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PROPOGATION OF SHOCKS IN A HIGH-INFLATION ECONOMY: ISRAEL, 1980-85

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ABSTRACT

The purpose of this paper is to provide empirical answers to questions related to the propagation of shocks in a high-inflation economy. Do one-time inflationary shocks give rise to long-term persistence, or inertia? Do balance of payments' shocks trigger a process that, through indexation and monetary accomodation, results in long-term changes in inflation? Within the context of a specific hypothesis, influential both in policy discussions and in economic analyses, the paper addresses these issues using Israeli data and vector-autoregression techniques. The evidence does not support the hypothesis that one-time nominal shocks have a persistent effect on the inflation rate, or the hypothesis that long-term changes in inflation are triggered by autonomous fluctuations in the trade balance.

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1. Introduction

Despite the advent of high inflation in Israel and other economies (e.g., in Latin America), there is no widely accepted explanation for the fluctuations in inflation rates and for the transmission mechanisms of nominal shocks in these economies. In fact, there are only very few studies that have empirically examined the propagation mechanism of inflation in economies characterized by high degrees of indexation and monetary accommodation. The extent and role of expectations inertia, of government management of the exchange rate and controlled prices, and of government deficits and monetary accommodations are all examples of key issues subject to sharp debate and controversy.[1]

The purpose of this paper is to investigate key aspects of the propagation mechanism in the context of the Israeli economy for the first half of the 1980's. Israel represents an interesting case for examining the propagation mechanism of nominal shocks. During the first half of the 1980's, this economy was characterized by high and volatile rates of inflation, substantial monetary accommodation, a high degree of indexation, balance of payments crises, and a persistent policy of direct management of the exchange rate and of price controls, through government subsidies, in an attempt to slow down inflation.

One approach to the analysis of the propagation mechanism is to relate inflation to fundamentals, like current and expected future changes in the money supply, the government budget, as well as in external variables. In an open economy, the analysis has to take into account the exchange rate regime and the interactions between the balance of payments and domestic inflation.[2] Another approach emphasizes the independent role that key variables, like e.g. the foreign trade deficit, may have in generating inertia-type

effects in the inflationary process. The basic idea underlying this approach is that, due to institutional adjustments to inflation, and to accommodating monetary and fiscal policies, the stabilizing forces in high-inflation economies are generally weak, thus leaving the inflation rate in a "meta-stable" equilibrium. As a result, it is claimed, even a one-time shock to the price level, resulting e.g. from a change in the trade deficit, can lead to a long-term rise in the rate of inflation.[3]

Interestingly, similar controversies between theories that link inflation to fundamentals and theories that stress the independent role of balance of payments fluctuations emerged in the context of the German hyperinflation of the early 1920's.

> "The main division of opinion regarding inflation and dislocated exchanges lies between inflation and balance of payments theories. The former traces causation from quantity of money to domestic prices to rate of exchange; the latter, from real balance factors to rate of exchange, to certain domestic prices, and sometimes further to quantity of money." [Ellis (1934, p. 289)].

The "inertia approach" has been very influential. In fact, the actual policies implemented by finance ministers in Israel during the first half of the 1980's have been based, to some extent, on these ideas. The same is true for policies implemented in other countries, like e.g. Argentina in the late 1970's. Given the wide application of this approach in the design of policy, we confront in this paper some of its implications against time series data.

In particular, we consider the empirical implications of a specific hypothesis about the propagation mechanism. This hypothesis specifies a link between balance of payments crises, the policy reactions that they generate, and their implications for the inflation process. According to this hypothesis, balance of payments crises have played a key role in the acceleration of inflation through time. In response to these crises, it is claimed, the government devalues the domestic currency and lifts some of the existing price

controls. The initial cost-push effects that result from these measures are then quickly translated into an increase in the general price level through widespread indexation and monetary accommodation. To the extent that the economy is in a "meta-stable" equilibrium, this one-time increase in the price level is transformed into a persistent acceleration in the rate of inflation.[4]

In the context of this specific mechanism, our purpose in this paper is to provide empirical answers to the following questions: (i) Do one-time shocks to the variables that are suggested by the hypothesis above give rise to long term persistence, or inertia, of inflation? (ii) Do trade-deficit shocks generate the dynamic response implied by the hypothesis? (iii) What is the role of exchange-rate management and of price controls in the dynamics of inflation? (iv) How important, statistically, are different nominal shocks in the transmission of inflation? We provide in this paper answers to these questions by using a model-free estimation method: Sims' vector auto-regression technique.[5] By using this method, we are also able to present important "stylized facts" regarding the propagation of shocks in the high-inflation economy of Israel.

The paper is organized as follows. Section 2 describes the data and discusses main developments in the 1980's. Section 3 reports the results of autoregressive analysis of a five-variable system, using Israeli monthly data for the first half of the 1980's. Section 4 presents our main conclusions.

2. Data Description

The discussion above suggests that at least five variables should be used in the present empirical analysis: a measure of trade balance fluctuations; policy-determined variables like exchange rate depreciation, controlled-prices inflation, and the extent of monetary accommodation; and the inflation rate. Accordingly, the following monthly time series are used in our vector

autoregression analysis: DEF_t is an index of the ratio of the foreign trade deficit to industrial production; DS_t is the monthly percentage change in the exchange rate of the Israeli shekel relative to a basket of five foreign currencies (U.S. dollar, pound sterling, deutschemark, Dutch florin, and French franc); DPC_t is the monthly percentage change in the price index of goods and services that are subject to government price controls; DM_t is the ratio of public sector monthly monetary infusion to beginning of month's M1 money supply; DP_t is the monthly percentage change in the consumer price index. The data sources are various reports of the Bank of Israel and the Israeli Central Bureau of Statistics.

Figure 1 plots inflation (DP_t), exchange rate depreciation (DS_t), controlled-prices' inflation (DPC_t), and the ratio of money creation induced by the government budget deficit to M1 (DM_t). From 1980 until the last quarter of 1983 the inflation rate was quite stable, but relatively high (5-7 percent per month). Following the October 1983 crisis, higher inflation erupted and more unstable rates have been observed (10-15 percent per month). Of particular interest are the sharp reductions in the rate of inflation following the "package deal" policy of the end of 1984, the rise of inflation at the beginning of 1985 after the collapse of this policy, and the disinflation that followed the new stabilization policies that were adopted since mid-1985. Exchange-rate depreciation and controlled-prices' inflation exhibit similar patterns of behavior, reflecting their joint management by the government. Typically, upon the adoption of a new inflation-stabilization program there are sharp increases in these prices set by the government, in an attempt to "correct" for their previous erosion relative to the general inflation rate. Later on, these variables are slowed down with the purpose of disinflating the economy. These cycles reflect the unsustainability in the long run of price-management policies

that are not accompanied by contractionary adjustments in the government budget and the money supply. Regarding the latter, it can be seen from Figure 1 that money creation induced by the government budget deficit exhibits remarkable similar behavior to that of inflation. Figure 2 plots the trade deficit which exhibits wide fluctuations reaching a peak in 1983 following a previous policy of slowing down devaluation and controlled-prices' inflation. The focal point of our empirical analysis is to test a specific hypothesis that links these trade deficit fluctuations with movements in the variables depicted in Figure 1.

3. Analysis

Let X_t be a (5x1) vector giving the stochastic processes followed by the foreign trade deficit/output ratio (DEF_t), exchange rate depreciation (DS_t), controlled prices' inflation (DPC_t), money creation induced by the government budget deficit (DM_t), and inflation (DP_t):

$$X_t = \begin{bmatrix} DEF_t \\ DS_t \\ DPC_t \\ DM_t \\ DP_t \end{bmatrix}$$

The second-order vector autoregression for this process is[6]:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + u_t \qquad (1)$$

where A_0 is a (5x1) vector of constants, A_1 and A_2 are (5x5) matrices of least squares coefficients, and u_t is a (5x1) vector of least squares disturbances. The latter are also termed innovations, in that they represent the part of X_t that cannot be predicted linearly from two lagged values of X. Equation (1) is the form actually estimated in this section, using monthly

data for Israel from 1980:1 to 1985:12. Due to data transformations, the sample period for the dependent variables is 1980:4-1985:12. The estimated coefficients are difficult to interpret in the present framework, and thus are not reported here. (They are available from the authors upon request.)

Given the estimated parameters of the A matrices, it is possible to solve Equation (1) for X_t in terms of the u process,

$$X_t = C_0 + u_t + C_1u_{t-1} + C_2u_{t-2} + \ldots + C_iu_{t-i} \ . \qquad (2)$$

This is the system's vector moving average representation. Since the u process is composed of disturbances that may be contemporaneously correlated, it is useful to transform this process into one with contemporaneously orthogonal disturbances. This can be done by imposing a specific ordering of the variables, thus yielding the orthogonalized moving average representation--or impulse response function

$$X_t = Q_0 + e_t + Q_1e_{t-1} + Q_2e_{t-2} + \ldots + Q_ie_{t-i} \ , \qquad (3)$$

where, by construction, the e process contains mutually orthogonal disturbances that are functions of the u's. The coefficients of the impulse response function in (3) represent dynamic multipliers, in that they display the current and subsequent responses of the system to shocks in the components of e. The specific variables' ordering used in this section, suggested by the hypothesis to be tested, is as in the list of components of X_t; that is, DEF_t enters first, DS_t second, and DP_t enters last.

Table 1 reports the correlation matrix of contemporaneous disturbances. Seven out of the ten reported cross-correlations are of a small order of magnitude. The remaining three cross-correlations are around the 0.8 value, and correspond to the three price variables that are included in our analysis: DS_t, DPC_t, and DP_t.

In order to analyze the dynamic effects of shocks we plot in Figures 3 through 7, the responses, derived from the impulse response function up to 24 months, to a one-standard deviation shock in each one of the five variables considered. Each figure corresponds to a different shock.

Consider first the effects of trade-deficit shocks depicted in Figure 3. A worsening in the trade deficit is followed by an acceleration in exchange rate depreciation, in controlled prices' inflation, and in overall inflation. This shock is also followed by an increase in money creation which can be interpreted as reflecting monetary accommodation. The responses of both inflation and exchange rate depreciation reach their peaks by two months after the occurrence of the shock. Interestingly, this observed propagation mechanism conforms closely to the one specified in the Introduction. However, in contrast to the "inertia approach" all these responses to a trade deficit shock are of a temporary nature and no long-term persistence or inertia are detected.

Figure 4 gives the dynamic responses to exchange rate depreciation shocks. An increase in exchange rate depreciation is followed by temporary increases in controlled-prices inflation, overall inflation, and money creation. In terms of the implied effect on the real exchange rate, it can be seen that the increased nominal depreciation is partially offset by the increased inflation. Thus, a nominal depreciation shock induces a depreciation in the real exchange rate, but only to a small extent. This shock has negligible effects on the foreign trade deficit, which first increases and later on decreases.

Variables' responses to a shock in the inflation rate of controlled goods and services are depicted in Figure 5. A shock increase in this inflation rate is shown to be followed by short-lived accelerations in exchange rate

depreciation and in overall inflation which are subsequently reversed to decelerations in these two variables. The shock is also followed by monetary contraction. These findings are consistent with the view that although increases in controlled prices are inflationary in the short run, they need not be so in medium or long runs--especially in view of the reduction in subsidies that they induce. Thus, typically these increases in controlled prices may lead to a fall in the budget deficit and in money creation that they induce. That is, shocks to inflation of controlled prices do not generate long term inflation inertia. Last, these shocks have only mixed and small effects on the foreign trade deficit.

Figure 6 gives the effects of monetary shocks. A shock increase in the monetary infusion induced by the government budget deficit is followed by accelerations in the four nominal variables considered (DS_t, DPC_t, DM_t, and DP_t). As above, these accelerations are only temporary. The monetary shock has a somewhat surprising effect on the trade deficit, which moves in an opposite direction than that of the shock.

The dynamics of the system in response to an inflation-rate shock are depicted in Figure 7. A shock increase in inflation is accompanied by subsequent increases in foreign exchange depreciation and by monetary accommodation. The response of DPC_t shows wide fluctuations. It first decreases and then increases; one possible explanation would be that in the short run the government is attempting to offset the inflationary shock by decreasing DPC_t. As expected, the shock is followed by an appreciation of the real exchange rate. However, its effects on the foreign trade deficit are mixed.

Having traced out the system's responses to innovations, there is still a question as to the relative importance of each type of the shocks in statistically accounting for its own behavior over time as well as that of the

other variables. To assess this issue, we turn to the system's variance decompositions, which give the proportion in the forecast error variance of each variable that is accounted for by each one of shocks' variances. The i-months ahead error in forecasting X_t linearly from its own past is given by

$$X_t - E_{t-i}X_t = e_t + Q_1 e_{t-1} + Q_2 e_{t-2} + \cdots + Q_{i-1} e_{t-i+1} , \qquad (4)$$

where $E_{t-i}X_t$ is the linear least-squares forecast of X_t given X_{t-i}, X_{t-i-1}, etc.

Table 2 reports variance decompositions for $i = 24$ months. The figures reported in the table indicate that trade deficit shocks and exchange rate depreciation shocks are mostly autonomous, in that in each case lagged own shocks account for more than 70 percent of own forecast error variance. A similar, yet somewhat weaker finding holds for monetary shocks, despite the accommodation uncovered in the above analysis of dynamic responses. On the other hand, most of the forecast error variance in controlled prices' inflation and in overall inflation is accounted for by the variance of foreign exchange depreciation. In all cases, the variance of foreign trade deficit shocks has a relatively minor role in accounting for variances in the other variables considered.

4. Conclusions

Our key findings on the propagation mechanism of the inflation process in the high-inflation economy of Israel during the first half of the 1980's are as follows:

(i) There is no evidence in support of the notion that some shocks in Israel give rise to long term inflation persistence. This finding obviously questions the notion that the inflation rate is in a "meta-stable" equilibrium.

(ii) In most cases, and for most shocks, there is a close link among the nominal variables considered (DS_t, DPC_t, DM_t, and DP_t). This link is to be

expected in a highly indexed economy that is also characterized by extensive monetary accommodation.

(iii) Although some of the results tend to confirm the hypothesis that trade deficit shocks trigger inflationary responses, these shocks turn out to be unimportant in accounting for the behavior of key nominal variables. For example, only 11 percent of the forecast error variance of inflation is accounted for by these shocks; this is so even though the fact that the present orthogonalization procedure allows these shocks to enter first.

(iv) The results highlight the important role of innovations in exchange rate depreciation in accounting for the behavior of inflation and of controlled-prices' inflation.

(v) Monetary shocks have only a partial role in the propagation mechanism, and most of the statistical evidence is consistent with the existence of monetary accommodation.[7]

Although these findings are informative, there are at least four reasons for suggesting caution in interpreting and applying them. First, the analysis assumes that during the sample period the coefficients characterizing the vector autoregression remained invariant. Unfortunately, the small number of observations available for the period under study prevented us from testing this assumption. Second, we analyze the responses of the variables only with respect to <u>random</u> disturbances. There could obviously be important real events affecting the dynamics of inflation in Israel that are not captured by the innovations in the vector autoregression. Third, as previous work (using U.S. data) indicates, the results could be sensitive to changes in the list of variables included in the analysis as well as to the measurement and definition of these variables. Fourth, as suggested by the Lucas-critique, the findings of the present vector autoregression analysis may have limited

use in determining the effects of changes in policy rules on the propagation mechanism of the inflation process.

All in all, the findings reported in this investigation constitute a set of "stylized facts" that structural models of the propagation of shocks in a high-inflation economy such as Israel should account for.

FOOTNOTES

[1]For a recent controversial analysis of these topics in the context of hyperinflationary economies, see Dornbusch and Fischer (1986). For another analysis, see Sargent (1982).

[2]For an analytical framework which emphasizes the roles of exchange rate management, reserve movements, and budget deficits, see Helpman and Razin (1985).

[3]This approach, and its applications to Israel, has been put forward by Bruno and Fischer (1986).

[4]While not rigorously formulated, this hypothesis served as a basis for the adoption of some of the policy measures that were included in two recent inflation stabilization programs in Israel. The hypothesis is formulated in Liviatan and Piterman (1986), though it is not subjected to econometric tests. Fischer (1985) indicates that policy-makers in Israel seem to be concerned with high inflation rates only to the extent that the latter are accompanied by deteriorations in the balance of payments. The notion that monetary policy, and thus inflation, responds to fluctuations in the balance of payments is familiar from the literature on policy reaction functions for open economies; see e.g., Black (1983). Similar points were made in the discussions following the German hyperinflation:

> "There are certain instances in which a rise of prices follows <u>necessarily</u> and <u>inevitably</u> from the phenomena of foreign trade and the position of the rate of exchange; ... However great the pressure may be upon the central bank, however much further credit extensions and note issues may seem imperative, further inflation is an act of its own authority for which it is answerable." (Ellis (1934), pp. 268-269).

[5]For a recent application of this technique to U.S. data, see Litterman and Weiss (1985).

[6]To save degrees of freedom the number of lags has been set to two.

[7]Most of these findings conform with those reported by Helpman and Leiderman (1986) in their comparative study of inflation in Argentina, Chile, and Israel for the late 1970's and early 1980's.

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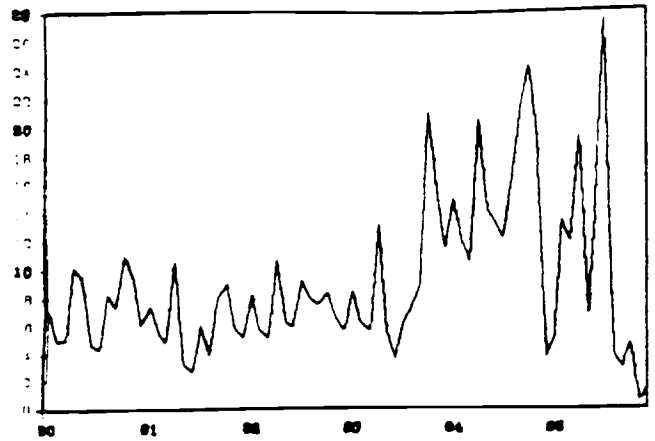
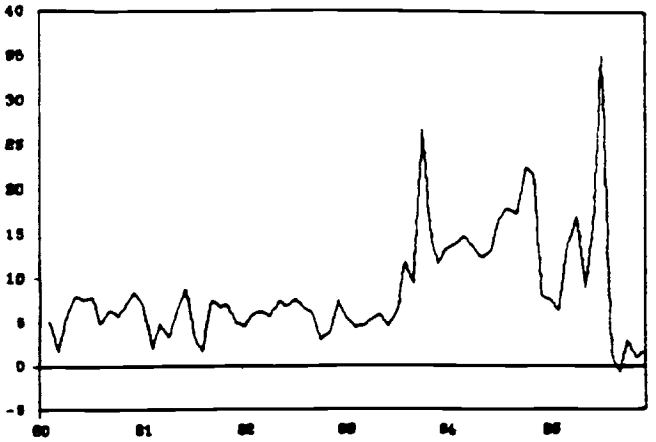


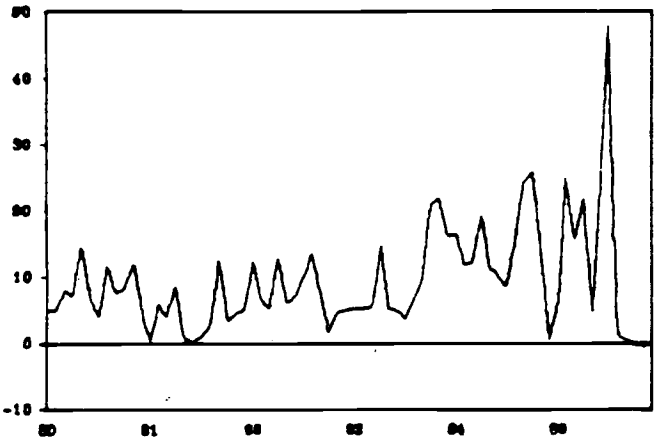
Inflation Rate

(Monthly % change in CPI)



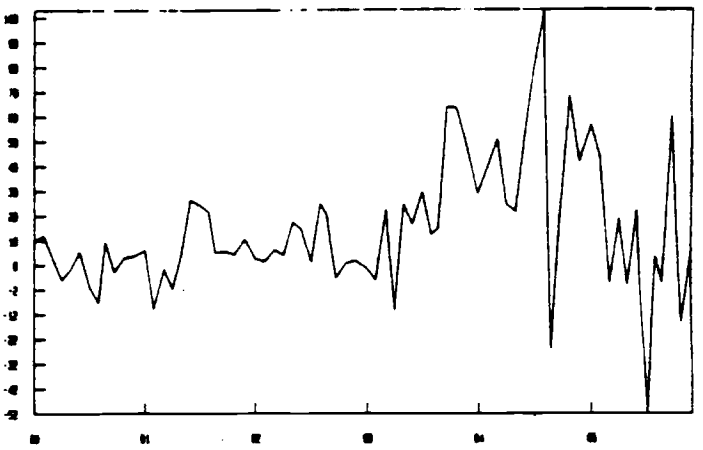
Exchange Rate Depreciation

(Monthly % change in shekel exchange rate against foreign currencies basket)



Controlled Prices' Inflation

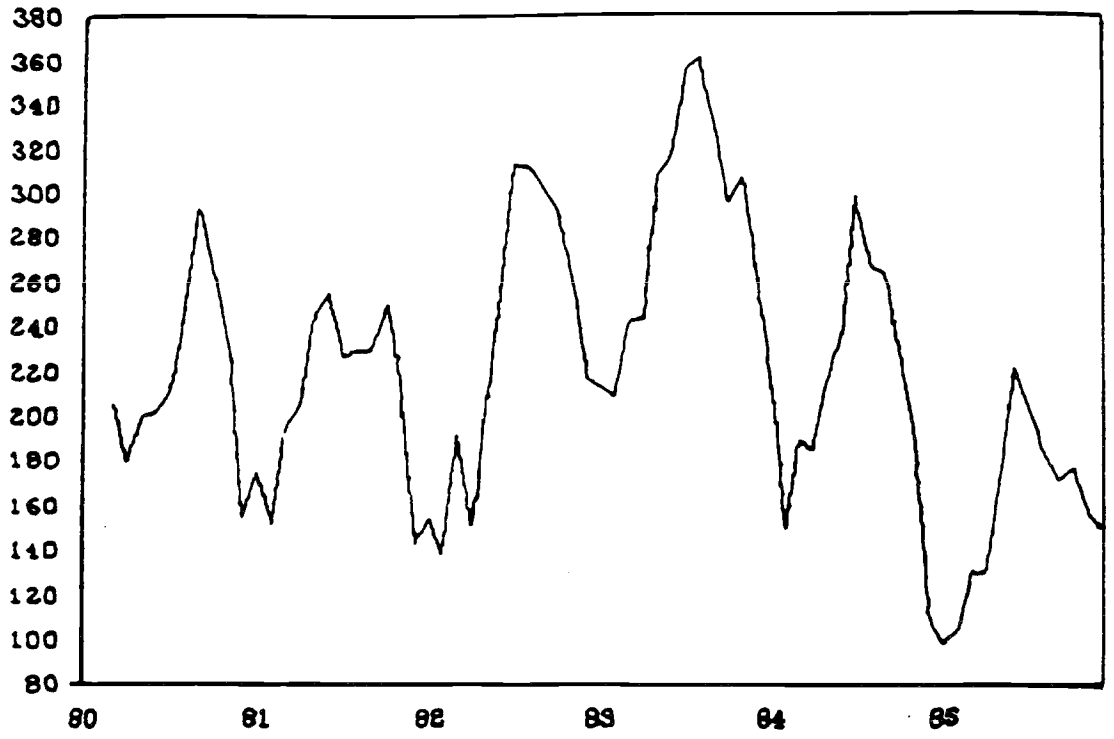
(In % per month)



Budget-Induced Money Creation

(As a fraction of the money supply)

FIGURE 1



Trade Deficit

(In millions of dollars, monthly, moving 3-month average)

FIGURE 2

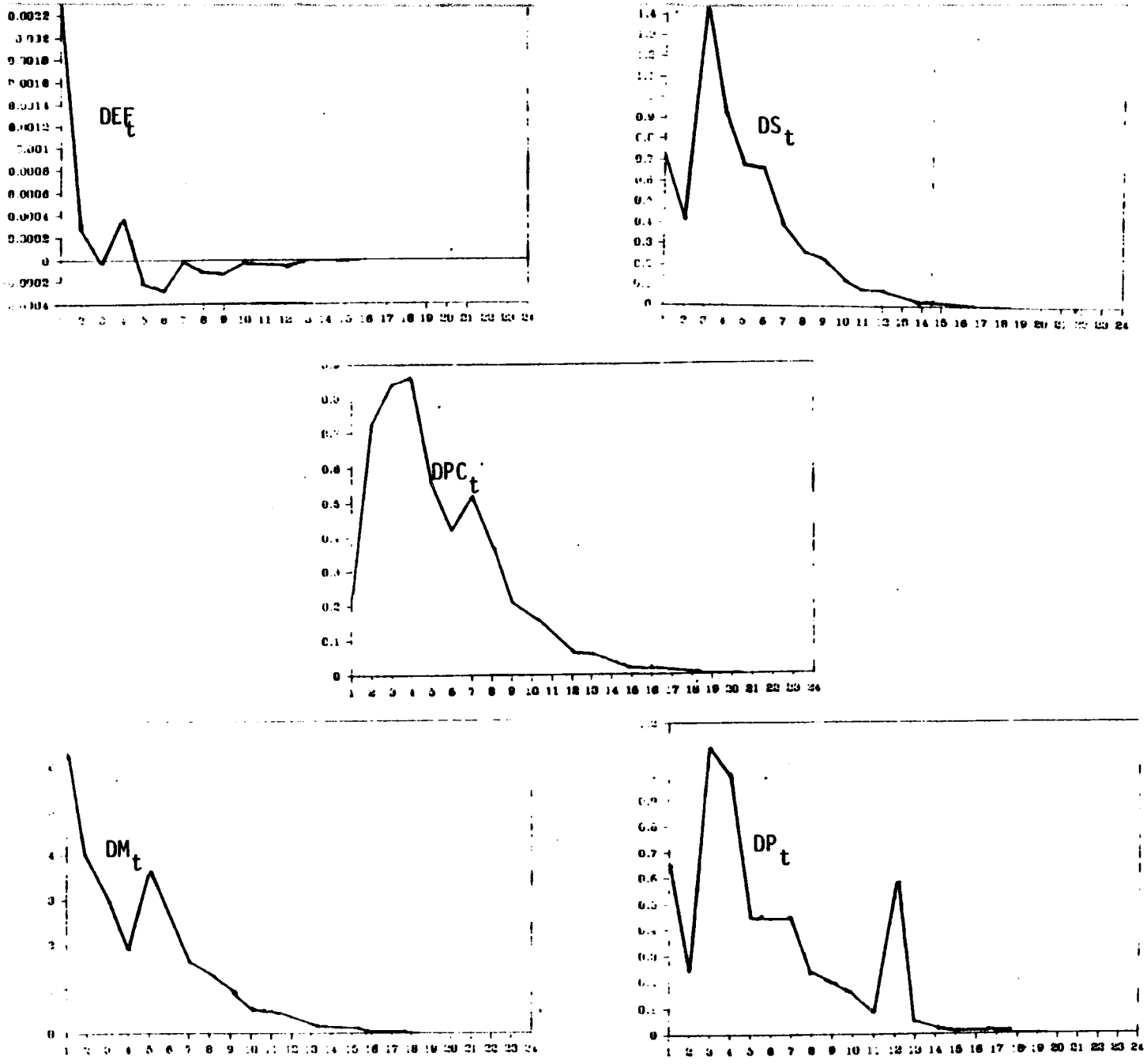
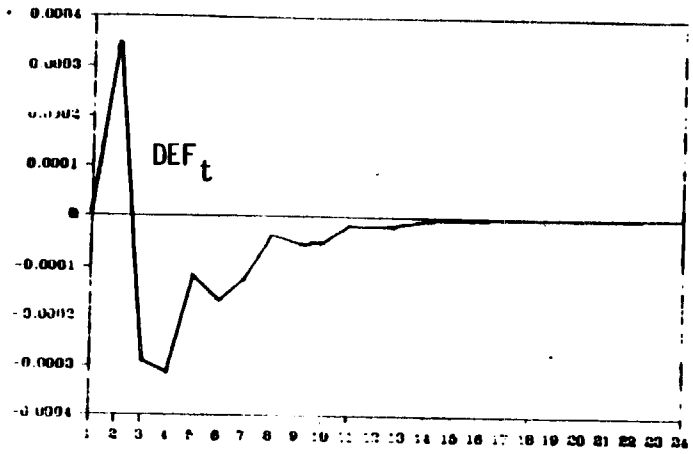
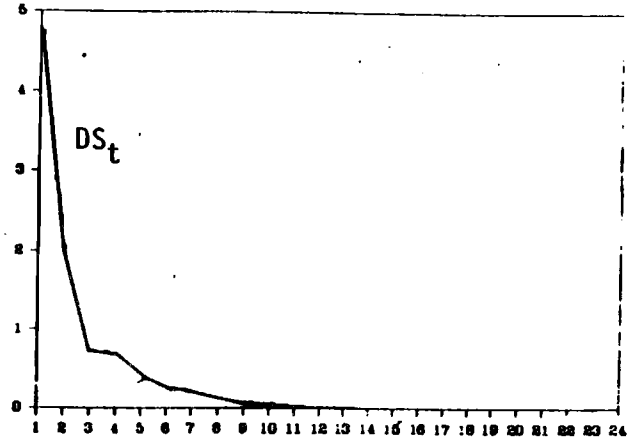
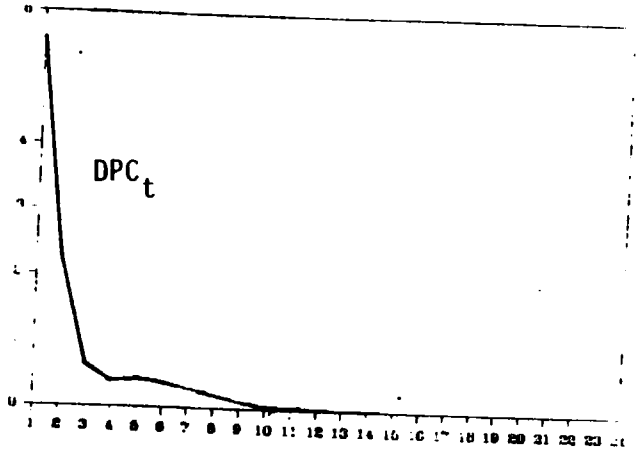
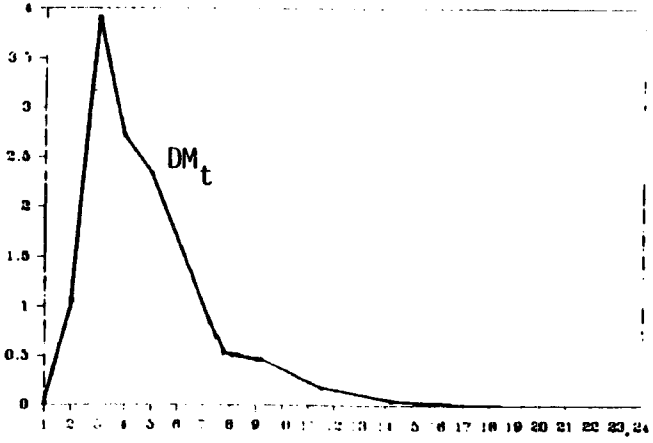


Figure 3 Responses to a trade-deficit shock









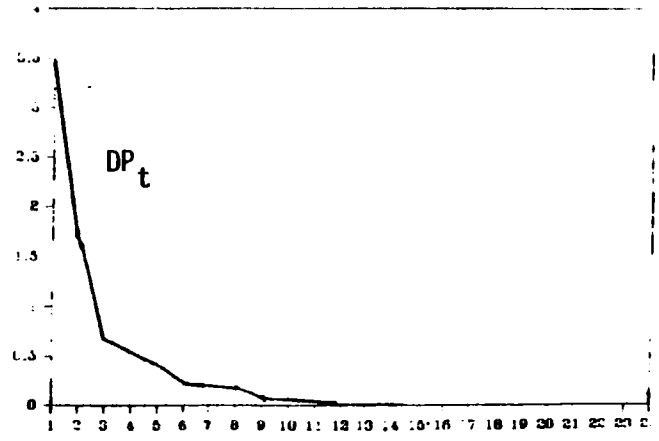


Figure 4 Responses to an exchange-rate depreciation shock

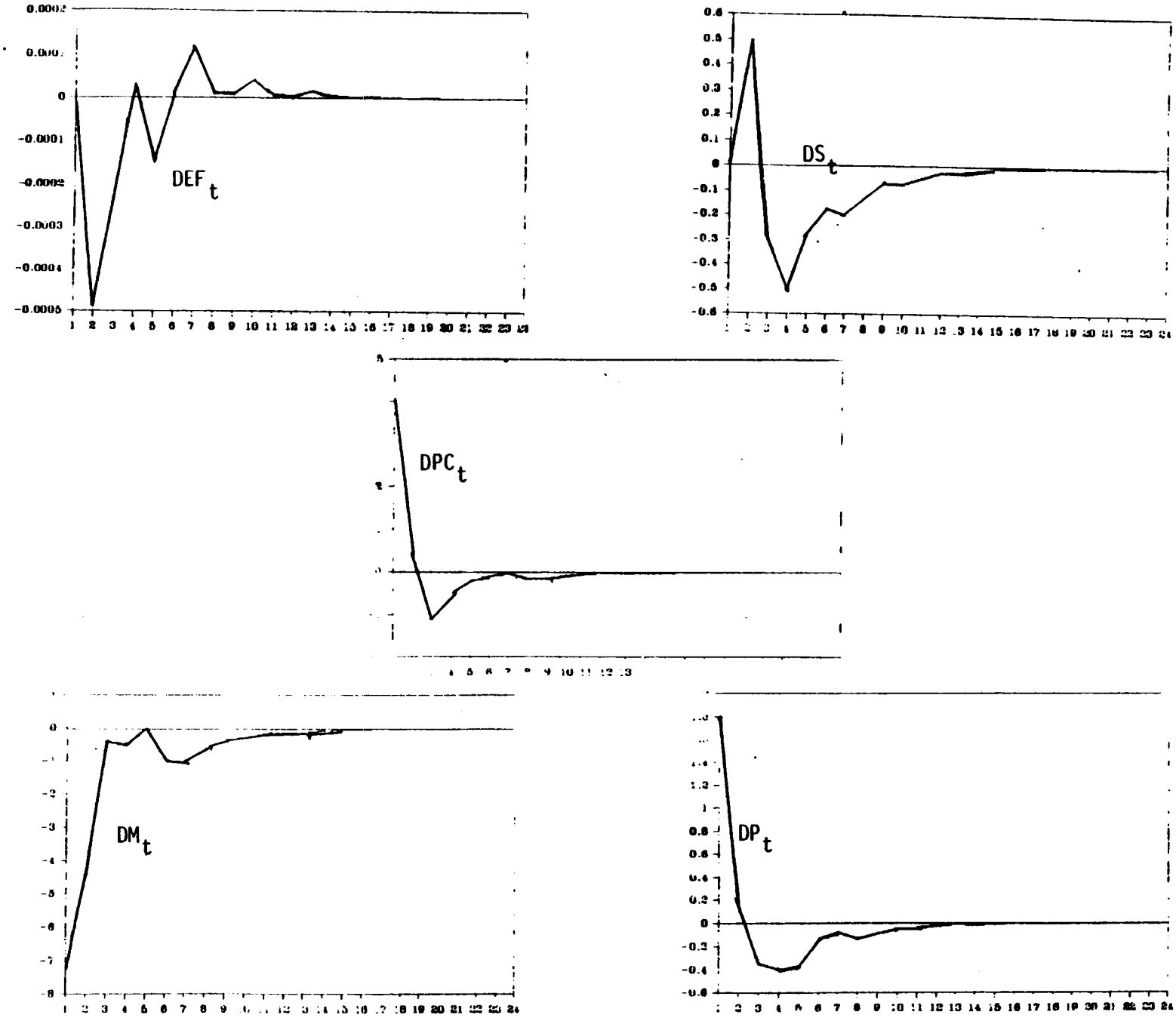


Figure 5 Resppnses to a controlled-prices' inflation shock

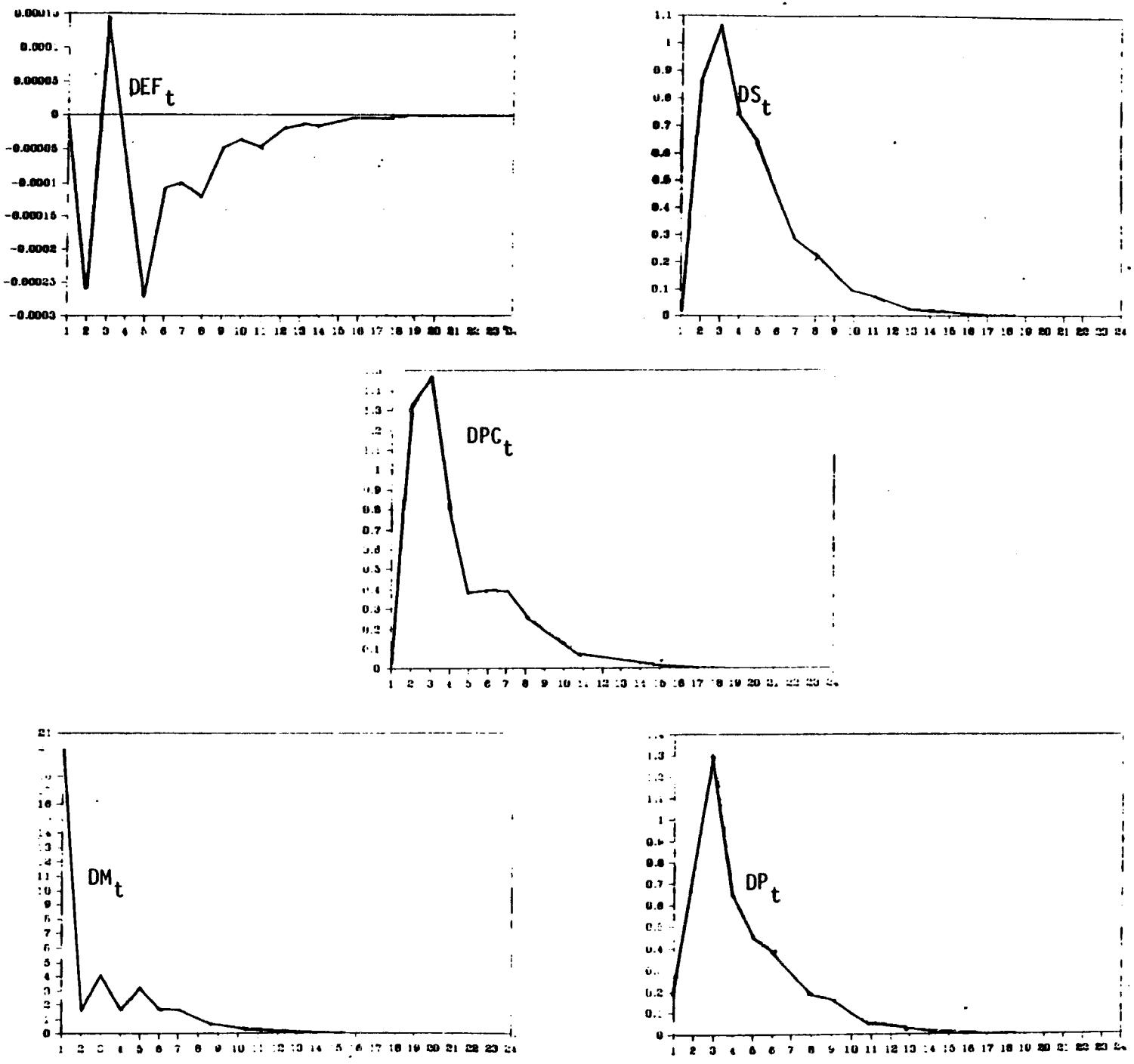


Figure 6 Responses to a money-growth shock

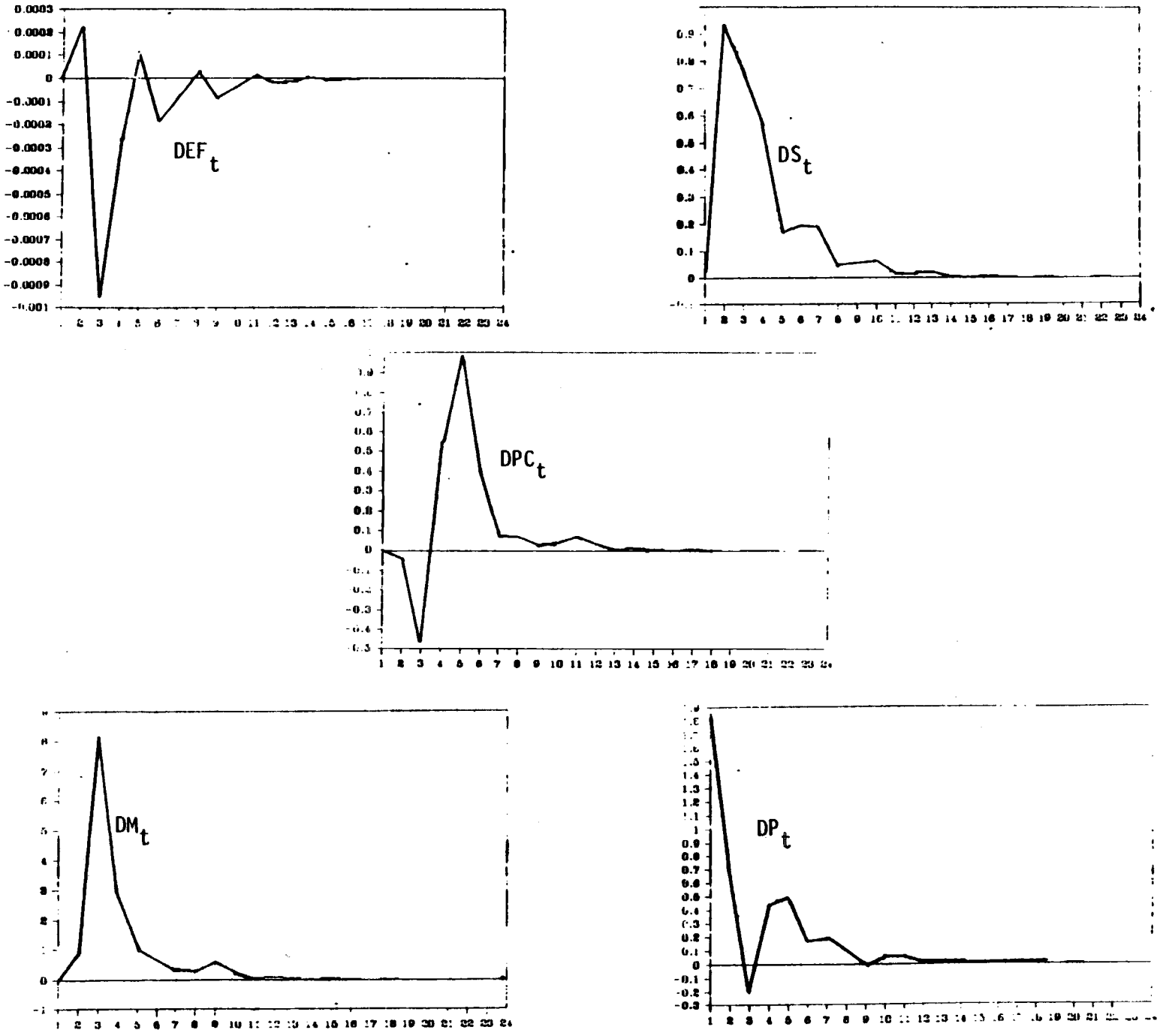


Figure 7 Responses to an inflation shock