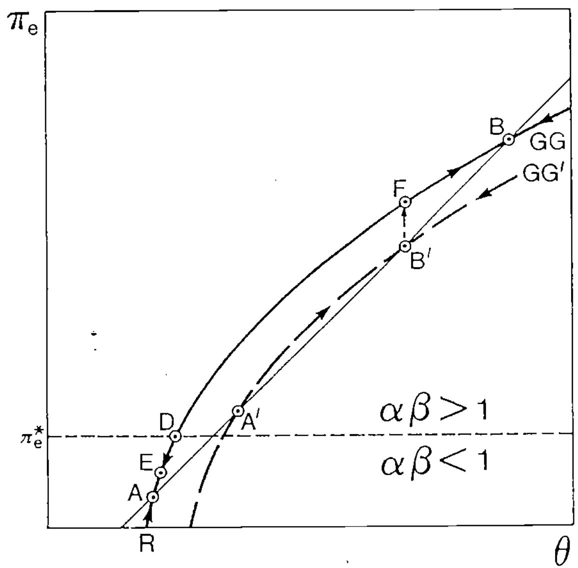

Fig. C1. Money growth

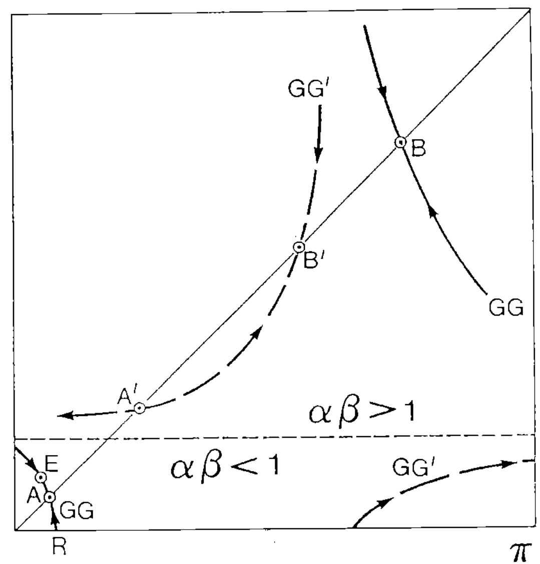

Fig. C2. Inflation

Depicts the case $\beta = \beta(\underset{+}{\pi_e})$ with $\beta(\pi_e^*) = 1/\alpha$.

On GG: A **and** B stable.

On GG′: A′ unstable, B′ stable.