The Timeliness of the Effects of Monetary Policy: The New Evidence from Econometric Models (*)

The usefulness of monetary policy for smoothing out cyclical movements or keeping the economy on its desired growth path has long been a matter of debate. In the past, monetary policy was often condemned as being ineffectual or at most as affecting the small and weak enterprises which were the ones most easily injured by any reduction in the availability of credit. More recently, the Chicago School led by Professor Milton Friedman has condemned discretionary monetary policy on the ground that its effects would be realized with an uncertain but long delay — usually a long enough delay to make policy measures useless or even dangerous. Most recently, there has appeared a number of very elaborate econometric models which showed either little or no effect of monetary policy measures on the real world or — in the last few years — have shown important effects which would be realized only after a long lag.

The latest of these findings is in an 80-equation model of the U.S. economy prepared by teams of economists from the Federal Reserve Board and the Massachusetts Institute of Technology (1). Because of its advantages in terms of up-to-dateness and skill and the prestige of its developers, its findings of an excessive monetary policy lag will be the focus of our attention, but the analysis to be

(*) The views expressed are not necessarily those of the writer's employer, the International Monetary Fund.

(1) F. DE LEEUW and E. GRAMLICH, "The Federal Reserve-MIT Econometric Model", *Federal Reserve Bulletin*, January 1968, pp. 10-40. The other participants in the formulation of the model include F. Modigliani and A. Ando plus C. Bischoff, D. Jaffe, M. Norman, R. Rasche, H. Shapiro, G. Sparks and R. Sutch (MIT); and E. Miller, H. Popkin, A. Tella and P. Tinsley (Federal Reserve).

See also R. H. RASCHE and H. T. SHAPIRO, "The F.R.B.-M.I.T. Econometric Model: Its Special Features", *American Economic Review*, LVIII, May 1968, pp. 123-49.

made will be shown to be pertinent to others of the well-known quarterly models of the U.S. economy.

The finding on the excessive length of monetary policy lags was that:

> ... monetary policy is ultimately quite powerful but the lags are long. To that extent, these tentative results suggest that monetary policy is difficult to use as a stabilization device. The powerful impact of a policy change will not come into play until one year hence, when it is inevitably more difficult to predict the needs of stabilization policy.
> ... fiscal policy suffers less from the lag problems that plague monetary policy. ... The lag problems that may interfere with the effectiveness of fiscal measures are lags between recognition of the need for action and actual changes in tax rates or expenditures, not lags in the economy's response to the policy changes (2).

The excessive length of monetary lags found is the consequence first of a finding of no influence for monetary policy (assumed by the model to operate through its influence on the rate of interest) on inventory investment. But there exists a fairly conclusive amount of non-econometric evidence that inventory investment is quickly and importantly influenced by the rate of interest (and/or by the changes in degree of availability of credit which accompany changes in the rate of interest). Moreover, the constructors of others of the large econometric models have found such an effect on inventory or concluded that the exceptionally difficult problems of constructing an inventory model have tended to cause the plausible role of the interest rate to be diminished or concealed. Finally, a misspecification of the Federal Reserve-MIT model's own inventory equation exists, and it may explain why variants of that equation could not find any significant role for interest: The "noise" introduced by the misspecification, while insufficient to obscure other, more powerful determinants of inventory investment, such as sales and unfilled orders, could quite plausibly have reduced the indicated significance of any role found for interest to unacceptable levels.

Even if this kind of problem should continue to prevent the influence of the interest variable from being determined econometrically, the policy maker would remain justified in assuming, from the other kinds of evidence available, that the influence did exist.

(2) DE LEEUW and GRAMLICH, *op. cit.*, pp. 27.28.

Since the interest rate is practically the only one of the determinants of inventory investment which is subject to his control, the policy maker cannot afford to rely on a technique which provides him with information merely on the other — the more easily measured — factors.

With respect to business fixed investment, the Federal Reserve-MIT model appears, like its predecessors, to have neglected what may be a quite significant quick-acting effect on the rate of capital formation — an effect which both theory and non-econometric evidence (such as that on the experience with exceptionally high interest rates in 1966) suggest may be quite important. This effect, too, may be difficult to detect econometrically because it is dependent on entrepreneurs' expectations about the course of interest rates and is observed relatively infrequently. This kind of reaction is the *postponement* or slowing of work on projects about to be started or recently started at times when interest rates are considered to be *abnormally high* or the rapid reinstatement of such projects when rates cease to be abnormally high. This kind of rapid influence on investment can occur when reactions are otherwise rather slow because the effective cost of borrowing long-term funds now, rather than a year or so later when rates are expected to be lower, will tend to be an extremely high one relative to the current long-term interest rate and therefore can plausibly affect the decision to continue work on projects about to be started or already started.

A presumption against any superiority of the more complex fixed and inventory investment equations here proposed might have been created if the Federal Reserve-MIT model's present equations had proved to be very good estimators of actual fixed and inventory investment. The test of accuracy that can be carried out with the available information is made; not surprisingly, it is found that ample room for improvement does exist.

From all points of view, therefore, the balance of evidence appears to remain in favor of the case for sufficiently short lags in the effects of monetary policy measures or at the least to be in favor of withholding acceptance from the econometric evidence which indicates too long a lag.

Not only must we conclude that the lag problem in the use of monetary policy may have been greatly exaggerated by the Fed-MIT and similar econometric studies; it also appears that the lag in the alternative fiscal policy has been understated. A slip in the presentation of their results has caused the Fed-MIT researchers to make the lag in effects from government expenditure policy seem shorter than what their model actually indicates. With the appropriate allowance for this point, monetary policy is seen to be much more promising than currently thought, both when considered by itself and when compared with the government expenditure policy alternative.

It should be noted in passing that the survival of discretionary monetary policy need not depend on the validity of the points just made. Correctness for either the long Fed-MIT lags or the variable lag of Friedman would not necessarily be inconsistent with successful monetary policy. This is so because the lags in achievement of stabilizing policy effects have a counterpart in the lags in the production of the effects of the destabilizing economic factors (changes in profits, capacity utilization, ratio of wage rates to capital-goods prices, etc.). In fact, the lag patterns in the Fed-MIT model require that the destabilizing factors operate with a lag which is the *same* as, or only slightly shorter than, the lag in the effects of monetary policy. Given the recent improvements in economic data, verification of this similarity of lag pattern would mean that monetary policy could work quickly enough to be a useful stabilizer in spite of any lag in its effects (3).

Misspecification of the Federal Reserve-MIT inventory equation

The model's equation for inventory investment (equation F. 18) (4) makes the current quarter's rise in total inventory holdings an increasing function of increases in the previous quarter's rate of consumer spending, in the following quarter's rate of government expenditure for military goods and of increases in the preceding four quarters' average rate of net new orders for producer's

(3) See W. H. White, "Inventory Investment and the Rate of Interest", *Banca Nazionale del Lavoro Quarterly Review*, June 1961, p. 147 (Brookings Institution Reprint No. 57, p. 10); and W. H. White, "The Flexibility of Anticyclical Monetary Policy", in *Monetary Theory and Policy*, R. S. Thorn, Ed., New York, 1966, pp. 135-36. A new econometric study, although partly subject to the biases being described in this paper, has found much more prompt fixed investment effects than those of the Fed-MIT and related models; and it finds that the other factors effects investment with a lag which is the same or *longer* than that of the interest rate (Shirley Almon, "Lags Between Investment Decisions and their Causes", *Review of Economics and Statistics*, L, May 1968, pp. 193-206).

(4) de Leeuw and Gramlich, *op. cit.*, p. 38.

durable equipment. Other determinants of current inventory investment are the previous quarter's inventory investment and, with a small but negative effect, the rise in the current quarter's rate of consumer spending (5).

Although no monetary policy variable is included in the equation, we may safely assume that various alternatives were tested but dropped because of unsatisfactory performance.

Of chief concern here is the part of total inventory investment which is created by increases in the rates of activity in the producer equipment industry during the preceding four quarters. This relationship reflects the producer "pipeline" effect: a rise in the rate of inflow of new orders leads to a build-up of raw material inventories needed for a higher rate of production and then to a rise in goods-in-process inventories as extra labor is combined with those extra materials in the course of construction of the extra ordered machines (6). There are two alternative means of representing this pipeline-filling part of inventory investment: having the pipeline filled — as is actually done in this model — with a fixed distributed lag *after* the extra orders are received; having the pipeline filled with a fixed distributed lead *before* the point where the extra equipment is completed and sold. A priori, the latter procedure would seem preferable, but given unchanging lags from receipt of order to delivery of completed machine, the choice would not be of much consequence. However, the present model quite rightly recognizes, and allows for, the fact of *changes* in the delay of delivery (sale) of the completed machine after receipt of the order. Investment equation A. 10 shows that the period of delay from order to delivery increases with the level of economic activity (with the ratio of unfilled order backlogs to current sales) (7). For this reason the choice of a variable, to which the equipment producer's pipeline-filling part of total inventory investment is attached, is a substantial one. When the lag from receipt of order to completion of work on it changes, then change must also take place in the lag from receipt

(5) *Op. cit.*, p. 37.

(6) That orders appreciably affect inventory investment as much as four quarters later (or even more at times, given the generalized lag term in the equation) may reflect the fact that after the pipeline has been completely filled (when the manufacture of the extra equipment has been completed) there will be a need for extra raw material inventory for use in the added productive capacity constituted by those very same new machines.

(7) *Op. cit.*, pp. 32-33.

of order to the start of work on it and, therefore, in the lag to the start of filling the inventory pipeline.

That failure to permit the proper, changing lag should tend to conceal the role of the interest rate can be seen as follows: The use of a fixed lag after the placing of the order presumably yielded a compromise length of lag, too long at times of low activity but too short when order backlogs are high. This means that, at times when order backlogs are above the average level, the model will tend to overestimate the current rate of inventory investment associated with given increases in the rate of new orders (attributing to the current period pipeline investment that in reality will not be carried out until later), and, when the rate of new orders is falling, the model will continue to overstate the actual rate of pipeline inventory investment (the pipeline reductions attributed to the current period actually being carried out later on). Opposite distortions of the true level of inventory investment will be found when backlogs are lower than average, for then changes in the rate of new ordering will affect pipeline inventories more quickly than is permitted by the model.

If over the cycle as a whole the two distorting tendencies are of just equal strength, the distortions introduced by the compromise fixed lag could be considered purely random ones. In that situation the chances of success for an attempt to add an interest-rate variable to the model might seem unaffected by the misspecification of the model. In fact, however, the net effect would still be a great reduction in the apparent contribution of the interest-rate variable to the explanation of total inventory investment. The indicated significance of the role of the other variables should also be weakened somewhat by the misspecification; but since they are inherently more powerful variables than interest rates, they can survive an increase in the size of random errors as apparently usable variables when the interest rate would not. (In technical terms, the t-ratio of a variable which, like the interest rate, is responsible for relatively little of the observed variation in inventory investment would be relatively close to the critical minimum and therefore is most likely to be disqualified by an equal proportional reduction of all t-ratios due to the random factor.) (8).

(8) It is not implausible that the influence of changes in the interest rate is substantially weaker at times when capacity utilization, interest rates, and inventories are low and many firms have paid off their short-term borrowings. This consideration introduces the need for

The preceding discussion is pertinent only under the assumption that inventory investment is adjusted to the tightness of money with a relatively short lag. That assumption is made reasonable by the combination of the survey evidence and other econometric evidence presented below and by the considerations that the inventory investment decision is a simple, quickly applied and easily reversed one, that for much of business it would be linked to the volatile short-term interest rate rather than to the long-term rate, and that the transitory nature of both the borrowing and the investment decision makes unnecessary any great delay in reacting to make sure that the given change in interest rates is a persisting one (9).

Other Evidence on Inventories

A large amount of non-econometric empirical evidence on the influence of the interest rate on inventory investment has been available for some time (10), and more was generated by the experience of extremely high interest rates in the second half of 1966. Thus a large proportion of the 172 executives of big and medium-big American manufacturing companies queried in December 1966 on the effects of the current tight money conditions on their companies' operations reported that tight money had caused them to restrict (the growth of) their inventories (11). While the precise frequency of inventory restriction was not given, the indication that it was a high one is given strong corroboration by the results of two late-1966 surveys by the National Association of Purchasing Agents. These monthly surveys (which provide two of the "leading business cycle indicators" published by the U.S. Census Bureau monthly,

testing a non-linear role for the interest rate — or, more crudely, simply assuming a zero interest elasticity of inventory demand at times of relatively low activity and low rates. And, if past econometric practice is any guide, non-linearization was overlooked when the interest rate variable was being tested for inclusion in this model. But, again, the failure to find a significant role for the interest rate during a period of several years could be explained by the fact that in just the low-activity half of that period the role was not very significant.

(9) Quick interest-rate effects on inventory must be supplemented by quick effects of monetary policy on interest rates. The Fed-MIT model finds extremely quick effects, even on the long-term bond yield. These follow from the violent instantaneous effects found to be exerted on the Treasury bill rate (DE LEEUW, *op. cit.*, Chart 1, p. 15 and equations, p. 31).

(10) For a presentation of this evidence and of the a priori and institutional considerations justifying belief that the interest rate should affect the inventory investment of a substantial part of business, see W. H. WHITE, "Inventory Investment and the Rate of Interest", loc. cit.

(11) "Meeting the Challenge of Tight Money", *Conference Board Record*, March 1967, p. 29.

Business Cycle Developments) are said to be answered by very well informed "purchasing executives" and therefore can be taken as fairly authoritative on matters of inventory policy (12). "When asked [in September] what effect the cost of money is having on their inventory policy for the balance of 1966, 53 per cent answered slight, moderate or serious; and 47 per cent, none". The following month's survey confirmed this evidence: "As anticipated in last month's report, remarks of members indicated that tight money is definitely influencing inventory policy. Purchasing executives are calling on every technique in their bag to free cash tied up [in inventories of purchased materials] and still keep production lines moving. This requires much skill with so many items still in short supply" (13).

That these results hold good for the big companies (assets of at least $50 million) who dominate total inventories is easily demonstrated by the quoted replies of a few executives to an informal *Wall Street Journal* survey on the reasons for the lowness of mid-1966 inventories (14). This survey covered relatively few of the big companies, was restricted to companies in manufacturing only, and took place when a major part of the tightening of money had not yet occurred (15). Nevertheless, the published results include direct citations of answers indicating effects from tight money by executives of no less than three of the big companies:

> Similarly, Charles J. McLaughlin, general manager of Westinghouse Corporation's Mansfield, Ohio Divisions, which produce household appliances, reports that the "high cost" of money has generated considerable pressure to reduce inventories and free funds for other uses.

(12) "They have been carefully selected as men of experience, with demonstrated ability to observe and report on the pulsebeat of their own businesses" (Sub-Committee on Economic Statistics, Joint Committee on the Economic Report, U.S. Congress; *Reports of the Federal Reserve Consultant Committees on Economic Statistics, Hearings*, Washington 1955, p. 553).

(13 Statements of National Association of Purchasing Agents, in *Commercial and Financial Chronicle*, October 6, 1966, p. 26, and November 17, 1966, p. 18.

(14) "Balance in the Boom? Factory Stocks Remain Low in Terms of Sales, Despite Record Total", *Wall Street Journal*, July 25, 1966, p. 1. The article sought to explain the relative lowness of inventories in the face of expectations of rising prices. The chief explanation found was materials shortages created by the Viet-Nam war "but a scarcely less significant factor, interviews suggest, is tight money". A third factor was the increasing use of computers, which permitted closer control of inventories.

(15) The yield on prime short-term commercial paper was 5.63 per cent at the time of this inquiry but then rose to 6.00 per cent in November and December.

A spokesman for Koppers Co., a Pittsburgh-based engineering and manufacturing concern, reports the company's inventory-sales ratio is at the lowest level for this time of year in 13 years. He adds that if money gets any tighter "Koppers would be forced to study its inventory policy" with an eye to reducing stocks further.

A typical view is expressed by Harlan Foulke, Vice President and Secretary of Arvin Industries, Inc. a Columbus, Ind. maker of auto parts and appliances. He says: "In planning our inventories, we don't consider inflation one single solitary bit. However, the money market will always affect inventories."

That such an attitude really was typical has been indicated by one strategically placed observer, the head of a large commercial finance company (James Talcott, Inc.):

> Increasing sophistication in the use of money was everywhere notable in 1966. Corporate treasurers moved their funds rapidly to take advantage of maximum returns. Closer and closer attention was paid to inventory controls, so that investment in this area could be responsive to the availability and cost of funds (16).

Several billion dollars of effect on total inventory holdings could plausibly be achieved by a sharp change in short-term interest rates. And most of it would plausibly occur during the first quarter of changed rates and the perhaps two quarters following. Such results would fill the greater part of the deficiency of effects now shown by the Federal Reserve-MIT model for the first few quarters after a change in monetary policy.

The plausibility of so much quick effect on inventory investment is supported by the findings of another multi-equation quarterly model of the U.S. economy, that of Goldfeld. The inventory equation finally used in that study requires that a 1 percentage point change in the commercial bank lending rate alter the inventory investment in the *same quarter* by more than $1 billion (an annual rate of more than $4 billion), with changes of rapidly diminishing

(16) *Commercial and Financial Chronicle*, January 26, 1967, p. 99. Continental Can and U.S. Plywood should probably be added to the above three firms known to have been affected in mid-1966, for these two began to fight the liquidity squeeze by charging divisional managers interest when funds tied up in accounts receivable or inventories exceeded specified amounts, thereby reducing the division's reported profits (and, presumably, the manager's profit-sharing bonus). See *Business Week*, June 11, 1966, p. 152.

size over the next few quarters if the new level of interest rates is continued (17).

The validity of the equation which produced these results has been challenged on the ground of an implausibly low value for the coefficient which, in the underlying theoretical model, represents the desired speed of correction of discrepancies between actual and desired inventory holdings (18). However, at the very least this model shows us that, if one model's misspecified inventory equation finds no significant role for the interest rate, it is still possible for other models — also misspecified perhaps — to find that the interest rate does exert a significant, quick influence on inventory investment. Moreover, exclusion of the interest rate from the Goldfeld equations did not significantly increase the indicated rapidity of inventory adjustment, and the equation contains certain ad hoc independent variables not included in its theoretical form which might prove to be responsible for that deficiency (19). These considerations increase the prospects that the role of the interest factor was properly evaluated.

The results of other econometric investigations are inconclusive but seem, if anything, to reinforce the indications provided by the Goldfeld model that correct specification and interpretation would indicate that the interest rate has a role in Fed-MIT inventory investment.

In a survey of the less recent econometric work on inventories, Lovell concluded that the evidence on the role of monetary policy variables was merely "conflicting" and not decisive a support for or against the monetary factors. The existence of such a conflict

(17) S. M. Goldfeld, *Commercial Bank Behavior and Economic Activity*, Amsterdam 1966, equation 519, p. 134; see also pp. 118-119, 122-123.

(18) M. J. Hamberger, "The Impact of Monetary Variables: A Selected Survey of the Recent Empirical Literature", Federal Reserve Board, Staff Economic Studies No. 34, p. 7.

(19) These ad hoc independent variables are the preceding quarter's value of the dependent variable (an ad hoc variable-of-all-work for the econometrician), and the current quarter's change in bank loans to business. Given the close correlation between changes in U.S. banks' loans to business, and (a part of) the same quarter's inventory investment (the funds being borrowed precisely for the purpose of financing inventory investment), it is not implausible that the quicker part of the response of desired inventory to changes in sales, etc., had to be divided between the sales variable and the commercial loans variable: with the rise in borrowings available to serve as the immediate explanation or cause of the rise in inventories, less scope is left to be claimed by a first cause such as rise in (expected) sales; exclusion of the loans variable might have yielded a much faster rate of adjustment of actual to desired inventories.

among findings was explained by the complexity of the inventory relationships (especially the need to infer desired inventories via inferences on expectations about sales), by the inadequacies of the data and possibly by the role of " data mining " in yielding ostensibly significant results for the monetary policy variables for the persistent investigator who wanted such results (20).

Other very important reasons for poor results from models whose period of observation extended much before, say, 1956 are the newness of the scientific inventory control procedures which have since become common at least among big companies and the fact that interest rates had been both very low and very stable in the late 1940's and early 1950's. From these considerations it follows that all but the most recent inventory models are distorted, reflecting in part the conditions of a period when there was little reason for the businessman to pay much attention to the cost of borrowed money in his inventory planning.

The inventory investment segment of the well known " Brookings Model " of the United States economy found a powerful, fast acting influence of the interest rate on the inventory investment of the trade sector of the economy. This finding was of only borderline reliability according to the conventional statistical tests of reliability, but the investigators thought that the results would have been stronger if the problems of multicollinearity between interest rates and other independent variables, which tend to move together over the business cycle, had been absent.

With respect to the Brookings results on inventory investment by manufacturers, the interest rate was found to have a logically impossible positive association with inventory, causing the investigators to conclude that an identification problem existed in the simple least squares approach used; the credit supply function might be dominating the results more than the inventory credit demand function. This inference was supported by the consideration that the " interest " elasticity of demand for credit should reflect not only the role of the cost of borrowing in influencing demand — about which there could be some disagreement — but also was

(20) M. C. Lovell, " Determinants of Inventory Investment ", *Models of Income Determination*, Studies in Income and Wealth, Vol. 28. National Bureau of Economic Research, Princeton, 1964, pp. 212-15.

" Data mining " is discussed in note 37.

a proxy for the degree of unavailability of money — a factor whose influence could not be doubted (21). But, if that is the view of the developers of the inventory segment of the Brookings model, the restriction of the role of the short-term interest rate to trade and services inventory in the model's final system of equations (22) must mean that the model understates the true short-run influence of monetary policy on GNP.

Probable Misspecification of the fixed investment lag pattern

Like those of its predecessors such as the Wharton and Brookings models, the Federal Reserve model's equations for fixed investment are constructed in such a way that the lag from change in factors determining the decision to invest (interest rates, sales, etc.) to actual expenditure for capital goods is very long and is *unchanged* over the business cycle in the case of buildings (and changes only with respect to the degree of capacity utilization in the case of producers' durable equipment) (23).

The reason that investment occurs with a substantial lag after its determinants is that time is needed for investment decision-making and for first planning and then constructing the buildings

(21) Michael Lovell and Paul Darling, " Factors Influencing Investment in Inventories ", in *The Brookings Quarterly Econometric Model of the United States*, James Duesenberry et al., eds., Chicago, 1965, pp. 142, 143, 151-54 and 156-57.

(22) *Op. cit.*, p. 688.

(23) The Wharton model is touched on below.

That a constant average length of lag was assumed in the Brookings model is seen in Duesenberry, et al., *op. cit.*, p. 80 ff. A recent updating of this part of the Brookings model continues the fixed lag assumption; it finds a zero effect from anti-cyclical monetary policy on GNP until one year has passed and a diminishing effect — which the researchers label a negative one — after the passage of one more year (D. W. Jorgenson and J. A. Stephenson, " The Time Structure of Investment Behavior in American Manufacturing ", *Review of Economics and Statistics*, XLIX, February 1967, pp. 16-27, esp. p. 26).

These results are of course invalidated by the disregard of the quick effect on GNP acting through inventory investment included within the same model, by the inflexibility of the lag, and by the exaggeration of even the average lag due to use of out-of-date (1947-60) evidence. Moreover, as in some of the other models, the lag of effect on GNP is further exaggerated by the assumption that the effect coincides with the induced change in fixed investment spending — a cash expenditure concept — rather than with the earlier time of physical capital formation: the capital-goods producer's pipeline filling process (see the writer's " Pitfalls in Statistics on Current Developments in Capital Spending ", July 1967, mimeographed and " Measuring the Inflationary Significance of a Government Budget " *IMF Staff Papers*, I, April 1951, pp. 356-357).

and equipment that were decided on. At any point of time, the entrepreneur adjusts his desires for capital goods to the current (and expected) sales volume, ratio of wage rates to prices of capital goods, the interest rate and comparable " cost " of equity capital, etc. If — as in times of expanding demand for his product — he finds that the desirable amount of capital goods exceeds his actual stock, he will place orders for additional equipment and plant. The construction of buildings and delivery of equipment will occur gradually afterwards.

Because the decision-making, planning and construction of capital stock is a gradual process, it follows that the separate investment projects underway at the present time reflect the levels of the various determinants of the desired capital stock which prevailed at different times in the past, specifically at those points of time which preceded the decision to carry out each of the various projects which are currently under way. Thus, the Fed-MIT model makes the current rate of capital spending dependent on a fixed weighted average of the levels of interest rates, etc., which prevailed over several past years. The current level of interest rates has no influence on current investment, and recent past rates have only a negligible influence because the investment decisions they determine for the most part have not yet advanced beyond the planning stage or have not been outstanding long enough to cause the delivery of ordered equipment (24).

In contrast with this pattern of long lags, there is known to be a potentially quite short lag reaction by fixed investment to changes in monetary factors. This quick reaction is the rescheduling of investment projects which were about to begin or had recently begun. A rise in interest rates to levels considered abnormally high can cause the postponement or slowing down of work on such projects; and, once they have been postponed, a drop of rates into the normal range can cause a rapid jump in fixed investment as

(24) If the interest rate (or other determinant) has been at the same level for a few years, the desired amount of capital stock will have remained unchanged and the process of adjustment of the actual stock of capital goods to the desired level will have had time to be completed. At that stage (almost) no new investment spending will be necessary. The model approximates this behavior by using as the determinant of new orders for producers equipment (equation A. 9) the *difference* between the weighted average levels of interest rates (etc.) in the preceding two years and in the two years before that.

such pending projects are reinstated or the speed of work on them is restored to normal (25).

The reason why long-term interest rates which are considered to be abnormally high affect near-future capital spending much more powerfully than allowed for in the Fed-MIT type of model is easily seen.

The relationship which is relevant to that situation is the borrower form of the speculative liquidity preference motive propounded by Keynes for the lender. Thus, if the rate of interest is expected to fall back to 5 per cent in one year from a current level of 6 per cent, the effective cost of borrowing long term now to finance investment now rather than waiting until next year ought to be considered many times the extra one percentage point of interest that would have to be paid now. This high effective one-year borrowing cost should discourage (temporarily) not only the projects found unprofitable by the Fed-MIT approach at the current 6 per cent level of interest rates but also many projects which that approach would still find profitable even at rates of, e.g., 10 per cent. This is so because the long-term borrowing commits the enterprise to paying the extra one per cent of interest for the next, say, 5 to

(25) This criticism of the models has been made before: " ... common sense tells us that the models should have permitted [the length of investment] decision lags [after a change in independent variables] to vary inversely with the amplitude of change in the independent variables... " (W. H. White, review of Locke Anderson's, *Corporate Finance and Fixed Investment — an Econometric Study*, *American Economic Review*, June 1965, p. 617). A more limited form of the same criticism was recently made by an economist-governor of the Federal Reserve System: " ... these models... do seem to confirm the importance of long lags in this [business investment] sector [during the 1966 tight-money episode]. However, I would guess that because the monetary shift was far larger and more dramatic than in the periods used for estimating their coefficients, these models... under-estimated [short-run] monetary effects " (Sherman Maisel, " Effect of Monetary Policy on Expenditures in Specific Sectors of the Economy ", paper presented at the Fifth Annual Conference of University Professors given by the American Bankers Association, New York, September 7, 1967, p. 30).

Maisel's conclusion might be thought invalidated by the finding from a very large scale survey that the frequency of effect on fixed or inventory investment among American businesses was negligible during 1966 (" The Impact of Monetary Stringency on Business Investment ", *Survey of Current Business*, August 1967, pp. 10-27). But Maisel's position seems unshaken both because other survey evidence supports it and because most of the respondents to this survey who denied any effect from tight money in 1966 appear to have given false answers to the survey's simple test question (whether the enterprise changed its 1966 fixed investment appreciably from the amount planned early in the year), whereas the indications are that a substantial proportion of those who gave correct test answers said that they *were* affected by tight money in 1966.

10 years; the advantage of carrying out the investment now — which is merely the advantage of starting to earn a profit on it one year sooner — must therefore be set against not only the payment of 5 per cent of interest one year sooner but also an additional payment of 5 to 10 percentage points of interest (over the next 5 to 10 years). This clearly constitutes a very powerful deterrent for those who would have to borrow long term (or issue preferred stock or, to some extent, issue common stock) but consider that current rates are abnormally high. And even where the project dependent on new borrowing, etc. is one for which substantial planning funds have already been spent or some investment outlays have already been made, this very high effective one-year borrowing cost is still sufficiently high to make postponement or slowdown of further work a plausible result (26).

It is clear that any reactions of this sort to changes in interest rates occur with much less than the normal lag, for the normal delays for project evaluation and approval and for engineering are reduced almost to negligibility; and those of the projects which had previously been partly completed would of course have relatively short residual periods of construction, so that they would be not only quickly reinstated but also quickly completed, thereby contributing further to the flexibility of monetary policy.

There is good evidence that such temporary postponements of planned investment do occur. For example, as early in the 1966 credit squeeze as May, *Business Week* magazine not surprisingly found, from interviews with big companies' executives, only a "handful" who were restricting fixed investment because of tight money. One such, cited for illustration, the president of an electronics manufacturer with assets of $75 million (United-Carr) was postponing the planned August start of construction of a new factory in the hope of a drop in long-term interest rates (27).

(26) It is usually argued that borrowing the remaining 80 per cent portion of the cost of a 20 per cent-completed project would remain the preferred course because it would yield a quicker start of receipt of profits not only on that same 80 per cent but also on the 20 per cent already sunk into the project. Here the effective rate of return on that 80 per cent will be 25 per cent larger than the return on the whole project — i.e., will be 25 per cent larger during a time period as long as the period of delay which is being considered. But, as above, the effective borrowing cost for that same period is very much *more* than 25 per cent larger than the one (5 per cent) in effect when the project was accepted as a profitable one. While this simplified presentation does require some qualification, it nevertheless does make the postponing or slowing of work on some existing projects a reasonable expectation.

(27) *Business Week*, June 11, 1966, p. 38.

Most of those providing usable evidence to a 1962 Canadian Royal Commission inquiry indicated still shorter lags than this (28). That at least some executives do find the deterrent very powerful when rates are considered to be only temporarily high is illustrated by one of the Canadian executives statements cited as illustration:

> Generally speaking, the anticipated return on investment... is substantially higher than the actual cost of funds required. ... *Theoretically*, then, *a large increase* in the cost of funds [above the existing "high" level] would have to occur before it would be uneconomical to proceed with a capital expenditure... *however*, it should be pointed out that *a nominal increase will* have an *effect* from a *timing* point of view... This is done either by borrowing temporarily on a short-term basis from a bank, or delaying the acquisition of capital equipment — or a mixture of both (29).

A mid-1966 survey of nearly 300 big American companies by an investment banking firm received replies reporting "*postponed or delayed* capital spending plans *in expectation of lower interest rates* within one-to-two years" from 14 per cent of the respondents, while just 6 per cent (including perhaps some already included in the first group) said they had made "outright cancellations" of projects because of "recent higher interest rates" (30). Cancel-

(28) J. H. Young and J. F. Helliwell, "The Effects of Monetary Policy on Corporations", Appendix to the *Report of the Royal Commission on Banking and Finance*, Ottawa 1965, p. 408.

The shortness of the summer-autumn 1962 credit squeeze might suggest that the quick reacters were the only ones who could report effects, so that their domination of the results is not a proper basis for generalization. However, there must have been many more quick reacters who did not react at all because they could still borrow in the cheap U.S. market, were already being deterred from investing enough to need to borrow by the high (6 per cent) unemployment rate, or foresaw that the latter would quickly take precedence in monetary policy-making over the need to use tight money for defending the newly fixed exchange rate.

(29) *Op. cit.*, p. 362, emphasis added.

(30) Emphasis added. Some of the firms did not specify the kind of capital spending plans involved, and some of these may have had in mind acquisitions of other companies rather than purchase of new capital goods. Any necessary adjustment should not greatly change the significance of this evidence, however.

After two months of further tightening of money a telephone check was made of the financial officers of a large proportion of the companies which had reported being effected by high interest rates. This confirmed the accuracy of the previous replies and established that the restrictive effects being experienced had been intensified by the subsequent increase in the tightness of money.

Unfortunately, only the cancellations question in the mid-1966 survey distinguished the cases of reductions of investment expenditure which were to occur in 1966 from those of

lation of prior orders for machinery is known to be common. For machine tools, existing orders amounting to 5 per cent of current new orders were cancelled in the first quarter of 1966 and the rate of cancellation then rose — perhaps in reflection of the tightening of money — to 6-1/2 per cent in the third quarter and 8-3/4 per cent in the month following (31).

That the lag pattern used in the Fed-MIT model is a rigid one which cannot reflect the fast readjustments of imminent or recently-started investment projects has been shown earlier. The weighted average lag used does of course reflect the influence of the "last minute" lengthenings of lag at times of exceptionally high rates and abrupt shortenings of the lag when rates have fallen back from exceptionally high levels which are being proposed here. But while these extremes must have influenced the average lag derived, that average is itself used to represent the actual lags under *all* conditions. And a fixed lag pattern cannot allow for the fact that at these crucial points of time for monetary policy — times of attainment of or retreat from exceptionally high or low interest rates — monetary policy itself has *caused* the *lags* to *change*. It is possible, of course, that some models embodying this aspect of the interest-rate

1967 or later (and the published results do not show what the actual distribution was). (See DONALDSON, LUFKIN and JENRETTE, INC., *Timely Review of 1966 Credit Shortage Effects on Business Financing and Spending Decisions*, July 1967, pp. 1, 6-9, 10, 22-26). However, for the question on postponements due to temporarily high borrowing costs the time distinction may have been found simply unnecessary. Such postponements would not normally be made as much as a half year in advance of the expenditure; the first thing to be postponed would be the borrowing (or firm commitment of funds), and that presumably would not occur as much as 6 months in advance of the start of the expenditure. Moreover, the Federal Reserve Board presumably had access to full data on the survey results, the covering letters sent, etc. (part of the investment bank's 1966 surveying having been sponsored by the Federal Reserve and done in cooperation with MIT); and Governor Maisel relied on this survey for his published conclusion that the high interest rates of 1966 did have substantial effects on big companies' investment spending during 1966 (MAISEL, *op. cit.*, pp. 26, 30).

(31) See *Business Week*, December 1, 1966, p. 28. The suspension of the official investment subsidy program was thought not to be responsible for the high October rate because most of the ordered equipment had been ordered before the credit was revoked.

Under some conditions, cancellation of new orders for producers' durable equipment on which production was about to start may yield immediate anti-inflationary effects of only an indirect form: for a time the fact of the cancellation will accelerate work on more recent orders rather than cause a decline in the rate of production. But this neutralization of the rapid effects of cancellations will not be complete; and after the cyclical peak is passed, order backlogs have shrunk, and interest rates have dropped, the ability to reinstate the cancelled orders will permit the shortening of reaction lags in response to interest rates described above to make its full contribution toward prompt effects from monetary policy.

expectations factor were tested and found to yield inferior results to the form actually employed (32). But statistically inferior results found when an elaborate expectations model is attempted would not necessarily justify rejection of that model if its other empirical and *a priori* justifications are strong, for the difficulty of measuring expectations correctly by use of the available data (e.g., current long-term rate minus its moving average past level) is great enough that inferior results to those of simpler models could be expected even though the factor was really a powerful one in certain phases of the cycle.

The chances of discovering the influence of the difference between the current and the normal level of interest rates are also reduced by the need to apply a special form of the relationship. Differences of less than, e.g., one standard deviation will yield a negligible inducement to the rapid expectations response and should be excluded from consideration. Given this situation, tests of the more obvious form of the relationship must almost by definition yield poor results; most of the observed variations of the independent variable are simply irrelevant (33).

(32) In the case of new orders for producers' durable equipment, the lag pattern actually used for the interest rate is in great part the difference between more current and more remote interest rates. But, the model is said to be a somewhat sluggish stock adjustment one (*op. cit.*, p. 17) and the "current" rates include no representation for the interest rate prevailing after the orders were placed but before work on them began nor for the interest rate in the quarter during which the orders were placed, but only the average of the interest rates of the *preceding* two years. This makes it clear that the formulation used is *not* intended to represent the strong influence on today's ordering or on today's decision whether or not to cancel or delay yesterday's order exerted by the current change in interest rates.

(33) A test of quick effects on fixed investment that is similar in part to what is proposed here has been made by one of those responsible for the investment equation in another recent quarterly model of the U.S. economy, that of the Wharton School. He found a role for appreciable "last minute" readjustments of prior investment plans in response to changes in economic conditions which occurred just before the plans began to be embodied in actual investment. (The existence of a limited "almost-last-minute" reaction of this sort had been proposed by THOMAS MAYER, "The Inflexibility of Monetary Policy", *Review of Economics and Statistics*, XL, November 1958, pp. 362-63, with scope for a more fully last-minute one then being suggested by W. H. WHITE, "The Flexibility of Anti-Cyclical Monetary Policy", *Review of Economics and Statistics*, XLIII, May 1961, pp. 145-46 and note 22). But, while Evans found this quick reaction to last-minute changes in sales, he did not find it for last-minute changes in interest rates. Thus, although the interest rate did have an important influence on fixed investment, that influence was exerted only with a substantial lag (M. K. EVANS, "A Study of Industry Investment Decisions", *Review of Economics and Statistics*, XLIX, May 1967, pp. 151-64).

Professor Evans has explained that the attempt to find last-minute interest rate effects yielded the wrong sign for the interest variable, indicating the presence of an identification

In the case of investment in producers' durable equipment, as already described, the sale of the equipment by the producer is assumed to occur with an increasing lag as the producers' order backlog increases in the course of a cyclical expansion, and to occur with a decreasing lag in the downswing as the order backlog shrinks. But this fact means that it is quite possible that the capacity-utilization factor is stealing some influence properly attributable to another cyclical factor i.e. the rise in interest rates to excessive levels and return from such levels which parallels the movements in the length of lag.

Such a theft would be doubly damaging: not only would a delaying of investment which was attributable to high interest rates be lost from view, it would instead be treated as if it was an aggravation of the *tardiness* of whatever interest rate effect had been discovered. It is true, of course, that these two factors' causations may be confused economically as well as statistically: for example, a slowing of deliveries on new orders due to supply conditions may coincide with and overlap the slowing of desire for deliveries of prior new orders, and this would make an allocation of the resulting restraint of investment between the two factors impossible to make; either one would have caused (most of) the observed restrictions of investment if the other had been absent, and similarly for the speed-up in deliveries as new orders fall and order backlogs are worked down. But, as pointed out in note 31 above, this consideration does not establish that no net restraint (stimulus) is exerted by the changes in the customers' desired length of lag; all that it establishes is that allocation of causation between these two factors, both of which are classed as coincident with the business cycle, is very difficult. Moreover, whatever increase in lags which is validly attributable to high order backlogs is in great part spurious

problem: the relationship actually measured being more a supply-of-money one rather than any (possible) demand-for-money relationship. But, as noted by Lovell and Darling in connection with their finding of the wrong sign for the influence of the interest rate on manufacturers' inventory investment, such a result does not constitute a rejection of the role for the interest rate indicated by other evidence; since the wrong sign for the interest variable implies the measuring of a different behavior relationship, it cannot serve as very strong evidence against the existence of the relationship under study. Finally, even without any identification problem, as explained in this paper, the fact that the Evans technique could not detect any last-minute interest-demand relationship on *average* does not conflict with the existence of a detectable effect when only movements to or from the more extreme values of interest rates are considered.

in an economic sense (see appendix) and should not have been retained in the model.

One way of testing for the existence of a net influence for interest expectations might be the introduction of the expectations factor in the equation for non-residential construction, a category where, as described above, the lag is assumed to be constant, regardless of the pressure of demand on productive capacity (34).

If conclusive evidence on this matter proves to be unobtainable by the econometric approach, the present formulation must be assumed to yield some exaggeration of the lags, and the Fed-MIT model would have to be ruled as simply inconclusive about the length of monetary policy lags (35). The combination of whatever may seem safely ascribable to the interest expectations effect plus the apparently substantial influence of interest rates on inventory investment should suffice to establish a presumption of much shorter lags than the model yields even if the model itself cannot detect them. Outside evidence in this case will suffice to demonstrate that a substantial amount of quick response exists which is being ignored by the model.

(34) It could be argued that any such influence found for the expectations variant of the long-term interest rate really represented, to an unknown but perhaps large extent, the influence of a sort of backlog of construction contracts waiting for contractors to become willing to make bids on them. But the risk of this possible frustration of the effort cannot justify doing nothing and leaving unquestioned the equally suspect assumption of zero short-run effect from abnormal long-term interest rates.

(35) There is another sense in which the customary use of constant lags has probably caused the various models to overstate the relevant monetary-policy delays. The average lag found is customarily derived from capital spending data covering the last 15 to 20 years. But there is strong evidence that the radical increases in the efficiency of industrial production realized over that period extend to the construction branch of industry as well (White, "The Inflexibility of Monetary Policy: Reply", *Review of Economics and Statistics*, XLVI, August 1964, p. 323). It follows that the fixed, average lag fitted to the data is likely not only to have increased the "noise" in the model but also to have overstated the current length of delay in attainment of monetary effects on fixed investment. The new study by Almon, *op. cit.*, which has the advantage of dealing with more up-to-date behavior patterns and of concentrating on years of relatively wide movement in interest rates, finds that a change in the interest rate attains substantially its maximum effect on fixed investment in the second three months following the change, with half as great an effect already being produced in the first three months after the change.

Insufficient Reliability of the Federal Reserve-MIT Model's estimates

If the Fed-MIT model proved to yield accurate estimates of investment and, specifically, of the influence of the interest rate on investment, then the validity of the above criticisms of the form of the equations would be brought into question. It is necessary, therefore, to see how accurate the model's estimates have been.

The first step in justifying the accuracy of the influence attributed to any one of the factors included in an estimating equation is testing the accuracy of the estimates provided by the whole equation. If the combination of factors presented as responsible for determining, e.g., the size of investment spending yields estimates which are quite close to the amount of investment spending actually observed, at least some presumption is created that the separate influences of each of the factors (e.g., of the preceding quarter's rate of interest) are also correctly estimated. Such a finding can create no more than a presumption of correctness because the recent past interest rate is only one of many factors — and on average a relatively weak one — so that any errors in its estimated influence would not greatly distort the estimate derived from all the factors taken together. In the present case, an expectation that the equation yielded inaccurate estimates is created by the researchers' warning that their findings on the length of the monetary policy lag are still tentative (36); and, although the information they published on the goodness of their results is not completely appropriate for our purposes, it appears to show the existence of ample room for improvement of the equations.

The kind of preliminary test of reliability needed for our purposes would show how accurately the equation could estimate the dependent variable from known data on the various independent variables, those data being different ones from those which were used in the derivation of the equation itself (37). The published

(36) DE LEEUW, *op. cit.*, p. 27.

(37) The given equation was selected because it yielded the best estimates of the dependent variable on average during the time period covered. The fact of the goodness of the estimate (low " standard error ", high " t-ratio ") was sufficient proof of the validity of the equation before the coming of the high-speed electronic computer, for then the selection had to be made from only a few alternative candidates. But now a very large number is customarily tried out so that the one selected — the one yielding the best estimates of the dependent variable during the period — can plausibly owe its success merely to random

test, however, is a lax one because the data for two of the four usable quarters of estimates were also employed in the derivation of the equations (38). On the other hand, the test for the latter three of these four quarters was an excessively strict one in the sense that some of the estimated values of dependent variables were then used among the *in*dependent variables in the estimation of dependent variable values in subsequent quarters (e.g., inventory investment in one quarter was partly determined by the estimated value for inventory investment in the preceding quarter). This procedure has the consequence that errors in estimating such dependent variables in one quarter may add to the errors in the following quarter, increases in errors which would not have been present if the actual values had been used for such independent variables. (The reason for applying so difficult a test of accuracy of estimates was, of course, to see the usefulness of the model for forecasting events a year in the future; if inventory investment four quarters hence is dependent on inventory investment three quarters hence, a fair test of forecasting ability four quarters ahead must rely on the presumably error-prone forecasts of third quarter inventory.) For this reason, only the first quarter's estimate — for which all independent variables use actual values — is free of this disadvantage; but, as noted earlier, it (and the second quarter as well) is biased in the direction of *over*stating the goodness of results because of use of its data in the derivation of the equation tested.

In the absence of unbiased test data, the effects of the biases can be made at least partly offsetting through application of the test to an average of the results for the first four quarters. The admittedly poor results of the estimates for the fifth and sixth quarters ahead will not be given much weight in our evaluation, although they must, of course, be taken seriously in a judgment of the model's forecasting ability, and, perhaps, for the validity of the model in

chance: if enough alternatives are tried, chance will be certain to turn up some which yield very good results even though they have relatively little or even no real connection at all with the dependent variable. It follows that the fact of good estimates during the period used in the derivation of the estimates is no longer persuasive; therefore, the validity of the supposed causal relationships derived can be established only by seeing how well the equation can estimate the dependent variable in a time period which was *not* already employed in the selection of that equation. For details on this and other shortcomings of the traditional tests of the reliability of econometric models, see W. H. WHITE, " The Trustworthiness of 'Reliable' Econometric Evidence ", *Zeitschrift für Nationalokonomie*, 1967, Nos. 1-2, pp. 19-38.

(38) This is indicated in DE LEEUW, *op. cit.*, pp. 11-12, 14.

the neighborhood of cyclical turning points (a crucial test which every model should undergo).

Results for the inventory equation — an equation which includes no interest rate or money-availability variable — were very poor (39). Even in the first quarter, when the goodness of estimate was biased upward, the estimate was 31 per cent below the actual inventory investment. For all of the first four quarters averaged together, the constant-prices estimate showed a rise above the base-period quarter (or, as it happens, above the base-period four quarters) of 22 per cent; but the actual figures show no less than a 33 per cent rise. The average discrepancy would have been tripled if results had been taken quarter by quarter, for in the average the errors of the two middle quarters could offset part of the opposite errors found for the two extreme quarters. (The estimates in the fifth and sixth quarters after the base period were of course unacceptable, averaging 45 per cent below the semester's actual inventory investment.)

For investment in producers' durable equipment, the four new quarters showed an actual rise over the base quarter of 8-1/2 per cent while the estimated (real) figure showed a reasonably similar increase: 10-1/2 per cent (results for the fifth and sixth quarters again being poor) (40).

In contrast, investment in non-residential structures was badly estimated even for the first quarter and also for the average of the first four quarters. While the actual rate of structures investment was 7.3 per cent higher in real terms than in the base-period quarter, the estimated figure for those four quarters was 6.1 per cent below the actual. Thus, the model's equation for investment in business structures implied a negligible real growth whereas actually a 7 per cent growth occurred.

The discrepancies of the individual quarters would have yielded a much larger over-all error except again for the fact that some of the adjacent quarters had errors which were of opposite sign. (The

(39) Derived from *op. cit.*, Table 3, p. 22, with price deflators and base period figures for the same series found in the national accounts data of the *Survey of Current Business*.

(40) These and the following figures are derived from *op. cit.*, Table 2, p. 19 and from the comparable national accounts series published in the *Survey of Current Business*. Unlike the figures published in the table, the ones used here are deflated to real terms. The equations themselves were in real terms, with the price level factor being essentially merely added to the estimated and to the actual real figures before their presentation in the tables. However, this procedure may give an impression of closer conformity than actually existed and has not been followed for the fixed investment figures used above.

estimate of the change from the base to the fifth and sixth quarters was somewhat better for this series but still completely unacceptable: 39 per cent below the actual change.)

Thus only one of the three segments of business investment could be estimated well enough to justify any confidence in the exclusion of interest or in the long lag pattern used when interest was represented. And for that one — producers' equipment — grounds have already been suggested for belief that another variable — order backlogs — acted as a proxy for interest, taking credit for the rapid effects which might be expected from the interest rate. Hence, the goodness of results for the present form of the producer equipment equation, which allows only slow-acting interest rate effects, cannot serve as evidence against inclusion of the quick-acting interest rate effects.

Understatement of Lags of Effects of Fiscal Policy Measures

In addition to its apparently serious exaggeration of the lag of the effects of monetary policy measures, the Fed-MIT model has been erroneously applied in the derivation of the length of lags in achievement of significant effects from changes in government expenditure policy. The true length of lag in the effects of changes in government expenditure policy has been *understated*.

As now shown by the researchers, the very rapid effects derived from a change in expenditure policy (a $5 billion change in the rate of military expenditures) explicitly assume that much of the effects begin to be realized in the quarter *before the change in policy has occurred* (which also means exaggeration of the size of the multiplier effects in the next few quarters as well) (41).

The erroneous shortening of the lag in the effects of budget expenditure policy occurred because any rise in expenditure on these products was assumed by the model (equation F. 18) to be preceded by a rise in pipeline inventory investment during the *preceding quarter* on the part of manufacturers of the goods. And the model builders have dated the policy change at the time of the spending

(41) This is seen most clearly in the final chart showing the effect on GNP quarter by quarter of a $5 billion (annual rate) rise in purchases of military goods (Chart 9, *op. cit.*, p. 29), and is also stated explicitly, p. 24.

change, even though the spending could have changed only because the government changed its rate of placement of orders for these goods at least one quarter before. (The lead of policy/order-placing change over payment for the goods will of course be *longer* than one quarter if there must be a lapse of time for production planning and contract negotiation, for the producer's ordering of materials or even waiting in line for work on the order to be started.)

An indication of the seriousness of this exaggeration of the promptness of government expenditure policy effects is shown by the fact that the assumed $5 billion jump in the annual rate of government spending in one quarter is required to have been preceded by no less than a $2 billion jump in (annual rate of) pipeline inventory investment in the preceding quarter and, in consequence, about a $2-1/2 billion jump in GNP in that preceding quarter. The proper timing of effect would have been produced by delaying the occurrence of this $2-1/2 billion (1/3 of one per cent) jump in GNP and the subsequent quarter's $10 billion jump (1.3 per cent) at least one quarter after the ones now shown and perhaps delaying them even more.

It may be noted that the erroneous acceleration of the occurrence of effects on GNP might have been a smaller one if a normal mix of government expenditures had been used rather than the category of purchases actually used as illustration, military goods, for then the necessary lead of orders before payments would have been a shorter one (42). In that situation less distortion would have been possible and the degree of promptness of effect found for government expenditure policy would have been reduced. In either case — correction of the present distortion or use of government spending categories which are not susceptible to this distortion — the presently indicated inferiority of monetary policy relative to fiscal policy would have been diminished. Then the adjustments proposed earlier could

(42) This is not a completely certain result, for the practice of making progress payments for long-lead-time military items means that much of the payment takes place long before the pipeline has been filled. From another point of view, if the role of consumer expenditures in affecting inventory investment is representative of that of a more normal government mix, one-seventh of a rise in the rate of expenditure would be counterbalanced by unintended inventory disinvestment in the same quarter, so that only 6/7ths of a jump in such government spending could contribute anything to the same quarter's GNP. Instead of erroneously having exaggerated the effect in the previous quarter, for such a mix of government purchases the investigators would have found no effect in the previous quarter and a reduced net effect in the given quarter.

very plausibly lead to a finding that a 3/4 percentage point change in long-term interest rates and the associated change in short-term interest rates could affect GNP substantially as much and as promptly as the $5 billion changes in government expenditure or revenue policy presented in the investigators' study.

Given the additional net disadvantage of fiscal policy noted by the investigators — much more delay in getting approval for the changes in policy which appear to be necessary — the case for retention of monetary policy as an actively used tool of economic stabilization seems fully justified.

W. H. White

Washington

APPENDIX

Understatement of Model's Actual Lag Countered by Bias in Model

The published one-year lag in the attainment of significant effect on GNP in the Fed-MIT model appears to have referred to average (1962-63) conditions, conditions under which monetary policy would normally be neutral (de Leeuw, p. 26). The lag the model would actually show under the conditions in which restrictive monetary measures are usually adopted should be a still longer lag. No attention has been given to the need for lengthening the illustrative one-year lag because the part of the model which would call for such an adjustment also contains an error; correction of that error would eliminate much or most of the excess of the lag over one year (1).

The model includes separate estimates of the two segments of the investment lag. One (equation A. 9) estimated new orders for producers durable equipment (the larger part of fixed investment) as occurring with a fixed amount of delay after the determinants of investment such as the interest rate. The other (equation A. 10) estimated the investment in (acquisition of) producers durable equipment as a function of prior levels of the new orders. As described

(1) If the peculiar conditions influencing the availability of funds for house mortgages which have made housing exceptionally sensitive to monetary policy are modified, and provided that the cost-of-money effect which remains proves not to have been capable of most of the reaction seen for the total, cost-plus-availability effect, then a further reason for lengthening the delay of significant effects would appear. This matter is being passed over because the aggregate delay need not be radically increased, especially so because of the other possible shortenings of the lag (increase in speed of building and capital goods production, continuing spread of scientific investment decision procedures).

earlier, this equation quite properly provided that the length of delay from order to investment increase as the size of the backlog of unfilled orders increased. However, the increase in the length of the order/investment lag should in great part be counterbalanced by a simultaneous reduction in the delay from the determinant of desired investment to the placing of the order. The failure to provide for this adjustment in the first equation — i.e., the use of a constant rather than a varying lag from investment determinant to placing of order in equation A. 9 — has introduced some spurious variability in the length of the total lag (investment determinant to acquisition of the capital goods). At times of high order backlogs, economic activity and interest rates — the cycle phase of chief interest — the lag is exaggerated, with an understatement of the total lag in the less important conditions of low activity, backlogs and interest rates.

The reason why increases in the order/acquisitions lag tend to be compensated by reductions in the determinants/order lag are easily seen. The decision to order machinery needed for a new plant will be made a little before the start of construction of the plant; but when capacity utilization in the machinery industry is not high the actual placing of a firm order will be delayed (to permit shopping for a better price, to take maximum advantage of new technical improvements, to postpone making an advance deposit). As capacity utilization rises these advantages from delay in placing the order shrink and the risk of late delivery of the machine increases. Therefore, at times of fuller employment — the time when restrictive monetary policy is of interest — the placing of orders should occur with a *shorter* than average delay after the decision to order is made.

According to the Federal Reserve Consultant Committee on General Business expectations, similar considerations also cause more rapid placement of construction contracts after the investment decision has been made (2); that acceleration provides further scope for accelerating the placement of the associated machinery orders. (Expressed in different terms, the backlog of construction contracts and of orders for machinery has risen, although no increase in the demand for plant or equipment has taken place.) But the Fed-MIT model ignores this cyclical variation in length of lag of orders after the change in the determinants of investment. The model uses the same (cyclical average) lag for *all* phases of the cycle; and, in that way, it exaggerates the delay from restrictive monetary measures to the effect on investment.

There should exist a parallel shortening of delays in the placing of orders for the other segment of equipment investment, machines to be installed in

(2) Federal Reserve Board, *An Appraisal of Data and Research on Businessmen's Expectations*, Washington 1955, pp. 629, 633.

existing plants. In part the increase in delay of delivery after order will cause the increase in over-all lag (investment decision to delivery) actually assumed in the model. But, for the rest, the buyer of the machine will find it possible to speed up the placing of the order after his decision to buy or to speed up the making of that decision itself. Thus, whether the machinery is to be placed in new plants or in existing plants, a reduction of the lag from determinant of investment to placing of order must be introduced into the model when an increase in the lag from placing of order to investment has already been built into it.

W. H. W.