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COMPARISON OF INTERWAR AND POSTWAR CYCLES: MONETARISM RECONSIDERED

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ABSTRACT

When monthly data on production, prices, and the money stock are interpreted, via a vector autoregression, as generated by dynamic responses to "surprises" in each of the variables, a remarkable similarity in dynamics between interwar and postwar business cycles emerges, though the size of the "surprises" is much larger in the interwar period. Furthermore, the money stock emerges as firmly causally prior, in Granger's sense, in both periods and accounts for a substantial fraction of variance in production in both periods.

When a short interest rate is added to the vector autoregression, the remarkable similarity in dynamics between periods persists, but the central role of the money stock surprises evaporates for the postwar period. While there are potential monetarist explanations for such an observation, none of them seem to fit comfortably the estimated dynamics. A non-monetarist explanation of the dynamics, based on the role of expectations in investment behavior, seems to fit the estimated dynamics better. That this explanation, which is consistent with a passive role for money, could account for so much of the observed postwar relation between money stock and income may raise doubts about the monetarist interpretation even of the interwar data.

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I. Monetarism and evidence

I take monetarism to be the view that monetary policy is of central importance in the business cycle and that the time path of the money stock is a good single index of monetary policy. As set forth by Milton Friedman and Anna Schwartz , monetarism emphasizes the relation of the level of the money stock to the level of aggregate real economic activity, without a detailed theory of why money fails to be neutral in the short run. In its more recent guise, as surveyed recently by Barro , monetarism develops an explicit basis for non-neutrality by positing barriers to information flow about prices.

Whether in its earlier or more recent form, monetarism claims support in the observed behavior of aggregate economic time series. At least over some time periods, the money stock and income are highly correlated. Such correlation, while it is an implication of the theory and hence corroborates it, is easy to explain as non-causal, representing a passive response of the money stock to real activity. Friedman therefore has documented a tendency for movements in the money stock or its rate of change to precede movements in aggregate activity. This is a more complicated implication of the theory, and hence is stronger corroboration than the correlation by itself. It is also harder to explain as a passive response of the money stock to real activity. James Tobin, however, showed that such timing patterns could be explained by a model in which money played a passive role.

Friedman and Schwartz did not rely only on statistical timing relationships, however. Through detailed analysis of historical episodes, they attempted to document the existence of major swings in the money stock which not only preceded major swings in real activity, but were not themselves reflex responses to developments in real activity. In the postwar period, though, the relatively smooth behavior of the money stock, and the acceptance by the government of

full-employment goals make isolation of convincingly "non-reflex" movements in the money stock very difficult. At the same time, the pre-war episodes involve, for the most part, banking panics and international capital movements. The panics, at least, are almost inevitably sudden and unanticipated, but neither they nor the capital movements are ordinarily without antecedents in real economic activity. Furthermore, even to the extent one accepts such episodes as shocks to the money stock which produced subsequent real developments, it is not obvious that one should extrapolate the dynamics of such events to the postwar period, where the movements in the money stock are at least thought to represent deliberate government policy moves to a much greater extent. Thus my 1972 demonstration that the money stock could be taken as exogenous in GNP on money stock distributed lag regressions was an important piece of support for the monetarist position. Despite the possibility that a substantial part of money-GNP correlation in the postwar period represented policy responses to developments in the economy, the data showed no evidence of such feedback; the observed statistical correlations and timing relationships were consistently interprable as representing entirely causal effects of money on income.

Modern rational-expectations monetarism has shifted attention away from structural interpretation of distributed lag regressions of GNP on money stock. Nonetheless the fact that the money stock is causally prior to GNP in Granger's sense in postwar U.S. data is important for the modern monetarist position. Rational-expectations monetarism suggests that it is the surprises in movements in the money stock which generate non-neutrality. This implies a difference in the way data are examined for support for the monetarist position. Instead of finding the percentage of variation in real activity which can be explained by a distributed lag on the levels of the money stock, one looks

for the percentage which can be explained by a distributed lag on surprises in the money stock. Now when "surprise" is taken to mean "innovation" in the technical time series sense of "the prediction error in a best linear predictor," it is easy to show that Granger causal priority of the money stock amounts to the equivalence of the percentages of variance in GNP accounted for by a distributed lag on the money stock and by a distributed lag on money stock surprises. Rational expectations monetarism yields a drastically different economic interpretation of the coefficients in distributed lag regression of output on money, but it gives the same interpretation to the substantial fraction of variance explained by such regressions. With money Granger causally prior, this fraction of variance represents under new or old monetarist views an unnecessary source of variability which could be eliminated by reform to make monetary policy more predictable.

Innovation accounting for interwar and postwar data

A multivariate linear time series model generates, according to the Wold Decomposition theorem, a representation of each series in the model as a linear combination of current and past innovations in the variables in the system. These innovations are by construction serially uncorrelated, and if they are transformed to be contemporaneously uncorrelated as well, variance in the variables in the system can be unambiguously decomposed into components attributable to each innovation. The results reported in this paper come from autoregressive systems linear in the logs of the variables, using twelve lags of each variable, monthly data, and a constant term but no trend term. Estimation was by unconstrained least squares. The "postwar" period refers to 1948-78, using[1] data on 1947 for initial conditions, while the "interwar" period refers to 1920-41, using data on 1919 for initial conditions.

Table 1 shows that data on money, industrial production, and wholesale prices fit, in most respects, a familiar monetarist mold. For both periods, money is nearly entirely accounted for by its own innovations -- i.e. behaves as if Granger causally prior. Tests of the hypothesis that all 12 lagged values of industrial production or of prices have zero coefficients in the money equation easily accept the null hypothesis. The smallest marginal significance level on these four F-tests is .18, confirming that the upper left corner of Table 1 is insignificantly different from 100 in both periods. Money innovations explain a substantial fraction of variance in industrial production in both periods, with the fraction notably more substantial in the interwar period. The fraction of price variance attributable to money innovations for the postwar period is smaller than what I had found in the earlier work with quarterly data already cited; this may be due at least in part to the use here of the more volatile WPI in place of the implicit price deflator, so that the long-run component of price variance is a smaller portion of the total.

In both periods the patterns of response of the system to innovations in the variables largely fit the monetarist framework. Production and prices respond positively to money innovations, both responses being smooth in both periods. Somewhat at variance with rational-expectations monetarism is the lack of a tendency for production responses to money to be temporary in either period. Though both periods' responses peak at about 18 months, neither has decayed to half its peak level after four years. Despite the tendency of monetary shocks to persist in both periods, price responses in the interwar (not the postwar) period do show up as temporary, with the price response gone after four years. Production responses to a given shock in the log of money are larger in the postwar period, and price responses are

smaller. This type of result has been interpreted in some recent work as evidence of greater price rigidity postwar, yielding greater real effects of given nominal surprises.

The most striking difference between the periods is in the variances of the innovations. Innovations in the log of money have a larger variance in the interwar period by a factor of about 22, for prices the factor is about 13.5, and for production the factor is 5. This fits the monetarist story that larger real fluctuations should be associated with larger monetary surprises, though the large difference in production innovation variances suggests that not all of the difference between periods is attributable to monetary policy and institutions -- as most monetarists would certainly agree. Contemporaneous correlations among innovations are all much weaker in these monthly data than in quarterly data. For the postwar period they are all at most marginally significantly different from zero; for the interwar period output innovations have significant correlations of .22 and .30, respectively, with money and prices.

The monetarist interpretation of these results could be explored in more depth, but let us turn instead to the more exotic pattern of results which emerges when short interest rates (the rate on 4-6 month prime commercial paper) are introduced into the system. I had found in earlier work with larger (9-variable) systems of quarterly data for the U.S. and Germany and of annual data for the U.S. that the proportion of variance in real variables attributable to money innovations shrank considerably in the larger systems. I had not been sure of the source of the difference between the larger and smaller systems. Meditation on the results of Yash Pal Mehra, who showed that money's causal priority clearly evaporates in systems including an interest rate, led me to try a system with the added interest rate variable to see if the behavior of this variable would fit into the monetarist story about the data.

As Mehra's results would lead one to expect, Table 2 shows that with interest rates included, the money stock is no longer strongly Granger causally prior. This

result is in itself not counter to the monetarist position; the strikingly non-monetarist aspect of Table 2 is that in the postwar period at the 48 month horizon only four percent of the variance of production is accounted for by money innovations. If this result is taken at face value, a rational expectations monetarist must admit that surprise changes in the money stock have in fact played a trivial role in postwar business cycles, that therefore imposition of a monetarist rule to make the quantity of money more predictable could have had little real effect.

If one examines the moving average representation (partially described in Table 3) in detail, one finds that the response of the log of production to a surprise unit increase in the log of the interest rate is essentially zero for about 6 months, followed by a smooth decline reaching a minimum around 18 months, with the minimum at -.17 with interwar data and at -.23 with the postwar data. After 48 months the output response has in the interwar data begun to turn back down again, being by this point -.20, and in the postwar data it has begun turning back up, being -.12. For the log of money stock, responses to an upward unit surprise in the log of interest rate are also in the form of a sustained, smooth decline. The shapes of these responses are similar across periods and their differences are marginally statistically significant at most, as can be seen from Table 3.

Thus in both periods some of the observed co-movements of industrial production and money stock are attributed to common responses to surprise changes in the interest rate. With this shift in attribution, surprise changes in the money stock are left with a very small role in explaining production variance in the postwar period.

Though there is not space here to discuss Table 3 in detail, it is worth noting a few things about it. In nearly every case, estimated response patterns are smooth in between the points for which data are displayed. While the responses

are broadly similar, there are apparently important differences in the responses of interest rates to money and production, both these responses being much stronger in the postwar period. Also, response of production to prices is significantly negative in the postwar period in the first year, and is not negative in the first year in the interwar period. Because of the computational expense, standard errors have not yet been calculated for the interwar responses, so some of these apparently significant differences between the periods may not be in fact. A chi-squared test for constancy of the dynamics, scaling residual variances in the triangularized autoregression to be constant across periods, yields a χ^2 (202) = 378.2 . While this would certainly reject the null hypothesis of constancy if the asymptotic distribution theory were taken seriously, it is smaller than the Akaike criterion which aims at rejecting only restrictions "false enough" to increase mean square prediction error.

Possible monetarist explanations

A rational expectations monetarist, to avoid the conclusion that monetary policy surprises are not important in explaining the real component of postwar business cycles, must argue that in the results described above monetary policy surprises are being mismeasured. One possibility is that interest rate and monetary surprises are being confounded. The decompositions in Table 2 use a triangular orthogonalization of the innovations, in effect attributing to effects of interest innovations, and so on down the list displayed in the Tables in the order interest, money, prices, production. This ordering was chosen because it maximizes the extent to which inter-period differences show up as differences in innovation-variances rather than differences in responses to innovations. However, because the postwar data yield such small correlations among innovations, the results that money innovations account for a trivial proportion of production variance is robust to the ordering of the orthogonalization. In other words, there is not much relation in the data between interest and money surprises.

But the innovations might be mismeasured because the time unit is wrong. If the time delay relevant to rational expectations business cycle theory is longer than a month, it may be that some of the true money stock surprise shows up spuriously as interest rate surprise with this fine time unit. This possibility seems ruled out, however, by the fact that the decompositions of variance with annual data show precisely the same anti- monetarist phenomenon -- money surprises account for less than ten percent of output variance when an interest rate is included in the system.

What about the possibility that some people in fact often anticipate policy-induced movements in the money stock? In this case one might expect the interest rate to rise in anticipation of forthcoming monetary tightness. If in addition the true time delay relevant to the rational expectations theory exceeds a month, one might then get the pattern of results we have displayed. This line of argument deserves further exploration, but it is not immediately clear that it can avoid internal contradictions. It certainly requires that some economic agents ignore published information on current interest rates.

A monetarist not maintaining the rational expectations stance might have an easier time explaining the results. If one is not claiming that changes in the money stock must be unanticipated in order to have a real effect, the notion that some money stock changes are anticipated, are therefore preceded by upward movements in short interest rates, and nonetheless have real effects just as if they were unanticipated, is quite acceptable. In fact one reason that this might happen leaps to mind.[2] Changes in base money might be transmitted to the stock of currency and demand deposits only with a delay, while having quick effects on the interest rate.

When the postwar system is estimated with reserves or base money replacing the money stock, however, almost precisely the same pattern of results emerges. The percentages of variance in industrial production explained by money innovations remain at or below 10 percent. The only notable difference is that base money, unlike currency plus demand deposits or reserves, shows no negative response to interest rate innovations; production still shows the same negative response to interest-rate innovations in the system with base money.

More generally, there is another difficulty with interpreting interest rate innovations as simply anticipated movements in the money stock. For both interwar and postwar data, the price level responds to money shocks with a steady price inflation over a year, while interest rate shocks, despite their effects on money supply, produce no substantial effect on prices. If interest rate innovations are simply anticipated money stock innovations, it is hard to see why they should affect prices so differently. Of course the rational expectations monetarist view does predict a difference here, but of the opposite sort -- anticipated money stock changes should have more effect on prices.

In the interwar years there were "panics" and in the postwar years there were "liquidity crunches." If these are interpreted as shifts in the public's preferences toward cash, away from deposits, they might be the source of the observed response to interest innovations. If, as the public tries to convert deposits to cash, the Federal Reserve responds weakly or not at all with injections of reserves, one would expect a quick rise in interest rates, a fall in the money stock, and a decline in output as if there had been a deliberate monetary tightening. This story is not "monetarist" in the sense I gave the term at the outset, in that it does not attribute the observed pattern to surprises in monetary

policy directly. On the other hand, this story is in the spirit of Friedman and Schwartz's own discussion of the depression, in which they claim not that the initial shocks came from arbitrary monetary policy, but rather that failure of monetary policy to respond appropriately to shocks originating elsewhere magnified the effects of those shocks.

This explanation is not implausible to me. It does have defects. It leaves open the question of why price responses to this type of shock are different from those to innovations in money supply. It seems to require that the monetary authorities in the postwar period respond in almost the same pattern to an increased demand for cash as did the monetary authorities in the interwar period, which might seem implausible. And it leaves unexplained the origin of these sudden, cyclically important shifts in the demand for cash.

A non-monetarist expectational theory to fit the facts.

A Keynesian view of the business cycle centers attention on the relation of capital purchases to expectations of future profitability. As is now widely understood, in order for expectations of the future to play the central role in investment behavior which Keynesian theory gives them, it must be costly to adjust the capital stock rapidly. The theory which emerges is much the same, whether one has adjustment costs internal to the firm or external, in the form of a capital goods industry with increasing costs. In the latter case, firms which are capital-goods pricetakers will have as an equilibrium condition

*) $$r = \dot{P}_k/P_k + \pi/P_k,$$

where P_k is the effective price of capital goods (including discounts, the cost of obtaining prompt delivery, etc.) r is the instantaneous interest rate, and π is the real marginal product of a physical unit of capital. Suppose information becomes available indicating that the real yield on capital, π , will decline at some point several months from now. It seems plausible that this would lead to a drop in the rate of investment, and hence to a drop in P_k. If this drop in investment is persistent over several months, P_k must remain small initially. From (*) above we can see that this means that r must rise.

This story does of course depend on some implicit assumptions. If P_k is held rigid either by a very flat capital-goods supply curve or by a rate of saving which is insensitive to returns, even over the short run, then (*) will be satisfied by a persistently tight link between r and π . Knowledge of a future decline in π could not then raise current r.

Clearly this story fits the response of production to interest rate innovations, in particular to the 6-month period following the shock, in both interwar and postwar response patterns, during which production remains flat. The observed responses of money stock to the interest shocks could simply be the tail following the dog: non-monetary economic developments raise interest rates, then push production down; and the demand for money declines smoothly in response, as standard theories lead one to expect.

This theory explains the similarity in response to interest shocks across periods by similarity in the short run supply elasticity for capital goods and similarity in short-run yield-elasticities of savings. This seems more plausible to me than the similarity of persistent patterns of monetary policy errors which the monetary theories seem to require. The theory does not directly explain why price-responses to interest and to money-stock innovations should be different,

but such differences are certainly no paradox from the point of view of the theory. For monetarist theories, the absence of price response to a change in money stock following an interest rate surprise does seem a problem.

It should be noted that this theory is not contradictory to the interpretation of interest rate shocks as representing "liquidity crunches." The interest-rate surprise in this theory represents a surprise decline in valuation of existing assets while current real productivities of capital remain high. One would expect such a situation to result in problems in maintaining collateral for bank loans and complaints that loans for legitimate working capital purposes are available only at high interest rates.

Conclusions and implications

Certainly the theory put forth in the preceding section must at this point have only the status of an interesting working hypothesis. It should also be noted that, despite elements giving it a Keynesian flavor, it has no direct implications for whether active countercyclical monetary or fiscal policy can have good effects, or any effects.

Even as a working hypothesis, though, the theory raises some interesting issues. The theory treats an historically reliable pattern of dynamic statistical relations, which look like causal relations ought to look, as reflective of the workings of anticipations through financial markets. It has long been recognized (as pointed out in some detail in my 1977 paper) that prices of freely traded durable goods, including especially financial assets, should behave to a close approximation as if "Granger causally prior" to any time series observable by market participants. The stock of money is not the price of an asset, and we are used to thinking of it as determined by the Federal Reserve, with shifts in demand for money having little immediate impact on the stock. But the demand for money ought certainly

in principle to be related to the value of existing assets. If we view the stock of money as quickly responsive on a month-to-month basis to shifts in demand for it, the prospect arises that distributed lag regressions of production on money have predictive value for the same reason that similar regressions using stock prices do. A theory which rigorously developed this possibility would amount to a stochastic version of Tobin's "Money and Income: Post Hoc Ergo Propter Hoc?" Exploring the implications of theory in this line seems to me a major item on the agenda for macro-economic research. Money innovations after all still seem to explain most of the interwar business cycle. Is this because surprises in monetary policy were really more important in that period, or would the result evaporate in a model which treated monetary surprises symmetrically with a wider array of financial surprises?

Table 1

Three-Variable Innovation Accounting

Percentages of 48-month Forecast-Error Variance Explained,

Interwar/Postwar,

Variables Explained	by Innovations in M1	IP	WPI
M1	92/97	4/2	4/1
IP	66/37	28/44	6/18
WPI	38/14	19/7	43/80

Table 2

Four-Variable Innovation Accounting

Percentages of 48-Month Forecast-Error Variance Explained

Interwar/Postwar

Variables Explained	by Innovations in R	M1	WPI	IP
R	63/50	28/19	7/4	1/28
M1	39/56	58/42	1/1	1/1
WPI	1/2	54/32	43/60	3/6
IP	16/30	58/4	7/14	18/52

Table 3

Responses to Unit Shocks

Variable shocked	Months later	Responses: Interwar, Postwar R		M		P		IP		Approximate Postwar Standard Error R	M	P	IP
	1	1.0	1.0	-.05	-.01	.02	.01	-.04	.02	.02	-	.001	-
	3	1.1	1.4	-.06	-.03	.02	.01	.01	.05	.06	.004	.01	.02
	8	.89	.68	-.12	-.07	.05	.02	-.07	-.09	.11	.01	.02	.05
R	16	.59	-.07	-.15	-.10	.02	.01	-.13	-.24	.23	.02	.04	.07
	24	.65	-.59	-.19	-.10	-.01	-.01	-.14	-.19	.27	.02	.05	.07
	48	.46	-.11	-.23	-.10	.01	-.04	-.20	-.12	.27	.02	.04	.06
	1	0.0	0.0	1.0	1.0	.01	.10	.47	.42	-	-	.03	.06
	3	-.25	3.02	.94	1.19	.34	.24	.85	.95	1.40	.08	.15	.26
	8	.06	10.08	1.32	1.52	1.18	.71	2.43	1.51	2.78	.26	.33	.57
M	16	2.32	11.71	1.76	1.51	1.80	1.40	3.06	1.58	4.62	.36	.64	1.20
	24	3.25	13.38	1.63	1.34	1.31	1.76	1.89	.16	4.92	.38	.87	1.04
	48	3.56	-.31	.51	1.37	-.06	2.04	.51	.53	2.61	.48	1.03	1.04
	1	0.0	0.0	0.0	0.0	1.0	1.0	.39	.03	-	-	-	-
	3	-.31	.79	.17	.03	1.39	1.37	1.15	-.12	1.0	.05	.07	.20
	8	.93	-1.84	.25	-.08	1.58	1.74	.58	-.78	1.9	.11	.22	.43
P	16	1.21	-.08	.08	-.03	.67	1.70	-.46	-1.51	2.6	.20	.39	.54
	24	1.14	-1.26	-.06	-.06	.26	1.38	-.66	-1.53	2.0	.28	.47	.72
	48	1.32	-2.18	-.21	-.22	.16	.78	-.10	-.81	2.1	.43	.47	1.02
	1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	-	-	-	-
	3	-.33	1.37	.09	.05	.05	.12	1.48	1.48	.42	.02	.04	.11
	8	.65	3.40	.08	.03	.17	.24	.94	1.24	.98	.05	.08	.21
IP	16	.34	3.24	.21	-.01	.28	.25	.48	.72	.97	.08	.14	.27
	24	.22	1.32	.18	0.0	.13	.05	.11	.49	.97	.10	.16	.32
	48	.24	1.45	.01	.09	-.06	-.23	.02	.87	1.03	.15	.24	.47

NOTES ON THE TABLES:

A linear model for a vector stochastic process x can be expressed as

$$x_t = \sum_{s=0}^{\infty} A_s e_{t-s},$$

where $e_t = x_t - E(x_t | x_{t-1}, x_{t-2}, \ldots)$. If we then choose a lower triangular matrix B such that Be_t has a diagonal covariance matrix and B has ones on its diagonal, we can replace A by $C = AB^{-1}$ and e by $f = Be$, to obtain

$$x_t = \sum_{s=0} C_s f_{t-s}.$$

For the linear model fit to logs of the variables of this paper, the coefficients in C are what is reported in Table 3 as "responses to innovations." The variance-covariance matrix of $x_t - E(x_t | x_{t-k}, x_{t-k-1}, \ldots)$, the k-period-ahead forecast of x, is given by

$$V_k = \sum_{s=0}^{k} B_s \, \mathrm{Var}(f_t) B_s' .$$

This formula, with k=48, is used to generate Tables 1 and 2. The approximate standard errors in Table 3 were generated by Monte-Carlo integration of the likelihood, and correspond to the standard errors of Bayesian posterior distributions with a flat prior. They are approximate not mainly because of their Monte Carlo source, but rather mainly because they were generated with the data orthogonalized in a different order than that used to generate the responses tabulated. Because of the near-orthogonality of the postwar residuals, this makes little difference to the responses, but it does affect the standard errors of first and second period responses quite a bit, in percentage terms.

Data Sources

All postwar data are from the Citibase data base maintained on the TROLL system at MIT. Definitions and primary sources are: M1: Currency plus demand deposits, seasonally adjusted; Federal Reserve. R: Rate on prime commercial paper, 4-6 months; Federal Rkserve. IP: Industrial production, total index, seasonally adjusted; Federal Reserve. P: Producer price index for finished goods, seasonally adjusted; Bureau of Labor Statistics.

For the interwar data, definitions and sources are as follows: M1: Currency plus demand deposits, seasonally adjusted; Friedman and Schwartz. R: Rate on prime commercial paper, 4-6 months; Banking and Monetary Statistics, a volume published by the Federal Reserve Board. IP: Industrial production, total index, seasonally adjusted; from the Federal Rkserve Board publication Industrial Production, 1971. P: Wholesale price index; total index from a 1970 mimeographed BLS release.

FOOTNOTES:

[1]Space limitations prevent my providing adequate documentation of the methods used, or even of the statistical results. The methods are described in more detail in my 1978 and 1980 papers. I intend that the results will be presented in more detail in a forthcoming discussion paper. Estimation was carried out with the assistance of Thomas Doan, using his recently minted program for econometric time series analysis, RATS.

[2]It leaped to my mind, however, only after Robert Gordon had pointed it out to me.

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