NBER WORKING PAPER SERIES

THE INTERNATIONAL ECONOMY AS A SOURCE OF AND RESTRAINT ON UNITED STATES INFLATION

Michael R. Darby

Working Paper No. 437

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

January 1980

The author acknowledges comments from Arthur Gandolfi, James Lothian, and Anna Schwartz and the generous support of the National Science Foundation (grant APR78-13072), the Relm Foundation, the Scaife Family Trusts, and the Alex C. Walker Foundation. Michael T. Melvin and Andrew A. Vogel provided able research assistance. The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #437
January, 1980

The International Economy as a Source of and Restraint on United States Inflation

ABSTRACT

The balance of payments, changes in our terms of trade, and other foreign influences are widely believed to be a major, if not the dominant, cause of U.S. inflation. This is possible only if the international economy has caused a significant increase in the growth rate of the nominal quantity of money supplied, a significant decrease in the growth rate of the real quantity of money demanded, or both. Unlike nonreserve countries maintaining pegged exchange rates, the balance of payments need not influence the growth rate of the nominal quantity of money supplied by the Federal Reserve System. The Fed's reaction function is estimated and no effects of the (scaled) balance-of-payments can be detected. Nor is found any other channel by which the international economy has affected the growth rate of the nominal money supply. Changes in the terms of trade will cause some transitory self-reversing effects on real income, real money demand, and the price level and also some permanent shifts in these variables. Because the permanent shifts in the level are nonrecurring, they average out when we examine the average growth rate over substantial periods. Indeed for four year averages, all autonomous variability (domestic and foreign) contributes negligibly (standard error of 0.4 percent per annum) to variations in average inflation. Thus, except possibly a supporting role in the short run, international economy has contributed negligibly to U.S. inflation.

Michael R. Darby
Department of Economics
University of California, Los Angeles
Los Angeles, California 90024

(213) 825-3343

For presentation at the Annual Meeting of the American Association for the Advancement of Science, San Francisco, January 7, 1980.

D.3: January 8, 1980

THE INTERNATIONAL ECONOMY AS A SOURCE OF AND RESTRAINT ON UNITED STATES INFLATION

Michael R. Darby*
University of California, Los Angeles
National Bureau of Economic Research

The balance of payments, changes in our terms of trade, and other foreign influences are widely believed to be a major, if not the dominant, cause of United States inflation. This paper shows that such beliefs imply that the international economy influences the growth rate of the nominal quantity of money supplied or of the real quantity of money demanded or both in particular, testable ways. The postwar United States data are used to test these hypotheses. It is shown that the international economy has had at most trivial effects on the average inflation rate over a period of four years or more. Although the effects of the international economy are negligible in terms of American inflationary trends, they may be significant in terms of quarterly or even annual inflation rates and of inflationary trends in some other countries which maintained fixed exchange rates.

---

*The author acknowledges comments from Arthur Gandolfi, James Lothian, and Anna Schwartz and the generous support of the National Science Foundation (grant APR78-13072), the Relm Foundation, the Scaife Family Trusts, and the Alex C. Walker Foundation. Michael T. Melvin and Andrew A. Vogel provided able research assistance. The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

In Section I, the inflation rate is shown to equal the difference between the growth rates of the nominal quantity of money supplied by the Federal Reserve System and of the real quantity of money demanded by the public. International influences on the behavior of the Federal Reserve System are examined in Section II. International influences affect real money demand, particularly via changes in real income, but because these effects are once-and-for-all shifts their effect on the average inflation rate over four years is negligible, as seen in Section III. Summary and conclusions are presented in Section IV.

I. Proximate Determinants of the Inflation Rate

The price level P states the amount of money which exchanges for a standard basket of goods and services. We call this basket -- the average amounts bought with $1 in the arbitrary base year -- a base-year dollar (B$), and the price level is measured as dollars per base-year dollar. The inverse of the price level, 1/P or the amount of goods per dollar, is the price or value of money. As with any commodity it is useful to organize our discussion of the determination of its price by examining the conditions of supply on the one hand and demand on the other.

The nominal quantity of money supplied M^S is the total amount of currency, coin, and checking deposits held by the public. It is measured in nominal or dollar amounts. Operating through the commercial banking system, our central bank, the Federal Reserve System or Fed, determines M^S. The factors which affect the Fed's behavior are the subject of Section II.

The nominal demand for money has the useful property of being homogeneous of degree one in the price level. That is, a doubling of the price level, other things equal, doubles the nominal quantity of money demanded. This is so because people are concerned with the real quantity of money measured in terms of base-year dollars and not its nominal amount whether measured in dollars or dimes or whatever. Thus, we normally write the nominal quantity of money demanded M^d as the product of the real quantity demanded m^d and the price level

$$M^d \equiv m^d P \qquad (1)$$

The determinants of the real quantity of money demanded will be examined in detail in Section III with particular reference to channels of international influence.

In equilibrium, the nominal quantities of money supplied and demanded must be equal, so substituting in (1) and solving for the price level:

$$P = \frac{M^S}{m^d} \tag{2}$$

This equation states the price level in terms of the ratio of its proximate determinants: the nominal quantity of money supplied and the real quantity of money demanded.

We are concerned here with inflation, which is the growth rate of the price level. Let us define Γ_j as the growth rate operator such that

$$\Gamma_j X = \frac{\log X - \log X_{-j}}{j} \text{ for any } X > 0 \tag{3}$$

where X_{-j} is the value of X j years previously. Thus Γ_j computes the continuously compounded growth rate per annum of a variable averaged over a period of j years. The j-year-average inflation rate $\Gamma_j P$ is, therefore,

$$\Gamma_j P = \Gamma_j M^S - \Gamma_j m^d \tag{4}$$

The inflation rate is the difference in the average growth rates of the nominal quantity of money supplied and of the real quantity of money demand over the same period.

For the observable nominal and real quantities of money, equation (4) is true by definition; the usefulness of the approach comes from our ability to explain those quantities in terms of supply and demand conditions. Figure 1 illustrates the main channels by which the international economy might influence these supply and demand conditions. The balance of payments is hypothesized to influence the quantity of money which the Federal Reserve System chooses to supply. This influence has been observed for other countries

which fix their exchange rate to the dollar, but this evidence is not necessarily applicable to a reserve-currency country like the United States. Factors which influence our terms of trade -- such as the creation and decisions of OPEC -- affect our real income which is a major determinant of the real quantity of money demanded. We must examine empirically whether these factors have had a sufficiently large impact to cause significant variations in the growth rate of the real quantity of money demanded.

The general-equilibrium approach embodied in equation (4) elucidates the error in the partial-equilibrium or adding-up approach. This latter approach explains the inflation rate as a weighted sum of the inflation rates of individual goods and services without due allowance for the adjustment of wages, profits, and rents to make equation (4) hold. That is, the partial equilibrium approach starts from the definition of the price level as a weighted sum of the prices P_a of m commodities identified by the subscript a:

$$P \equiv \sum_{i=1}^{m} w_i P_a \tag{5}$$

For growth rates, the following formula therefore holds approximately

$$\Gamma_j P \simeq \sum_{a=1}^{m} \frac{w_a P_a}{P} \Gamma_j P_a \tag{6}$$

The argument goes that a rapid increase in the price of an individual commodity, such as oil, contributes to inflation according to its weight $\frac{w_a P_a}{P}$ plus any induced increase in other prices of closely related products. The problem with the approach is that it ignores the small but pervasive downward effect on the prices of all other commodities so that the general equilibrium condition (4) holds. Factors which make on particular group

of prices rise more rapidly influence the average growth rate of prices only to the extent that they increase the growth rate of the nominal money supply or reduce the growth rate of real money demanded.

II. Determinants of Nominal-Money-Supply Growth

The Federal Reserve System, a semi-independent agency within the legislative branch of government, operates through the commercial banking system to control the nominal quantity of money. Among the factors which influence the Fed's behavior are recent inflation and unemployment rates and unexpected changes in government expenditure. The first two factors are relevant to the Fed's role in attempting to stabilize while the third factor refers to the central bank's traditional financing of unexpected government expenditures by resort to the printing press.

A general behavioral function describing the nominal money supply behavior of the central bank is drawn from the Mark III International Transmission Model[1] and reproduced here:[2]

$$
\begin{aligned}
\Delta \log M = {} & \underset{\substack{(0.003)\\ 1.59}}{0.004} + \underset{\substack{(0.12)\\ 3.98}}{0.461}\,\Delta \log M_{-1} - \underset{\substack{(0.12)\\ -1.98}}{0.230}\,\Delta \log M_{-2} + \underset{\substack{(0.00005)\\ 5.06}}{0.00025t} \\
& + \underset{\substack{(0.029)\\ 0.14}}{0.004}\,\hat{g} + \underset{\substack{(0.021)\\ 0.08}}{0.002}\,(\hat{g}_{-1} + \hat{g}_{-2}) + \underset{\substack{(0.020)\\ 1.46}}{0.029}\,(\hat{g}_{-3} + \hat{g}_{-4}) \\
& + \underset{\substack{(0.090)\\ -0.64}}{0.058}\,(\log P_{-1} - \log P_{-3}) - \underset{\substack{(0.100)\\ -2.38}}{0.237}\,(\log P_{-3} - \log P_{-5}) \\
& \underset{\substack{(0.193)\\ -0.60}}{-0.117}\,u_{-1} + \underset{\substack{(0.363)\\ 1.49}}{0.539}\,u_{-2} \underset{\substack{(0.367)\\ -1.18}}{-0.432}\,u_{-3} \underset{\substack{(0.195)\\ -0.28}}{-0.055}\,u_{-4} \qquad (7)
\end{aligned}
$$

$$\bar{R}^2 = 0.56, \text{ S.E.E.} = 0.0046, \text{ D-W} = 2.05$$

The estimation is based on quarterly data for 1957-I through 1976-IV. The notation is t for time in quarters, $\hat{g}$ for unexpected real government expenditures, P for the GNP deflator, u for the unemployment rate, and the negative

subscripts indicate lags in quarters. The regression explains 56 percent of the quarterly variation in the growth rate of money, although the policy response to government spending, inflation, and unemployment is realtively weak and a long time coming. A great deal is hidden in the trend term which implies a gradual increase in the steady-state growth rate of nominal money from 0.2% per annum at the end of 1956 to 6.0% per annum at the end of 1976.[3] We shall return to this shortly.

A great many countries choose to fix their exchange rate with some other currency. This requires that they adjust nominal money growth to their balance of payments. This is not true for a fiat reserve country such as the United States,[4] but it is worthwhile to check whether the Federal Reserve System in fact responded to the balance of payments. To test this, I added three terms B, $(B_{-1} + B_{-2})$, and $(B_{-3} + B_{-4})$ to equation (7) where B is the ratio of the balance of payments to income. The F (3/64) statistic for testing the hypothesis of 0 coefficients on all 3 variables was only 0.25, and the coefficients in fact all were very small and of the wrong sign. So the evidence strongly indicates that international factors have not affected U.S. nominal-money growth via the balance of payments.

Absent the main channel by which international factors affect the nominal money supply in nonreserve countries, we must consider indirect effects. If there are temporary effects on the inflation rate or unemployment rate this would have a temporary effect on the growth rate of the nominal money supply. Possibly some of the unaccounted for variance could result from Fed responses to international factors which are uncorrelated with the balance of payments, but these factors are apparently serially uncorrelated and so not a source of a continuing effect on the nominal quantity of money supplied.

Summarizing, the balance of payments has had no effect on U.S. nominal money growth. No other channel would appear to offer any possibility for other than temporary effects on nominal money growth from the international sector.

The central bank's reaction function (7) mainly labels our ignorance as to the cause of the upward trend in nominal money growth. It has been widely supposed that financing of the Vietnamese War by printing money began the process. However, neither the fraction of the total labor force in the military nor the number of troops in Vietnam, when added to reaction function (7) enter at all significantly.[5] So the Vietnamese War apparently had no more effect than would be implied by any similar series of unexpected increases in government spending. If the upward trend reflects a gradual increase in the acceptable level of inflation as a result of our experience, then perhaps the Vietnamese War was indeed the beginning of the process which has since fed on itself.

III. Determinants of Real-Money-Demand Growth

The demand for money is one of the most thoroughly investigated topics in economics.[6] There are a number of variations, but the main theme is that the real quantity of money demanded m^d is a stable function of the interest rate r and total real income y. In the short run, unexpected changes in the growth rate of the nominal quantity of money supplied induce movements in r and y which change the growth rate of real money demand by the source amount. However, it is argued that these changes in r and y are temporary and in the long run all the effects are on prices with the real quantity of money demanded returning to its original growth path.[7]

Changes in other terms of trade can affect the real quantity of money demanded and hence the price level in two distinct ways -- one transitory and one permanent. The temporary effect occurs because an unexpected adverse change (an OPEC price increase, say) will shift up the supply curve of tradeable goods immediately while it takes time for the adjustments in domestic factor prices to occur as discussed at the end of Section 1. Figure 2 illustrates how a temporary upward shift in the aggregate supply curve from AS to AS′ would cause a temporary fall in real income from $\bar{y}$ to y′ and rise in the price level from $\bar{P}$ to P′. But these temporary effects are self-reversing as factor prices adjust and unemployment falls back toward its normal level.

Permanent effects of changes in the terms of trade on the real demand for money (and so the price level) would arise from permanent changes in the steady-state growth paths of real income or the interest rate. Some economists[8] have argued that the change in U.S. terms of trade associated with the creation of the OPEC reduced real income permanently by as much as

3 to 5 percent. This author would argue that those estimates are on the high side because price controls, which caused an overstatement of real income in the official data, were coincidentally taken off.[9] Be that as it may, note that this is a once-and-for-all reduction in the level of real income and not a permanent reduction in its growth rate. Figure 3 illustrates such a once-and-for-all percentage reduction in log m^d at time t for a given constant growth rate of the nominal quantity of money supplied. An equal once-and-for-all percentage increase in the price level is implied. Note that the average inflation rate (the slope of log P) is affected only for observations including time t.

Suppose that μ is the normal growth rate in the real quantity of money demanded due to normal growth in real income and the interest rate plus any technological change in payments technology and institutions. A once-and-for-all decrease in real income reduces real money demand but does not affect μ. When we look at average growth rates of the real quantity of money over substantial periods these once-and-for-all shifts will average out and have a negligible effect on inflation. For example if ε represents the once-and-for-all-shifts in real money demand over the previous year, the j-year-average growth rate of real money demand is

$$\Gamma_j m^d = \mu + \frac{1}{j} \sum_{i=0}^{j-1} \varepsilon_{-i} \qquad (8)$$

Assuming these shifts are uncorrelated with mean 0, the mean value of $\Gamma_j m^d$ μ and the variance is σ^2/j where σ^2 is the variance of ε. It is an empirical question as to whether the actual stochastic distribution of the ε's is such that the variance of $\Gamma_j m^d$ becomes trivial in a reasonably short period of time. If so, even though these shifts in the level of real money demand do

cause once-and-for-all price level shifts, the average effect of these price level shifts is negligible in discussing inflation trends.

To illustrate this empirically, I estimate the following regression

$$\Gamma_j P = \Gamma_j M - \mu + \varepsilon \tag{9}$$

for alternative observation lengths j. This ε includes not only the effects of once-and-for-all shifts in real money demand but also temporary induced movements in money demand. Since the induced movements are negatively correlated, they too average out for longer sample periods. Table 1 gives the standard errors, corrected R^2s, and Durbin-Watson statistics on the M_1 definition of money for data from 1954-IV through 1978-IV.[10] For quarterly data nominal money does not help predict the inflation rate.[11] For annual and biennial data we get improvement but still have substantial unexplained variance. With quadrennial data, however, the standard error of the inflation rate drops to about 1 percent per annum and the unexplained variance to around 19 percent. Thus, while real-money-demand shifts play a substantial role in short-run inflationary developments, long-run inflation trends are dominated by movements in the average growth rate of the nominal quantity of money supplied.

Some of these variations in the growth rate of the real quantity of money demanded are caused by the variations in the growth rate of the nominal quantity supplied as noted at the beginning of this section. We can get an idea of how much variation in the growth rate of real money demand is due to autonomous (non-supply) forces by regressing the current inflation rate on current and lagged nominal money growth:

$$\Gamma_j P = \sum_{i=0}^{4/j} k_i \, \Gamma_j M_{-ij} - \mu + \varepsilon \tag{10}$$

The four-year-distributed lag on money growth appears sufficient from the previous work of others to allow for most of the effects of variations in nominal money growth on the growth rate of real money demand. Table 2 reports regression estimates of equation (10). We see by comparison with Table 1 that about half of the standard error of the growth rate of real money demand is due to variations in the growth rate of nominal money supply. Indeed about 60 percent of the variance of quarterly inflation rates, 75 percent for annual and biennial inflation rates, and over 95 percent of the variance of quadrennial inflation rates is explained by current and lagged growth rates of nominal money alone. Since the total unexplained variance due to both domestic and international sources of variation in the growth of real money demand is so small, I conclude that as an empirical matter the international economy has had a negligible influence via the real-money-demand channel.

IV. Conclusions and Summary

We have organized our discussion in terms of the proximate determinants of the inflation rate: the average growth rates of nominal money supply and real money demand.

The balance-of-payments has a powerful effect on the money supply of countries which maintain fixed exchange rates. This need not be the case for a fiat reserve country such as the U.S. and no balance-of-payments effect on U.S. monetary policy was detected empirically. Only temporary and indirect channels were found by which the international economy could affect the growth rate of the nominal quantity of money supplied.

Effects on real money demand due to changes in real income appeared plausible. However, these effects are either temporary and self-reversing or of the once-and-for-all variety and result in price level shifts which only temporarily affect the inflation rate. Most of the variation in inflation rates is explained by variations in the growth rate of the nominal quantity of money supplied even for quarterly or annual observations. Measuring inflationary trends by quadrennial averages, over 95 percent of the variance in inflation is explained by nominal money (M_1) growth rates with less than 5 percent attributable to autonomous movements in the growth rate of the real quantity of money demanded due to both domestic and international factors. Thus the long-run influence of international factors on the U.S. inflation rate is negligible although they may play a supporting role in the short run. This negative conclusion leaves the responsibility for U.S. inflationary trends squarely on the Federal Reserve System. The international economy cannot be blamed for our poor performance to date nor used to excuse future failures.

REFERENCES

Carr, Jack and Darby, Michael R., "The Role of Money Supply Shocks in the Short-Run Demand for Money," U.C.L.A. Department of Economics Discussion Paper No. 98, October 1979.

Darby, Michael R., "The U.S. Economic Stabilization Program of 1971-1974," in Michael Walker, ed., The Illusion of Wage and Price Control, Vancouver: The Fraser Institute, 1976.

_____, Intermediate Macroeconomics, New York: McGraw-Hill Book Co., 1979.

_____, "The Monetary Approach to the Balance of Payments: Two Specious Assumptions," Economic Inquiry, January 1980, 18: in press.

_____ and Stockman, Alan C., "The Mark III International Transmission Model," National Bureau of Economic Research Working Paper No. , February 1980.

Goldfeld, Stephen M., "The Demand for Money Revisited," Brookings Papers on Economic Activity, 1973, No. 3: 577-638.

Laidler, David E. W., The Demand for Money: Theories and Evidence, 2nd ed., New York: Dun-Donnelley Publishing Corp., 1977.

_____, "The Demand for Money in the United States Yet Again," University of Western Ontario Department of Economics Research Report No. 7918, June 1979.

Mork, Knut A., and Hall, Robert E., "Energy Prices, Inflation, and Recession, 1974-1975," National Bureau of Economic Research, Working Paper No. 369, July 1979.

Rasche, Robert H. and Tatom, John A., "The Effects of the New Energy Regime on Economic Capacity, Production, and Prices," Federal Reserve Bank of St. Louis Review, May 1977, 59 (5): 2-12.

FOOTNOTES

[1]See Darby and Stockman (1980).

[2]The standard errors appear below the coefficients in parentheses, and t-values appear below the standard errors. The estimation was by two stage least squares using principal components of the predetermined variables in the Mark III model. Durbin's h cannot be computed in this case.

[3]This steady-state growth assumes all variables equal their expected values: $\hat{g} = \hat{g}_{-1} = \hat{g}_{-2} = \hat{g}_{-3} = \hat{g}_{-4} = 0$, $\log P_{-1} - \log P_{-3} = \log M_{-1} - \log M_{-3} - \frac{1}{2}\mu$, $\log P_{-3} - \log P_{-5} = \log M_{-3} - \log M_{-5} - \frac{1}{2}\mu$, $u_{-1} = u_{-2} = u_{-3} = u_{-4} = \bar{u}$, where μ is the steady-state growth rate of real money (see Section III) and $\bar{u}$, the natural rate of unemployment, is 0.0475 in 1956 and 0.0575 in 1976. The precise values of the natural unemployment rate are not important to these calculations and the 4 3/4 and 5 3/4 percent figures are my approximations of the mean estimates in the literature.

[4]See Darby (1980). A fiat reserve country is one which does not attempt to maintain a pegged exchange rate and which issues inconvertible paper money.

[5]Distributed lags of the military variables alone or in combination with the balance-of-payments variables also failed to enter.

[6]Standard reviews of the literature are Laidler (1977, 1980) and Goldfeld (1973). The author's own views are reported in Darby (1979) and Carr and Darby (1979).

[7]This holds strictly only in the case of superneutrality; we proceed on the assumption that this case holds sufficiently well for empirical work. See Darby (1979, pp. 134-137, 207-213) for analysis of the non-superneutral case.

[8]Notably Rasche and Tatom (1977) and Mork and Hall (1979).

[9]See Darby (1976).

[10]I started in 1954 to avoid the Korean War price controls, and 1978 is the last full year of data available at the time of writing.

[11]It would if the constraint that the coefficient of $\Gamma_j M$ equal 1 were not imposed. The negative corrected $\bar{R}^2$ is telling us that the variance in the quarterly growth rate of real money is greater than that of the quarterly inflation rate.

FIGURE 1

CHANNELS FOR INTERNATIONAL INFLUENCES

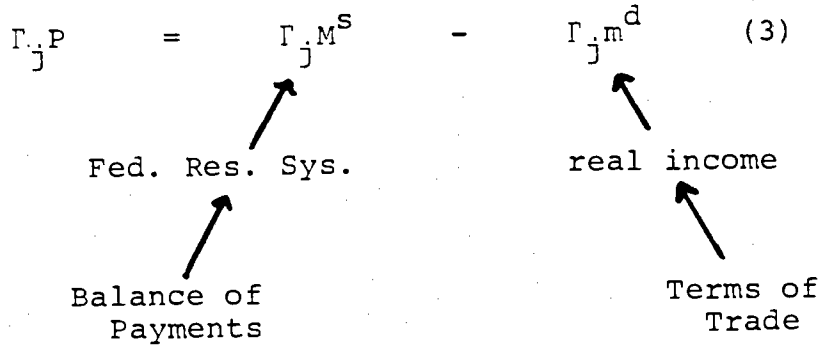


FIGURE 2

TEMPORARY PRICE LEVEL AND REAL INCOME EFFECTS FROM AN UNEXPECTED ADVERSE CHANGE IN THE TERMS OF TRADE

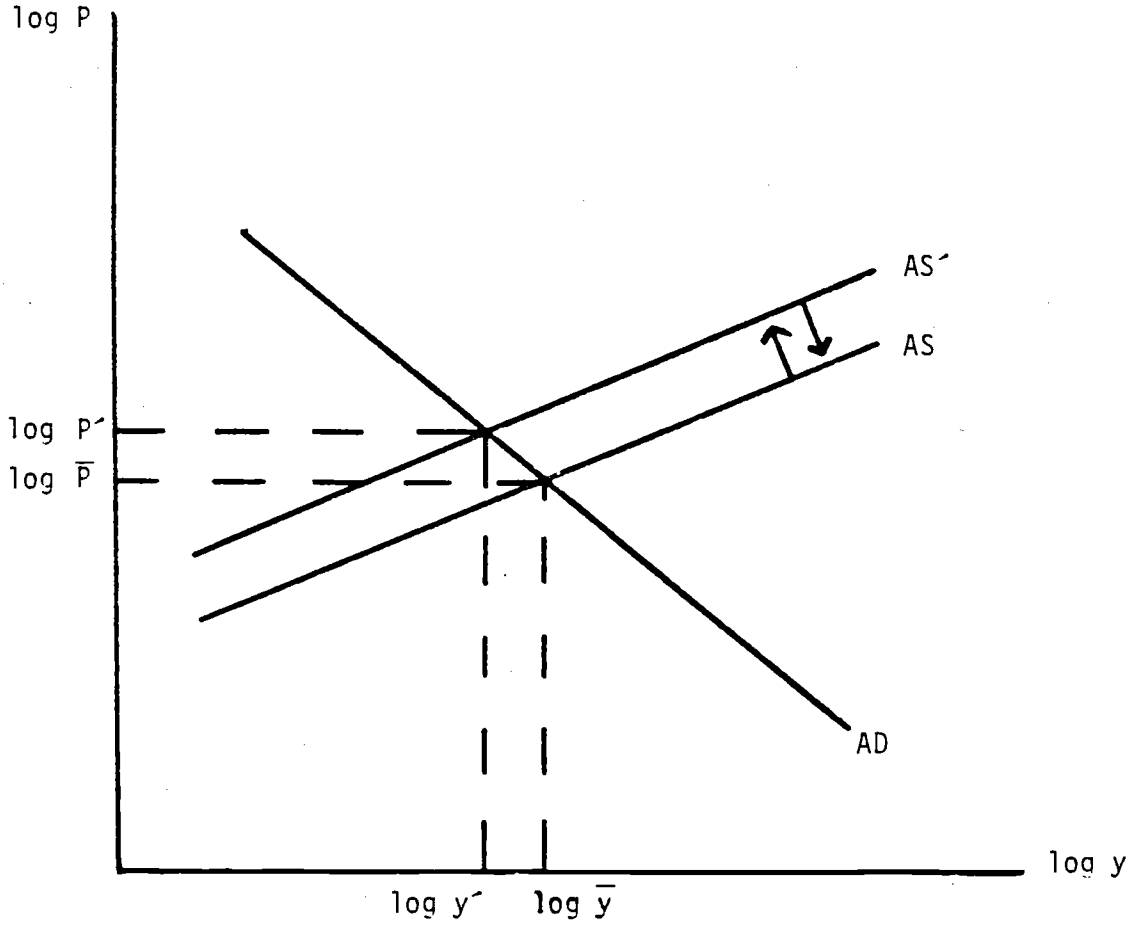
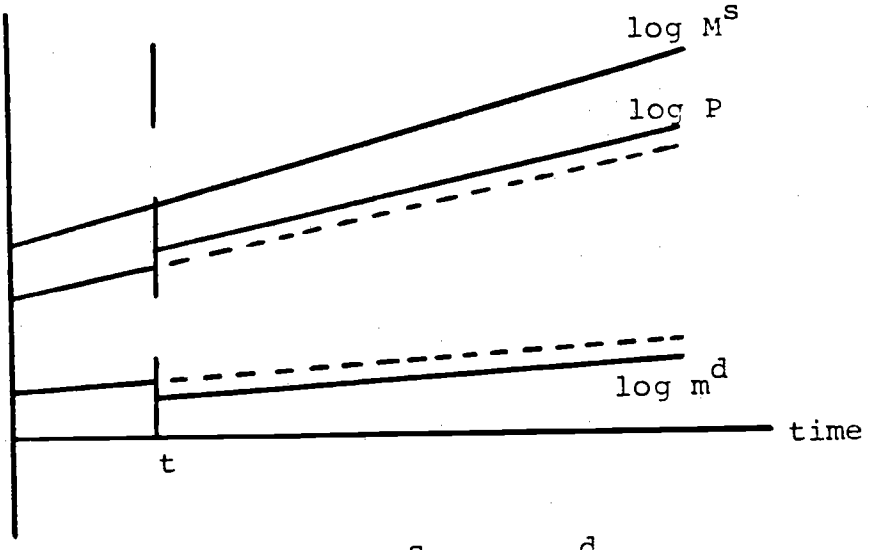


FIGURE 3

ONCE-AND-FOR-ALL SHIFT IN m^d AT TIME t



Note: $\log P = \log M^s - \log m^d$

TABLE 1

Summary Statistics for Prediction of Inflation Rate $\Gamma_j P$ as $\Gamma_j M - \mu$

Observation Length (j)	S.E.E.	$\bar{R}^2$	D-W
¼ year	0.0291	-0.2547	0.74
1 year	0.0229	0.1045	1.46
2 years	0.0189	0.3455	2.29
4 years	0.0095	0.8078	1.21

Notes: P is the GNP deflator; M is the M_1 (currency + demand deposits) money stock; all regressions are run on data from 1954-IV through 1978-IV.

TABLE 2

Summary Statistics for Prediction of
Inflation Rate by $\Gamma_j P = \sum_{i=0}^{4/j} k_i \Gamma_j M_{-ij} - \mu$

Observation Length (j)	S.E.E.	$\bar{R}^2$	D-W
1/4 year	0.0165	0.6264	1.00
1 year	0.0119	0.7802	1.48
2 years	0.0121	0.7586	1.74
4 years	0.0040	0.9699	2.83

Note: P is the GNP deflator; M is the M_1 (currency + demand deposits) money stock; all regressions are run for 1958-IV through 1978-IV on data from 1954-IV through 1978-IV.