Monetary Policy and Consumption:
Linkages via Interest Rate and Wealth Effects in the FMP Model

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I. Introduction and Outline

The purpose of the present paper is to examine the implications of the Federal Reserve-MIT-Penn Model (hereafter referred to as the FMP model) with respect to the central question with which this conference is concerned, namely whether and, if so, to what extent, monetary policy affects economic activity through its direct impact on cosumers' expenditure. For the purpose of this paper we have chosen to concentrate on three major monetary policy variables: bank reserves, money supply and short-term interest rates. The model, however, incorporates several other variables within the control of the Federal Reserve such as reserve requirements, the discount rate and ceiling rates under regulation Q.

It will be shown that according to the FMP model the answer to the above question is decidedly affirmative and that indeed consumption is one of the most important, if not *the* most important, single channel through which the above tools affect

While I bear the full responsibility for the main text, I wish to stress that the model construction and estimation, the method of analysis, and the specific results of simulations are the outcome of a close collaboration with many other persons who have contributed to making the FMP model possible. The present version of the model is primarily due to the efforts of Albert Ando, Robert Rasche, Edward Gramley, Jared Enzler and Charles Bischoff, besides myself. The consumption sector is primarily the result of collaboration with Albert Ando. However, we owe a substantial debt to earlier collaborators, and notably Frank deLeeuw and Harold Shapiro, who were responsible for part of the earlier work on this sector, Morris Norman had a leading role in developing the simulation program that made possible the simulation results reported here.

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directly and indirectly the level of aggregate real and money demand and thus, the level of output, employment, and prices.

The rest of this paper is divided into three parts plus a long epilogue. In Part I, we provide a summary description of the consumption sector of the model which differs in several important

TABLES and FIGURES

respects from the corresponding sector of other existing models. We review both the major equations of this sector and the basic hypothesis that underlie these empirical equations. We do not, however, go into the details of the procedures used in the testing and estimation of parameters and in constructing some of the variables; these topics are dealt with in a chapter of a forthcoming monograph describing the FMP model which is being prepared jointly with Albert Ando. A preliminary draft of that chapter is available on request.

The major novelty of the FMP consumption sector consists in introducing explicitly aggregate private net worth as a major determinant of consumption. As will become apparent, it is primarily (though not exclusively) through this channel – the so-called wealth-effect – that monetary policy has a direct impact on consumption. In order to grasp fully the nature of this channel, it is necessary to review also the channels through which monetary policy variables affect consumer's net worth. This review completes Part I.

In Part II, we examine certain "partial equilibrium" implications of our consumption sector, and especially the implications of the wealth variable. In particular, we are concerned with the magnitude and pattern of response of consumption and income to a change in "autonomous" expenditure or, in other words, with the so-called Keynesian consumption multiplier. The need for this analysis stems from the fact that the introduction of wealth in consumption, coupled with the recognition of the feedback of consumption on wealth via saving, has some rather unusual implications which must be grasped to understand and evaluate the dynamic response of the entire system examined in Part III. For instance, it will be shown that if tax revenue is independent of income, then under an accommodating monetary policy (i.e. one that adjusts the money supply so as to keep interest rates constant) the long-run conventional Keynesian multiplier is *infinite;* while, with taxes, the size of the long-run multiplier is basically controlled entirely by the marginal tax rate. Also provided in Part II is an analysis of two further partial mechanisms which are important in understanding the links between monetary policy and consumption. One is the response of consumption and income to a change in net worth; the other is the effect of a change in interest rates via expenditure on durable goods, on the assumption that all other components of demand, as well as wealth, are unaffected by the change in interest rates.

With the background provided by Parts I and II, we proceed in the last part to examine the full response of the system to a change in the various policy variables. Our focus here is both on the magnitude and path of response and on the contribution of the consumption sector, especially via wealth effect, to this total response. This last question is analyzed by comparing the path of response of the full system with the response of a fictitious system in which we sever the link between interest rates and wealth via the effect of interest rates on the market value of corporate equity. The upshot of this section is a clear indication that in the FMP model the wealth effect is a crucial link in the response of aggregate output and employment to the policy variables, both in terms of magnitude and in terms of speed of response.

The epilogue endeavors to shed further light on the reliability of the results reported in the main text, through a number of tests dealing with certain critical issues raised by the so-called "reduced form" approach.

I. The Structure of the Consumption Sector – A Summary View

I.1 – Consumption

The structure of the consumption sector of the FMP model basically rests on the life-cycle hypothsis of consumption and saving which has been set forth in a number of previous papers.[1] This hypothesis states that the consumption of a representative household over some arbitrary short period of time, such as a year or a quarter, "reflects a more or less conscious attempt at achieving the preferred distribution of consumption over the life cycle, subject to the constraint imposed by the size of resources accruing to the household over its lifetime" (Modigliani, 1966). This hypothesis implies that consumption – defined as the sum of expenditure on non-durable goods and services plus the rental value of the stock of durable goods owned by the household – can be expressed as a linear function of labor income (net of taxes) expected over the balance of the earning span, and of the net worth (including the value of claims to pensions, etc.), with coefficient which depend on age, allocation preferences and, in principle, the rate of return on net worth (Modigliani and Brumberg).

For our present purpose we are interested in the aggregate consumption function which is obtained by aggregating over

[1] For a fairly up-to-date bibliography on the life cycle hypothesis, see the references cited in Modigliani (1970).

households in all age groups. It has been shown in Ando and Modigliani, that aggregate consumption can be expressed as a linear function of aggregate expected income and of aggregate net worth. Furthermore, the coefficients of the two mentioned variables can be expected to be reasonably stable in time under the further assumption (which is sufficient though not necessary) that tastes, the age distribution and the real rate of interest are reasonably stable over the relevant time horizon. We regard the first two assumptions as reasonable; the third assumption is much more open to question and will be touched upon again below.

The above considerations lead to the hypothesis that aggregate consumption can be approximated by a linear function of aggregate net worth and expected income.

Aggregate consumers' net worth is in principle directly observable, and we have endeavored to develop an explicit measure, with the cooperation of the Flow of Funds Section of the Board of Governors of the Federal Reserve System. Our measure is obtained, basically, by adding to the flow of funds estimate of money fixed assets, less debt, of the household sector, an estimate of the market value of corporate equity, of the market value of consumers' tangibles (consumers' durables plus residentail structures and land), and of net equity in farm and non-farm non-corporate business. The estimate of corporate equity is obtained by capitalizing the national income account estimate of net dividends by the Standard and Poor index of dividend yields, and coincides fairly closely with the estimate provided in the Flow of Funds series. In dynamic simulations of the model, net worth is endogenized by a perpetual inventory method; i.e., by adding to the beginning of period wealth, current household personal saving, an estimate of capital gains on tangibles, (computed from the endogenous change in the stocks and the endogenous change in price) and of the change in the market value of corporate equity. (See I.3 below). These changes do not unfortunately totally exhaust the sources of changes in wealth (they leave out, for example, capital gains on non-corporate business and on land and also on long-term bonds which, incidentally, are omitted also in the flow of funds estimates); there is, therefore, a small and rather erratic residual difference between actual changes in wealth and those obtained by the above method which, in historical simulations, we take as exogenous, and in projections we estimate as best we can.

In previous empirical estimates, dealing with annual data (Ando and Modigliani), the measure of wealth used in the consumption function was net worth at the beginning of the year, valued at average prices of the current year. Since in the FMP model the dependent variable is quarterly consumption, we use average wealth in the year preceding the current quarter, obtained as a weighted average of net worth at the end of each of the previous four quarters. The weights, which were estimated empirically, assign about half the weight to the current quarter with the rest distributed over the remaining three quarters with a rapidly declining pattern.

Expected labor income on the other hand is not directly observable; in previous work (Ando and Modigliani) we have approximated this variable by a measure of current net-of-tax labor income, adjusted for the effect of unemployment. In the FMP model, for a number of reasons explained in the forthcoming monograph, we have been led to replace labor income with personal income net of taxes and contributions, which essentially coincides with the standard measure of disposable income (except for the fact that we treat personal taxes on an accrual rather than on a cash basis). Because this measure includes a substantial portion of property income, which is subject to large transient fluctuations, we have approximated "expected" income with a distributed lag of actual income over the previous three years. Our final estimate of the consumption function can then be summarized as follows:

(1) CON = 0.67 x a weighted average of disposable income over the previous three years + 0.053 x a weighted average of net worth over the previous year.

The actual pattern of the weights is given in Appendix A, equation I.1. Figure A.1 compares the actual behavior of consumption with that computed from equation I.1.

Since the results of Section III concerning the role of consumption in the response to monetary policy depend critically on the presence of wealth in the consumption function and on the size of its coefficient, it is proper at this point to inquire about the reliability of equation (1) above. We summarize here a few major considerations which, in our view, provide solid ground for confidence in our estimates, both qualitatively and quantitatively.

(i) From a narrow statistical point of view we can report that the coefficients of wealth in the above equation are highly significant by customary statistical standards; (the t-ratios of the individual coefficients reach a value of around 8 for the two middle coefficients).

(ii) Not only does the addition of wealth improve the explanation of consumption but in addition it produces a fairly dramatic reduction in the serial correlation of the errors, from over .8 to .6.

(iii) Furthermore, both the size of the coefficient and their significance is quite sturdy under variations in the detailed specification of the equation or variations in the period of time chosen for the estimation, provided the period is sufficiently long and includes some cyclical fluctuations.

(iv) The coefficients reported above, which were estimated over the period 1954-1 to 1967-4, are quite consistent with the results for annual data for the period 1929-59 reported in Ando and Modigliani, and with evidence on the stability of the wealth-income ratio in the United States at least since the beginning of the century, analyzed in Modigliani (1966). To be sure, the coefficient of the wealth variable is somewhat lower than reported in the papers cited; but this decline is readily accounted for both in principle and in order of magnitude, by the change in the definition of income which now includes the return on property, (cf. Modigliani, 1966, pp. 176-177).

(v) The basic form of our equation is a fairly straightforward implication of the life-cycle model which has by now passed a number of favorable tests. See, for example, in addition to the references already cited, Houthakker; Modigliani (1970); Leff; Weber; Landsberg; Singh et al.

(vi) Finally, aggregate consumption functions of the general form (1) above have by now been estimated for a number of countries, despite the serious difficulties encountered in securing estimates of private wealth, and have confirmed fairly uniformly the importance of wealth in explaining the behavior of consumption. In particular, to the author's knowledge such estimates have been carried out for the United Kingdom, Australia, (Lydall), India, the Netherlands, Canada, and Germany, (Singh et al) and the wealth variable has been found to be highly significant with the possible single exception of India. The coefficients of the wealth variable have an appreciable scatter (though they are generally higher than our coefficient) but this is not too surprising in view of differences in the comprehensiveness of the concept used and in the quality of the basic statistics.

Quite recently the role of wealth in consumption for the United States has been challenged at least implicitly by some authors, and in particular by Fair (cf. Fair (1971b) and the references therein) on the ground that the wealth variable may really be proxying for some measure of "consumer sentiment." First, Fair (1971a) has shown that an index of consumer sentiment based on the series compiled by the Michigan Survey Research Center, and which he refers to as MOOD, makes a significant contribution to his equations explaining, respectively, expenditure on consumer durables, non-durables, and services (though in his service equation the highly significant contribution of the MOOD variable is somewhat marred by the fact that its coefficient is *negative).* Next, Fair (1971b) reports the finding that both durable and non-durable expenditure (in current dollars) are more or less significantly correlated with the Standard and Poor index of stock prices, but that when the variable MOOD is added to the equations, with appropriately chosen lags (one and two quarters for durables, and two quarters for non-durables but, surprisingly enough, never contemporaneous) then the S&P index becomes altogether insignificant. He concludes from this evidence that "the level of stock prices does not have much of an independent effect" (p. 22). These results and conclusion can give rise to some justified concern, for while our measure of wealth is total consumer net worth, it is nonetheless true that movements in the stock market contribute non-negligibly to the short-run movements of this total.

In assessing the relevance of Fair's conclusions for our present purpose, it should be noted that, as Fair and others have found, the consumer sentiment index is significantly correlated with an index of stock market prices (cf. Friend & Adams, Hyman). The direction of causality in this observed association could of course run either way. Fair has actually faced this issue and provides some interesting evidence that the causation runs, at least in part, from the stock market to MOOD (1971(b), pp. 11-13, and Table 1). Under these conditions, if monetary policy can affect the level of stock prices, it would still have a direct impact on consumption by way of its effect on consumers' sentiment – and whether this effect on sentiment, and thus finally on expenditure, is a nondescript psychological response or instead the consequence of an improved financial position is a rather idle question of little operational significance. In any event, we are able to report here a more direct response to Fair's challenge. We have actually taken Fair's MOOD index and added it to our consumption function. For the sake of completeness, tests were run both with the current value of MOOD and with the value lagged one and two periods. In either case, the addition of MOOD has a hardly noticeable effect on our estimates of the wealth coefficients or their significance. Specifically, when the current value of MOOD is added, the sum of the wealth coefficient drops but by .004, and the individual coefficients as well as the sum remain highly significant. The coefficient of MOOD has a t-ratio of somewhat over two, but the point estimate implies that an increase of 1 percent in the MOOD index would increase real per capita consumption at annual rates, now running at around $2,300, by only about one dollar (or aggregate consumption by $.2 billion.) Since in 50 of the 60 quarters for which MOOD is available, it has remained in the range 90-100, and its extreme values are 78 and 103, it is seen that the contribution of MOOD is at best rather negligible. (By contrast a 1 percent change in wealth, now running at around $3 trillion, changes per capita consumption by some four dollars in the first quarter and some eight dollar within a year). When we add instead the value of MOOD lagged one and two quarters – which is more consistent with Fair's specifications – the t-ratios of these coefficients are respectively 2.2 and 2.7 but both signs are *negative*! The point estimates are in both cases – 1 dollar per point of the index. In view of this result it is not surprising that the sum of the wealth coefficients actually rises somewhat, by .012, while the sum of the income coefficients drops by .1.

We thus seem to be fairly safe in concluding that the wealth effect does not exhaust itself on changing consumers' sentiment. We have, at the moment, no plausible explanation for the negative sign of lagged MOOD and merely note that it is consistent with the negative sign for MOOD lagged two quarters reported by Fair in his service equation. Finally, in view of its modest and marginally significant contribution, we do not plan at the moment to add MOOD to our consumption function, especially since this would require adding an equation to explain MOOD itself. However, for purposes of short-run forecasting one might gain a little by making use of the actual value of the index, if one is not bothered by the negative sign.[2]

One final point deserves brief mention in relation to our present consumption function. We have noted earlier that, in principle, the coefficients of this function and, in particular, the coefficient of wealth could be a function of the rate of return on wealth. We have made some sporadic attempts at testing this possibility but since they met with little success, mostly because of multicollinearity problems, they have been abandoned for the moment. In part, this decision was motivated by the consideration that it is not possible to establish a priori whether a higher rate of return should increase or decrease consumption. However, a recent contribution (Weber) reports some evidence that the rate of return may matter at least marginally and

[2] It is interesting that the addition of lagged MOOD has the effect of reducing the autoregression coefficient of the error term from 0.5 to 0.3; in part for this reason the standard error S_u drops from 9 to 7 dollars per capita.

that it may actually have a *positive* effect on consumption (i.e. a negative effect on saving). It is our intention to look further into this matter, but at the present this possible effect has been ignored.

I.2 Consumer Expenditure

Consumption, the dependent variable of equation (1), is not directly a component of aggregate demand. The relevant component is instead personal consumption expenditure (EPCE) which is obtained by subtracting from CON the rental value of the stock of durables and adding consumers' expenditure on durable goods (ECD) or gross consumers' investment is durables. This expenditure is accounted for by a model analogous to that used for several other investment sectors – vis., a stock adjustment or flexible accelerator model. That is, expenditure is proportional to the gap between the "optimum stock" and the initial stock of durables, after allowing for depreciation, which in the case of consumers' durables is estimated to be quite high, 22.5 percent per year. The optimum real stock in turn is a linear function of consumption in which the coefficients of consumption is itself a linear function of the real rental rate. Finally the real rental rate per year is measured by the ratio of the price index of durable goods to the consumption deflator multiplied by the sum of three terms: the depreciation rate, plus a measure of the opportunity cost of capital minus a measure of the expected rate of change of consumers' durable prices. As a measure of the (risk-adjusted) opportunity cost of capital we have used the corporate bond rate (RCB).

Our model also allows for a short-run dynamic effect, by adding to the argument of the durable equations the current level of saving. The rationale for this term is that some portion of transient variations in income, and hence saving, will be reflected in corresponding variations in ECD. The resulting equation for consumers' durable expenditure is reported in Appendix A.1, equation I.2, while further details about the model and its estimation are provided in the forthcoming monograph. We may finally note that from the expenditure on durables and the depreciation rate we can compute endogenously the current stock of consumers' durables which is then used to estimate the rental component of consumption – see Appendix A.1, equations I.3 to I.6.

It is apparent from the above description that our durable equation is not directly affected by wealth (or the stock market) except through its effect on consumption. In the light of the results of Fair and Hyman, we have been led to test the possible effect of MOOD, which might indirectly bring the behavior of stock prices to bear also on this component of expenditure. Preliminary results indicate that this variable has a positive coefficient with a t-ratio of around 2. The point estimate implies that a 1 percent change in the index would increase expenditure by some 3/100 of 1 percent of consumption or roughly $100 million at current rates. This is again rather small compared with the current rate of over $80 billion, but may bear further analysis. Since the MOOD variable is not at present in the model, for the present analysis we ignore the possible role of MOOD on durable expenditure. As a result we may perhaps tend to underestimate the wealth effect via the stock market, but the bias would seem to be of a second order of magnitude at best.

I.3 Monetary Policy, Interest Rates and the Market Valuation of Corporate Equity

As we have indicated, the main channel through which monetary policy affects consumption via wealth is through its effect on the market valuation of corporate equity which is an important component of net worth – roughly one-third at the present time. We need therefore to provide an outline of the nature of this mechanism in the FMP model.

a) Corporate Equities

Conceptually, the market value of equity is obtained by capitalizing the expected flow of profits generated by the existing corporate assets at a capitalization rate which depends on the real rate of interest, a risk premium and expected growth opportunities. Expected profits is a function of dividends (on the ground that under prevailing payout policies dividends tend to be roughly proportional to expected long-run profits) and of current corporate profits. The real rate of interest is approximated by the corporate bond rate and adjusted for the expected rate of change of prices.

We have had, perhaps not surprisingly, a great many problems in translating this conceptual framework into an operational one and the actual structure of the model and estimated coefficients leave us far from satisfied. On the whole we must consider this sector of the model as unfinished business, and we are continuing work on it even if with some qualms as to whether it will ever be finished to our satisfaction.

For the moment the market value of corporate equity is obtained by capitalizing net dividends by an index of dividend price ratio. This dividend yield in turn is estimated as a linear function of the bond rate with a short distributed lag (5 quarters) and of a measure of the expected rate of change of prices. This measure is simply a weighted average of past rates of change of prices with weights derived from coefficients estimated in the term structure equation (see below). In our empirical estimates, however, we have been unable to uncover any significant effect of price expectations until 1966; for earlier years therefore the real rate coincides with the money rate up to a constant. This procedure is clearly a rather arbitrary one though it finds some faint support in survey data on price expectations of business economists collected by Livingston and analyzed both in a forthcoming paper on the investment function and by Turnovsky. Finally the list of interdependent variables includes the ratio of current profits to dividends; as expected this variable has a negative sign on the ground that when current profits are high relative to current dividends, then expected profits are also high relative to dividends, which raises the price of stocks relative to dividends thus reducing the dividend yield. We have had no success in measuring variations in growth expectations except insofar as these may be captured by the last mentioned variable. Finally we have not made much headway in measuring changes in the risk premium except through a decreasing time trend terminating in 1960, which accounts mechanically for the sustained decline in dividend yields during the Eisenhower era.

The specific form of the equation and its estimated coefficients are reproduced in Appendix B.1. The one slightly cheering aspect of the equation for present purposes is that the estimate of the effect of change in interest rates is both quantitatively sensible and statistically fairly significant (a t ratio of about 4). Finally the equation fits the data better than one might have expected; however, we take limited satisfaction in a good fit when the equation rests on somewhat shaky theoretical underpinnings.

As a final remark we should point out that there exists an alternative version of the stock market equation which we have occasionally used in simulation and extrapolations. This equation differs from the one in Appendix B by one main feature, namely that it contains a short distributed lag on the rate of change of the money supply. The addition of this variable makes a non-negligible contribution to the fit (though it also tends to increase the serial correlation of the errors). This is not surprising in view of the findings reported by several investigators and in particular, Sprinkle.

However, we can find little justification for the role of this variable — unless it is proxying for some other variable or variables, e.g. for the level of the stock market credit or for short-term interest rates. Unfortunately every attempt at testing such variables directly leads to most disappointing results as these variables were consistently insignificant while the money supply remained significant. We still cannot see any direct mechanism through which the rate of change of money could affect market values — except possibly because operators take that variable as an indicator of things to come. But even this explanation is hardly credible except, perhaps, in the last couple of years, when watching every wiggle of the money supply has suddenly become so fashionable. For this reason we do not use this alternate equation in the analysis reported here. We can report however that comparison of simulation of changes in money supply using the alternative equation indicates that this equation implies a somewhat stronger but mostly a somewhat faster response (especially to monetary expansion. See below).

b) The Money Market and Short-term Interest Rates

To complete our picture we need still to review the channels through which monetary policy affects the long-term rate which enters the stock market equation. In the FMP model the point of impact of monetary policy on the system centers on the money market in which the short-term rates (represented in the model by the three-month Treasury bill rate and by the commercial paper rate) are determined by the interaction of the money demand equation and the money supply. The modeling of these markets needs only brief mention since it has been discussed in detail in a recent paper (Modigliani, Rasche, Cooper). In the current version of the model this section differs only in minor details from the structure presented there.

In short, the money demand depends basically on the short-term rate (r) and the level of income. Hence, if we take the money supply as the policy variable, then the short-term rate is determined by the given money supply relative to the level of money GNP; furthermore, since there is but a small simultaneous (i.e. within the same quarter) feedback from short-term rates to GNP, one may say that, in the shortest run, r can be made to take any desired value by an appropriate level of M. In the construction of the model, however, we have actually assumed that, normally, the policy variable controlled by the Federal Reserve is unborrowed bank reserves; in this situation the money supply is itself endogenous and is determined together with r by the simultaneous solution of the money demand and supply equations. The money supply depends — given enough time for adjustment — on unborrowed reserves (adjusted for reserve requirements) and on r relative to the discount rate (which controls target free reserves). Thus, in the last analysis, r and the stock of money are determined by unborrowed reserves relative to GNP and, to a minor extent, by the discount rate. However, because the money supply as well as the demand have rather complex patterns of gradual adjustment, at any point of time these variables depend also on the recent rates of change of unborrowed reserves, of GNP and of commercial loans (which in turn are closely related to changes in GNP).

The gradual adjustment of money demand to interest rates has the well known implication that a given change in the stock of money causes the short-term rate to overshoot considerably the new equilibrium level which is reached with a one quarter lag by the bill rate and somewhat more gradually by the commercial paper rate. (For the bill rate the overshooting in the first quarter is by a factor of roughly 6, while for RCP it is somewhat below 4). The situation is strikingly different in terms of the response to a change in unborrowed reserves; the gradual response of banks to a change in reserves implies that the money stock responds gradually and smoothly. For instance, in a dynamic simulation of the money sector alone (i.e. with GNP and commercial loans exogenous) the increase in the stock of demand deposits per billion dollar increase in unborrowed reserves is but $1.3 billion in the same quarter and rises gradually to $4.5 billion at the end of one year and to somewhat over $7 billion by the end of the second year. As a result the response of interest rates is also gradual and smooth. For instance, in the above mentioned simulation it is found that both short rates decline fairly sharply in the first quarter but then continue their decline till the third or fourth quarter; furthermore while the level reached then is lower than the equilibrium level the overshooting is by a factor of less than two. These rather different patterns of response must be kept in mind when we proceed to examine in Section III the response of the system to alternative policy variables, especially since the differences are amplified by the mechanism determining the long-term rate to which we now finally turn.

c) Long-term Interest Rates

The long-term rate in the model is at present measured by Moody's yield on AAA rated corporate bonds. (We are no longer entirely satisfied by this measure which is distorted by tax effects and hope at some point to replace or augment it by an index of new issue rates). This rate is essentially generated through a term structure equation accounting for the spread between the short-and the long-term rate. We think of this spread as equalizing the short-term rates with the expected holding yield of long term securities plus a risk premium to induce investors with pervailingly short interest to participate in holding the existing stock of long-term securities. The spread thus reflects primarily the expectation of capital gains or losses arising from expected changes in long-term rates. It is well known that this formulation implies that the long-term rate can be expressed as an average of the current short-term rate and of expected future short-term rates (or equivalently of the expected future long-term rate) plus risk premium. Following, and somewhat generalizing, the approach set forth in Modigliani and Sutch, and in Sutch, we hypothesize that expected future rates are the sum of the expected *real* rates plus the expected rate of change of prices ($\dot{p}$), and that both the expected real rate and the expected rate of change of prices are largely determined by the past history of the real rate, and of the rate of change of prices, respectively. This leads to an equation in which the long rate is finally accounted for by a long moving average of short-term past money rates measured by the commercial paper rate, RCP, and of past $\dot{p}$. The underlying theory would lead us to expect that the sum of the coefficients of the distributed lag on RCP should be close to unity, while the sum of the $\dot{p}$ coefficients should be around zero. This conclusion follows from the consideration that if both RCP and $\dot{p}$ remain constant for a sufficiently long time (and hence the real rate is itself constant) then future short-term money rates should also be expected to remain constant at the current level. Finally, the risk premium is approximated by a constant, plus a measure of instability of the short-term rate over the recent past.

The resulting equation, reproduced in Appendix B.2, is found to fit the data remarkably well (the standard error is but 8 basis points) and the coefficients satisfy rather closely the above specifications. (The sum of the r coefficients is .94 and that of the $\dot{p}$ coefficients .07).[3]

Two points are worth stressing in connection with our term structure equation. First, the presence of the $\dot{p}$ term implies that, even though the short-term rate in our model is basically a monetary phenomenon, which can be manipulated through monetary policy, the long-term rate cannot be so readily manipulated. For, if the Central Bank, by holding down short-term rates, endeavors to make the long-term rate artificially low, the resulting excess demand will cause accelerating inflation which, in turn, will cause the long-term rate to rise even if the short-term rate is prevented from rising by a sufficiently fast (and accelerating) growth of the money supply.

The second point concerns the role of the variable representing the recent instability of the short-term rate (which we measure operationally by an eight quarter moving standard deviation of RCP).

The coefficient of this variable is quite significant (t ratio of roughly four); it is also again quite sturdy under alternative specifications and periods of fit as long as they are long and with varied experience. We stress this point because it turns out, somewhat to our own surprise, that this term has an important effect on the response of the system to monetary policy because it creates a significant *asymmetry* between *expansionary* and *contractionary* policies. The reason is simply that, through that term, any substantial *change* in short-term rates tends to produce an increase in the long-term rate; thus a restrictive policy tends to raise long-term rates in two ways, namely by increasing expectations of future rates and by initially increasing the risk premium; on the other hand the effect of reduction in short-term rates is partly offset in the short run by the increased risk premium. We are inclined to the view that, qualitatively, this mechanism is a real one and limits the feasibility of a fast reduction in the long rate, even if short rates are made to fall fast; this certainly seems to square well with certain recent experiences. We have of course much less confidence in our numerical estimate of the size of this effect; some of the results reported below suggest that we may be overestimating it and that further effort at refining the estimates may be very much worthwhile.

[3] The sum of the p weights reported in the Appendix is 28.9, but this figure must be divided by 400 to convert the index of prices used to a percentage at annual rate, so as to have the same dimensions as the interest rate.

Having thus reviewed the sectors of the model that are essential for an understanding and evaluation of the results reported in III, we proceed in Part II to the analysis of certain crucial component mechanisms of the total effect.

II. Analysis of Some Partial Mechanisms

II.1 The Consumption Multiplier: Implications of Wealth in the Consumption Function

The multiplier is generally defined as the increment in output brought about by a change in "exogenous" expenditure -- i.e. in any component of demand that is not itself directly related to income -- usually expressed per dollar of increment in the exogenous expenditure. The excess of the multiplier over unity is thus a measure of the amplification of the exogenous change, whether brough about by a policy variable or otherwise. In the most elementary text book version of the Keynesian system only consumption is directly dependent on current disposable income and taxes are independent of income: thus

$$(1) \qquad Y = C + E$$

$$(2) \qquad C = c_0 + c(Y - T)$$

where E is exogenous expenditure and tax revenue, T, is also exogenous. Then

$$(s.1)\ C = [c_0 + c(E - T)]/(1 - c),$$

$$(s.2)\ Y = [c_0 + E - cT]/(1 - c)$$

so that the income multiplier is $\frac{dY}{dE} = \frac{1}{1 - c}$ and the consumptio multiplier is $dC/dE = c/(1 - c)$.

However, as soon as we generalize the consumption functio (C.F.) to allow for some lag of consumption behind income, incon will respond but gradually in time to a one time change in E. Hence the multiplier must be described by the difference between two paths; namely the path of income with and without the exogenous change. This difference expressed as ratio to dE can be thought of as the multiplier path and generally changes in value with t, the length of time elapsed since the change in E; *the* multiplier is then frequently defined as the limit reached by this ratio as t grows, if such a limit exists.

Let us denote by $[Y^*(t), C^*(t)]$ the path followed by [Y,C] after the change in E at t = 0. Then the income multiplier at date t can be expressed as $\frac{Y^*(t) - Y(t)}{dE} \equiv M_y(t)$, where Y(t) is the path in the absence of the exogenous change (i.e. for dE = 0); and the consumption multiplier at date t is $M_c(t) \equiv [C^*(t) - C(t)]/dE$. *The* multiplier could then be defined as $M_y = \lim_{t \to \infty} M_y(t)$; and similarly for M_c. For the above elementary model we find

$$\text{(s.3)} \qquad M_y(t) = \frac{1}{1-c} \text{ for all } t = M_y$$

and

$$\text{(s.4)} \qquad M_c(t) = \frac{c}{1-c} \text{ for all } t = M_c\ .$$

Suppose now we replace the elementary consumption function (2) with a simplified version of our C.F. in which we neglect the lags: thus

$$\text{(2')} \qquad C(t) = c[\,Y(t) - T(t)] + w\,W(t)$$

where W(t) is net worth at the beginning of period t, and w a constant. Assuming no capital gains or losses, we also have the identity

$$\text{(3)} \qquad W(t) - W(t-1) = S(t-1) = Y(t-1) - T(t-1) - C(t-1),$$

where S denotes personal saving. In turn (3) implies

$$W(t) = W(0) + \sum_{\tau=0}^{t-1} S(\tau) \qquad t = 1,2, \ldots$$

Substituting from (1) we then find

$$S(t) = E(t) - T(t)$$

and

$$C(t) = c[C(t) + E(t) - T(t)] + w\left\{W(0) + \sum_{\tau=0}^{t-1} [E(\tau) - T(\tau)]\right\} + c_0 \ .$$

Solving the last equation for C(t):

$$\text{(s.1}'\text{)} \quad C(t) = \frac{1}{1-c}\left\{c[E(t) - T(t)] + w\,W(0) + w\sum_{\tau=0}^{t-1} [E(\tau) - T(\tau)]\right\} + \frac{c_0}{1-c}$$

Similarly $C^*(t)$ is given by the right hand side of (s.1′) but with E(t), T(t) replaced by $E^*(t)$, $T^*(t)$. Suppose that at t = 0 a once and for all increment dE is added to E so that $E^*(t) = E(t) + dE$. Then, from (s.1′) we find

$$C^*(t) - C(t) = \frac{1}{1-c}\left[c(dE) + w\sum_{\tau=0}^{t-1} dE\right]$$

and therefore

$$\text{(s.4}'\text{)} \qquad M_c(t) = \frac{C^*(t) - C(t)}{dE} = \frac{1}{1-c}[c + wt] = \frac{c}{1-c} + \frac{w}{1-c}\ t$$

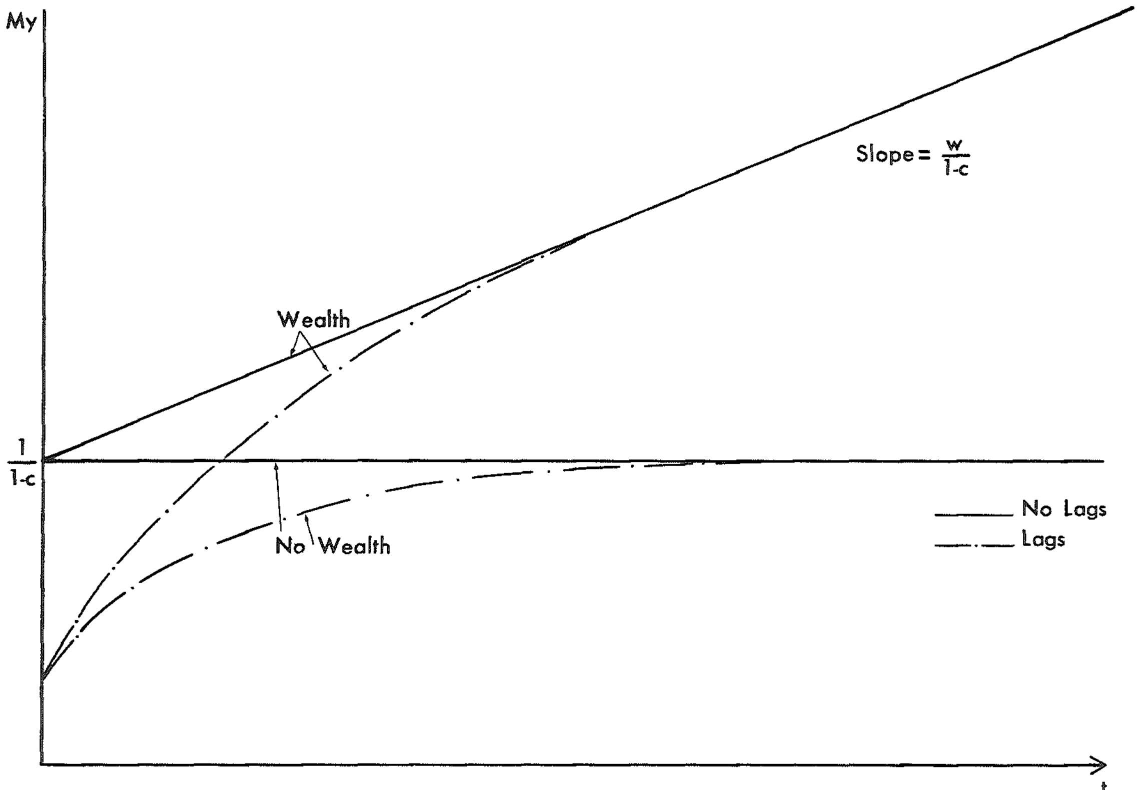
$$\text{(s.3}'\text{)} \qquad M_y(t) = \frac{Y^*(t) - Y(t)}{dE} = \frac{1}{1-c}(c + wt) + 1 = \frac{1}{1-c} + \frac{w}{1-c}\ t\ .$$

Thus if the C.F. includes wealth linearly the *multiplier increases with time, linearly at the rate w/(1 - c);* and as t grows the *multiplier also grows without bound.* This apparently paradoxical result can actually be readily understood. The increase in the exogenous expendtiure dE can be looked at as an increase in "offset to saving" which cause: saving in every period to increase by the same amount dE. But th(increase in saving in turn increases wealth which again increase: consumption and income, forever. The relation between th(multiplier implied by standard C.F. and that implied by (2′) is showr graphically in figure 1a below by the two solid lines.

If we allow for consumption to depend on an average of pas income and wealth and let c and w denote respectively the sum o the income and wealth coefficients, then, in general, the multiplier

Figure 1a

TIME PATH OF MULTIPLIERS
FOR ALTERNATIVE SPECIFICATIONS OF THE CONSUMPTION AND TAX FUNCTIONS



a: Tax Revenue Constant

will approach asymptotically the graph obtained in the no lag case, as shown by the dotted lines in figure 1a.[4]

If, instead of taking tax revenue as a constant, we assume, more realistically, that it is proportional to income, say

$$(4) \quad T = \theta Y$$

then, with the standard consumption function (2) one gets the well-known result

$$(s.3.\theta) \qquad M_y(t) = 1/[1 - c(1 - \theta)] \qquad \text{for all } t \geq 0 .$$

On the other hand with our function (2′) one can readily establish that the result is

$$(s.3'.\theta) \qquad M_y(t) = \frac{1}{1 - c(1 - \theta)} + \frac{\frac{1-\theta}{\theta}(1-c)(1-\lambda^t)}{1 - c(1 - \theta)} ,$$

$$\lambda = 1 - \frac{\theta w}{1 - c(1 - \theta)} < 1 .$$

Thus again the multiplier keeps growing in time (since $\lambda < 1$); however, in this case it approaches an asymptote:

$$M_y = \lim_{t \to \infty} M_y(t) = \frac{1 + \frac{1-\theta}{\theta}(1-c)}{1 - c(1-\theta)} = \frac{1}{\theta} .$$

It is seen that, in this case, the addition of wealth makes the limiting value of the multiplier, M_y, *totally independent* of the parameters of the consumption function and simply equal to the reciprocal of the (marginal) tax rate θ (though the time path $M_y(t)$ does depend on these parameters). What happens in this case is that, as consumption and income rise under the impact of the original change dE and the

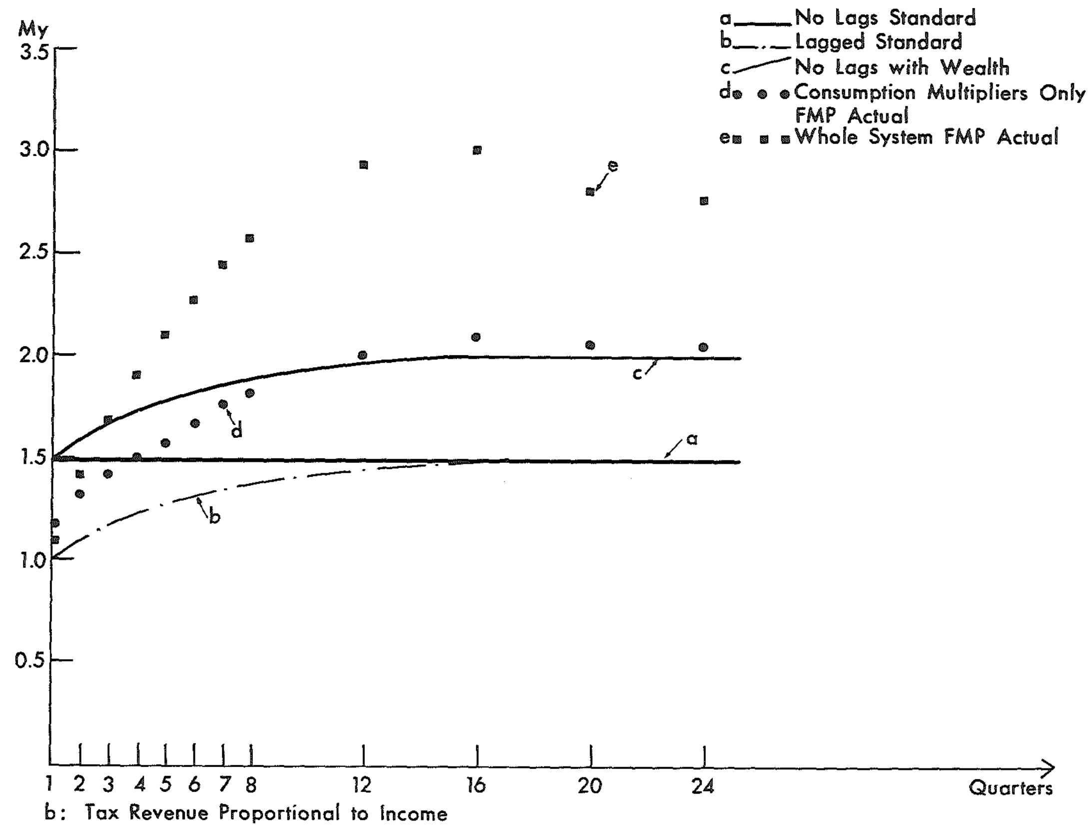
[4]Our result about the long-run multiplier follows directly from the fact that wealth appears in the C.F. with constant coefficients. It is not obvious, however, that this result is consistent with the life cycle model. Indeed, to derive from that model a C.F. of the form (2′), one needs a number of additional assumptions of "constancy" which might fail to hold when E is changed by a fixed amount once and for all. It can, in fact, be shown that our result is fully consistent with the life cycle model.

induced increase in saving and wealth, tax revenue also rises and this reduces disposable income and saving, and hence accumulation. The process comes to an end when the increase in income has become large enough so that the increase in tax take, $\theta M_y dE$, is just enough to offset the increase in dE. This obviously occurs when M_y is $1/\theta$. At this point dE is exactly offset by an increase in government receipts at the rate dE, the incremental saving is reduced to zero, and wealth stops growing. In figure 1b the solid rising curve c shows the approximate multiplier path implied by our C.F. (1) of part I, assuming an instantaneous response to income and wealth: it is computed by taking c = .7, w = .05 and $\theta = .5$. The assumed value θ is a rough approximation to the marginal tax rate for the U. S. economy for the mid-sixties, when account is taken of both the personal tax rate, (Federal plus state and local) social security contributions, and the tax rate on corporate profits. Then from equation (s.3′ .θ), $M_y(0) \simeq 1.5$, $M_y \simeq 2.0$. Also $\lambda \simeq .96$ so that the approach to equilibrium is rather slow, around 4 percent per quarter. The solid horizontal line a shows by contrast the multiplier implied by the standard C.F. assuming the same values of c and θ.

The lower dotted curve d in figure 1b shows the actual multiplier path computed from a dynamic simulation of the FMP model in which an exogenous component of expenditure – specifically exports – was increased by $10 billion above its actual value, beginning with 1962.1, while all other components of demand, except consumers' expenditure, were taken at their historical level. This path differs from the theoretical path c for two main reasons: i) the gradual response of consumption to income, and, to a minor extent, to wealth; ii) the fact that consumers' expenditure includes durable goods and the response of this conponent includes "accelerator effects." For an interim period ECD has to rise enough to generate the desired addition to the stock of durables, though eventually the increment settles down to what is necessary to offset the depreciation of the increased stock. It is this accelerator effect that is responsible for the overshooting of the accelerator path, though this overshooting is quite modest because of the very gradual response of consumption.

Figure 1b

TIME PATH OF MULTIPLIERS
FOR ALTERNATIVE SPECIFICATIONS OF THE CONSUMPTION AND TAX FUNCTIONS



As expected, the multiplier M_y is around 2. This rather modest multiplier reflects the powerful stabilizing effect of our very high marginal tax rate (combined with the assumption that neither the Federal nor state and local governments respond to the increased tax take by changing either tax rates or expenditure). It is also seen that the response is fairly fast, with some 75 percent of the total effect occuring within one year.

To complete the picture we also show by the upper dashed line c in figure 1b the multiplier response when we allow all other components of demand (except real Federal Government expenditure) to respond to the increase in output. We thus allow for i) "accelerator effects" on plant and equipment expenditure and inventories, ii) effects on residential construction, iii) for response of state and local government expenditure to the increase in the tax base, [5] and also iv) for larger imports (which reduces the multiplier). However since we keep the financial sectors and, in particular, *interest rates unchanged,* we are implicitly assuming a "permissive" monetary policy which accomodates the higher money income resulting from the increase in real output (and from the increase in prices which would accompany the expansion of employment) by an appropriate expansion of the money supply. Or, to put it in familiar text book language, we are measuring the effect of a change in exogenous expenditure on shifting the Hicksian IS curve, rather than the shift in equilibrium resulting from the intersection of the shifted IS curve with an unchanged LM curve.

It is not surprising that the resulting multiplier is distinctly larger, somewhat slower, and exhibits more pronounced overshooting than when only consumers' expenditure is endogenous. The peak value of the multiplier rises roughly from two to three. About 2/3 of the peal effect is reached within the first year, and by the second year the proportion rises to over 90 percent. In section III we shall have occasion to compare this response with the path resulting from a different monetary policy; viz. a constant money supply, and thus

[5] In the FMP model, both expenditure and receipts of state and local Government are explained endogenously.

assess the restraining effect of a non-accommodating monetary policy.[6]

II.2 Real System Response to Change in Wealth

Another useful way of assessing the role of wealth in the consumption function is to examine the effect on GNP of an exogenous shift in that variable. The direct effect on consumption can of course be estimated directly from the coefficients of the consumption function reproduced in Appendix A. From these we can infer e.g. that a $10 billion change in W would change CON by some $.3 billion in the same quarter and by $.53 by the end of one year. At current level of net worth this means that a 1 percent increase in W, roughly $30 billion, changes consumption by about $.8 billion in the same quarter and by $1.5 billion within a year. However, this measures only the direct effect on CON. To get the direct effect on consumers' expenditure one needs to add the effect on consumers' durables which is more spread in time. Finally, to get the full effect on GNP, one should take further into account the multiplier effect which we have seen to reach a value of roughly 3, but over an even longer span.

In order to see how these various lags interact we have carried out a simulation in which W was increased by $50 billion in 62.1 and all real sectors were taken as endogenous while the financial sectors are again exogenous. Since in 62.1 wealth was nearly $2 trillion, the assumed increase amounts to 2.5 percent. Figure 2a reports the results of this simulation for GNP, expenditure on durable goods (ECD) and total consumers' expenditure (EPCE) all in constant prices.

In assessing the results it is helpful to remember that the direct effect on CON should be around $1.5 billion in the first quarter, grow to some $2.5 billion by the end of one year, and then remain there. (These figures are only approximate because the change in W is

[6]It should be noted that since the multiplier reported in Figure 1b represents the response of the system to an exogenous change in any component of aggregate demand for real private GNP, it measures, in particular, the response to a change in government purchase of goods – provided, however, that the change in expenditure did not result from defense procurement. This is because in the FMP model defense procurement begins to affect GNP, through inventories, beginning with the time at which the order is placed, and hence well in advance of actual expenditure. The expenditure occurs only when the goods are delivered, at which time inventories are reduced, largely offsetting the expenditure. Similarly, expenditure on compensation of employees, which is not a component of private GNP, also generates a somewhat different multiplier path.

in money terms and hence the real effect is somewhat reduced in time by the increase in CON deflator; however in the chosen period this increase was small -- of the order of 1 percent per year). It is seen that, through the various amplifying mechanisms, GNP actually rises by 4.3 within two quarters (an elasticity η of .3) to 7 in one year ($\eta =$ .5) and reaches a peak effect of just over 8 by the seventh quarter ($\eta \simeq$.6), staying around that level till the end of the third year. It then declines slowly -- through this decline is, no doubt, due in part to increasing prices. Thus the direct effect on consumption, which is already sizable, gets amplified to a very substantial total. To illustrate, at current levels of W and GNP a 1 percent change in W would generate a change in GNP of nearly $3 billion within two quarters, over $4 billion within a year and nearly $5 billion before the end of two years. As for the composition of the total effect, it appears that, typically, around 2/3 is accounted for by consumers' expenditure and 1/3 by all other demand sectors (investment, plus state and local government, minus imports), though the share varies somewhat over time. It reaches its lowest point around the fourth quarter when the acceleration effects are most important. Some acceleration effects occur within the consumer expenditure sector itself through durables, though this is seen to be modest: the peak rate of durable expenditure is only some 30 percent higher than the steady state effect of about $1 billion.

In the light of these results it should not be surprising if a substantial portion of the impact of monetary policy were to occur through the role of wealth in the consumption function.

II.3 Real Systems Response to a Change in Interest Rates Via the Relative Cost of Durable Goods Services

The last partial effect to be examined here is the effect a change in interest rates on the rental rate of durables and thus on durable expenditure. We wish to stress from the outset that we have much less confidence in the numerical results about to be presented than in those given in the last subsections, because we do not regard our estimate of the coefficients of the rental rate in the durable equation as very reliable, especially with respect to the lag structure. We hope nonetheless that these results provide at least a bearable approximation to the order of magnitudes.

A first answer to the question posed could again be gleaned directly from the coefficients of the ECD equation given in

Figure 2a

RESPONSE OF DEMAND TO AN EXOGENOUS CHANGE IN NET WORTH

NET WORTH INCREASED BY 50 BILLION IN 1962.1

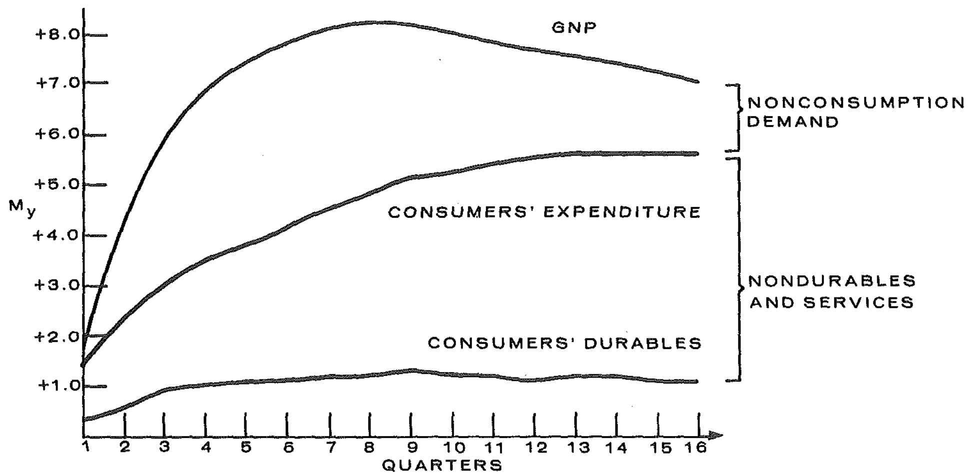
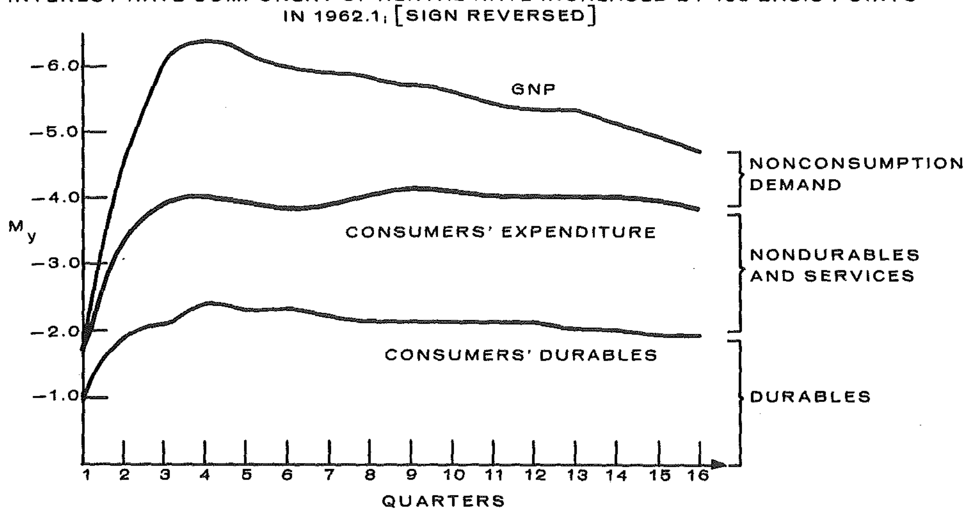


Figure 2b

RESPONSE OF DEMAND TO A CHANGE IN INTEREST COST OF DURABLE SERVICES

INTEREST RATE COMPONENT OF RENTAL RATE INCREASED BY 100 BASIS POINTS IN 1962.1; [SIGN REVERSED]



Appendix A: these tell us that a change of 100 basis points in the long-term rate (price expectation constant) would decrease durable expenditure by .002 of CON in the same quarter, and by more in the following quarter until the full impact effect of .0066 CON is reached in the fifth quarter. At current rates of CON, just below \$500 billion, this would be a reduction of roughly \$1 billion in the same quarter and over \$3 billion by the fifth. These are again non-negligible magnitudes, though of course a change of 100 basis points in the long rate is a rather large one. But again these are only the direct effects, which do not even allow for the feedback effects through a change in the stock of durables. To estimate the total impact we must also allow for multiplier effects, and their distribution in time. Again we have endeavoured to throw light on these total effects through a simulation in which we have increased the long-term rate (RCB) by 100 basis points from 1962.1 on, while at the same time keeping it at the historical level for every other component of demand in which this rate appears, directly or indirectly, including the stock market. Our simulation therefore depicts the total effect of a change in RCB *only through its effect on the rental rate of durables.*

The results of the simulation are given in Figure 2b (with sign reversed). As background we may note that, since in the period '62–'65 CON was running around \$330-380 billion, the direct effect should come to \$.7 billion in the first quarter and rise to around \$2 by the fifth quarter.

It can be seen from the table that initially, ECD rises a little more than these figures, reflecting the feedback of the multiplier effect on the desired stock of durables via CON; the peak effect is about \$2.3 billion reached in the third quarter and maintained for the next year or so. But, because of the multiplier, the total effect on GNP soon becomes two to nearly three times larger, reaching nearly \$5 billion by the second quarter and around \$6 1/2 billion by the end of the year. Thereafter it declines very slowly returning to \$5 billion at the end of four years.

Note that, given enough time, ECD declines again toward a long run level which is probably in the order of \$1 billion. The overshooting in the first few quarters reflects a type of accelerator or rate of change effect of RCB. This can be seen as follows. The rise in RCB reduces the desired stock of durable goods. It can be shown that equation I.2 implies a long-run elasticity of the stock of durables with respect to RCB somewhat below .1. Since a change of RCB of 100 points is roughly a 20 percent change, the desired stock should change by some 2 percent or around $4 billion. Thus, in the long run, ECD should decline by the depreciation on 4 billion of stock, or around 1 billion. Initially, however, the decline must be larger so as to generate a decline of $4 billion in the stock itself. This is the acceleration effect referred to above.

In summary, the impact of interest rates via consumers' durable alone in the FMP model is again surprisingly strong, especially once we allow for direct and indirect effects. As an order of magnitude it appears that a 10 percent change in the real long rate would tend, within three quarters, to change real GNP by around six-tenths of 1 percent or around $4 1/2 billion at current rates, and this effect would be roughly maintained for a couple of years.

III. System Response to a Change in Policy Variables and the Role of Linkages Through Consumption

III.1 The Basic Approach

Our major interest here is in examining the implications of the FMP model concerning the role of the wealth effect in the response of the system to a change in policy variables, especially those traditionally associated with monetary policy. The basic technique by which we propose to analyze this problem consists in comparing the response of the entire system with the response to a "fictitious system" in which monetary effects through wealth are suppressed. This suppression is accomplished by the simple device of severing the connection between interest rates and the rate (RDP) at which dividends are capitalized. That rate is instead taken as exogenous (i.e. at its historical value, see below). Note that this is *not* equivalent to taking wealth as exogenous, since wealth contains many assets beyond equity in corporate enterprises; indeed as noted earlier, in recent years that component has amounted to roughly 1/3 of the total. Nor is it strictly equivalent to taking the market value of equity as exogenous. For, that value is obtained by capitalizing dividends and we continue to treat dividends as endogenous; thus any policy change which affects GNP will affect wealth by changing the flow of dividends both via real and via price effects. We proceed to list below a number of further operational aspects of our method of analysis which are essential for an understanding of the results, their scope, and limitations.

(i) For present purposes, we choose to measure "response" by the broadest conventional measure namely GNP, as defined in the

National Income Accounts. However, we exhibit the response of both real GNP (XOBE) and GNP in current dollars (XOBE$) from which one can also infer the price response. In principle, of course, we could also exhibit the response of any other endogenous variable of the system – say consumption or investment, or imports, or tax revenue, or other financial variables. However, because of limitation of space the results reported in figures and tables and the discussion in the text will focus exclusively on the two above mentioned measures of GNP.

(ii) The response is computed by the method of comparative dynamic simulations inside the historical period. That is, we first simulate the model with the policy variable on their historical path. We refer to this simulation as an "historical" one and denote the GNP so computed by GNP^c. Next, we run a second simulation with one or more policy variables changed in some specified way. We refer to this second simulation as a "policy" run and denote the resulting GNP by GNP^*. Finally, to complete the multiplier we subtract GNP^c from GNP^*, and, possibly, divide the difference by some measure of the change in the policy variable, in order to normalize the result. It will be recognized that, in the special case where the policy variable is an exogenous component of expenditure such as government expenditure on goods and services, the result of this operation is precisely the multiplier M_y, as defined in II.1. However, when the policy variable is a different one, then the notion of a multiplier will generally be ill-defined since the unit of measurement for the change in the policy variable is arbitrary, especially if that variable has a different dimension than the numerator, (as for instance if it were the stock of money, or the short-term rate). We still find it convenient to refer to the change in GNP as a policy multiplier but we shall have to make explicit the unit in which we measure the change in the policy variable.

(iii) Since our system contains a number of essential non-linearities, the multiplier response is in general not independent of "initial conditions," that is, of the state of the system at the beginning of the policy simulations or of the actual path of the exogenous variables over the period of the policy experiment. Because of limitations of space, we focus our attention on a single policy experiment generally starting in the near past, around the beginning of '67. The reason for choosing this particular period as the basic period of analysis is explained in (iv) below. We recall here that 1967 is a year in which unemployment was already quite low, and which was followed, historically, by a prevailing expansionary fiscal and monetary policy which further increased the inflationary pressures in the economy. To assess the sensitivity of our results to the specific initial and historical conditions we shall report, for comparison, selected results of a policy simulation beginning around 1962, a period of considerable slack of the economy followed by a very gradual expansion of aggregate demand, reduction of unemployment, and reasonably stable prices until 1965. The comparison also helps to assess whether the above described difference in initial conditions produces differential effects that are a priori credible and "sensible."

(iv) As we have indicated, several of our sectors allow for price expectational effects. In particular, such effects play a significant role more or less explicitly on (1) the stock market through RDP; and hence on any other variable that is directly related to RDP such as consumption, and plant and equipment expenditure; (2) equipment expenditure; (3) on expenditure on durable goods, (4) to some extent on housing starts; and finally (5) on long-term interest rates, both corporate, municipal and mortgage rates. We have also mentioned that, empirically, we have not been able to detect a significant direct effect of price expectations on either RDP or equipment and durable expenditures, until around 1966. On the other hand, the evidence suggests that price expectations were important throughout in affecting the relation between short-and long-term interest rates. As will soon become apparent, and is hardly surprising, the presence of a price expectational terms in sectors (1), (2) and (3) above is apt to be highly unstabilizing, especially for certain types of policies. We, therefore, felt it desirable to present multipliers both for the full system and for an artificial system in which the price expectational effects in (1), (2) and (3) are suppressed. These effects are automatically absent for any policy simulation which terminates before 1966. For simulations beginning on or after 1966, we can suppress the "price expectational mechanism" by the device of taking the rate of change of price term which appears in (1) (2) and (3) as a measure of expected p, as exogenously given at its historical value, instead of calculating it endogenously from the history of prices generated by the simulation. These simulations ex-price expectational mechanism enable us to assess the role of this mechanism. In addition, they also provide information on multipliers under initial conditions of price stability, since, in general, the price expectational term in our equations only begins to operate when the rate of change of prices rise above some threshold value (empirically estimated at 1.5 percent per year) and becomes fully operative only if $\dot{p}$ remains above this threshold for a substantial length of time (three years). It follows that our basic design consists in showing four different multipliers as follows: (a) full system with wealth effects; (b) same, without wealth effects; (c) full system without price expectational mechanism; and (d) same as (c) but without wealth. This enables us to examine not only the wealth effect but also its interaction with the price expectational mechanism.

(v) Because many of the policy variables in our system are functionally related to each other, the number of possible independent policy variables in any simulation is smaller than the set of policy variables. In carrying out a particular policy simulation one has to decide which other policy variables are taken as exogenous at their historical level, and this decision, in turn, determines which other potential policy variables are taken as endogenously determined. To illustrate, the set of our fiscal policy variables includes Federal expenditure, tax rates and government surplus; but only two of these variables can be chosen independently. Thus, in a simulation in which we change government expenditure we might take tax rates at their historical level. In this case, the receipts and the surplus will differ from their historical level and the expenditure effect will be partially offset by the fiscal drag (or built in stabilizers). Alternatively, we may take the surplus at its historical level, in which case, we cannot take tax rates as given. The same choices arise if the policy change were, say in money supply, except that now we would also have the choice of taking surplus and tax rates as exogenous and expenditure as endogenous. The multiplier will, of course, be quite different for the different possible choices. In the case of fiscal variables all this is well understood, and multipliers are generally defined on the assumption of given expenditure and tax rates and endogenous receipts and surplus. We shall here adhere to this convention; i.e. we will always take tax rates as given, and we also take Federal expenditure as given (in real terms) except when expenditure itself is the policy being changed. But when it comes to the monetary sector the situation is more complex and there are few clear precedents to go by. In particular, when we change a fiscal variable we could take as exogenous in the monetary sector any one of the following: (i) the money supply (currency plus demand deposits); (ii) the demand deposit component, (iii) the unborrowed base (bank reserves + net currency less borrowed reserves); (iv) unborrowed bank reserves.[7] Furthermore, if one takes unborrowed reserves as given, one also has the choice of taking as historically given the discount rate or instead the spread between the discount rate and the bill rate. Again, alternative choices can have significant effects on the size of the multiplier. For the present paper we have found it instructive to make different assumptions in different simulations and the choices made will be made explicit in each case.

III.2 The Expenditure Multiplier

We begin by presenting results for the multiplier response to an exogenous change in expenditure. This multiplier is of interest not merely because it measures the effect of a change in government expenditure on goods, but also because the response to any other policy variable is profoundly affected by "this multiplier". Indeed, this response can be looked upon as the superimposition of two effects: a direct effect of the policy variable on one or more component of aggregate demand plus the multiplier response to this direct effect.

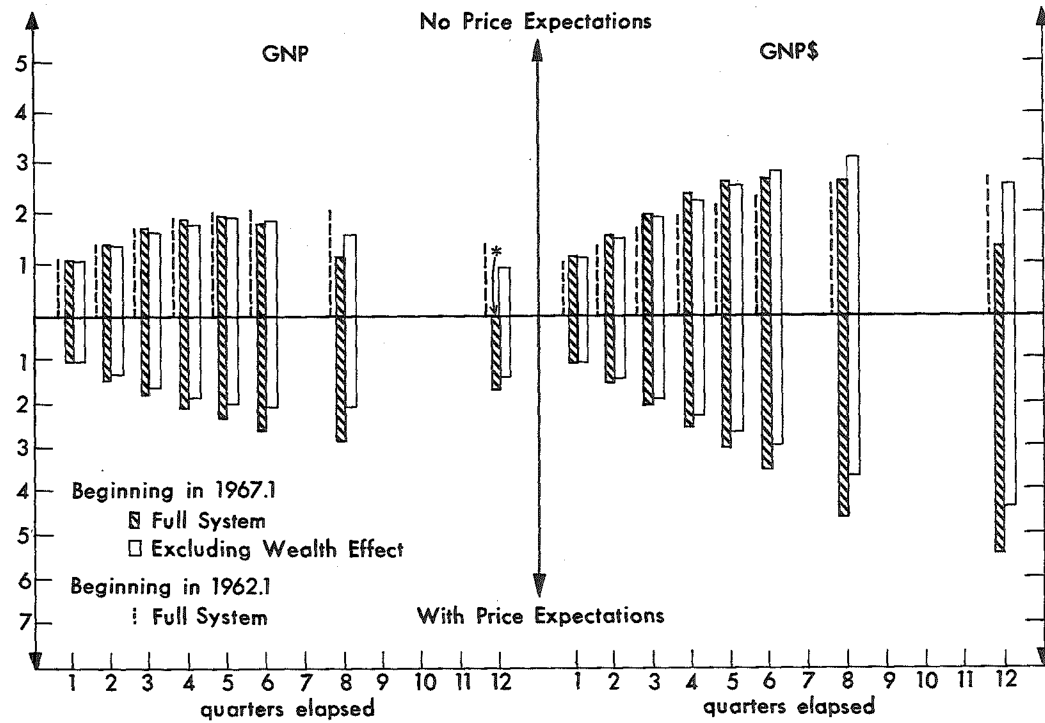
Unfortunately, for the reasons explained in III.1, (v), "the multiplier" turns out to be an ill-defined concept, for it depends on what assumptions are made as to which monetary variable is exogenous. One possible assumption is that the exogenous monetary policy variable is the short-term interest rate, the Central bank supplying whatever amount of monetary base is required to maintain the short-term rate at the historical path. The multiplier under this assumption actually coincides approximately with the multiplier we have already presented in section II.1, figure 1b. We say "approximately" because there we took as given not just the short-term rates but all interest rates. Now, to a first approximation in our system all rates are determined by the history of the short-term rate (at least if we take as historically given the ceilings on all deposit rates). However, this approximation is really a good one only if the rate of change of prices does not differ significantly from the historical path,

[7] It is more questionable whether one could take as exogenous the total base or total bank reserves, at least in the short run, for borrowing initially responds to changes in the unborrowed component. In particular, under the present system in which required reserves are against *past* deposits, at least in the very short run, the asset decisions of (member) commercial banks largely determine (up to the very small level of excess reserves) the amount of reserves that the central bank *must* provide unless it wants to force banks to violate their reserve requirements; what the Fed can control is the volume of unborrowed reserves which in turn determines the extent of borrowing.

Figure III.1

EXPENDITURE MULTIPLIERS

Based on 10 Billion Change in Exports



*negative value -0.7 omitted

for otherwise, as already indicated under II.3, the long rate could move relative to the history of short rates.

Another possible assumption, which is frequently made, explicitly or implicitly, in speaking about *the* multiplier, is to take the money supply as given. This is the multiplier which we present in Figure III.1 but with one modification: what we take as historically given is not the total money supply but, more narrowly, the stock of demand deposits. This multiplier therefore assumes that the central bank provides all the base necessary to enforce the historical level of deposits and to accommodate the currency demand of the public. This particular choice for the exogenous monetary policy variable is perhaps a little unusual and indeed it was made more out of computational convenience and precedent than as a result of careful deliberation. However, it should be remembered that this definition will be roughly equivalent to taking the total money supply as exogenous as long as the policy experiment does not generate a significant discrepancy between the historical and the simulated ratio of demand deposits to currency, which is general can be taken as a good approximation. We shall therefore take the liberty of referring to this multiplier as "the multiplier-money-supply-given."

Our quantitative results are summarized in Figure III.1 in which we have tried to pack a good deal of information. First, the left portion of the figure deals with the real GNP multiplier while the right-hand side presents multipliers for GNP in current dollars, GNP$. In each half, the histograms appearing *above* the heavy horizontal line refer to multipliers computed *excluding* the price expectational mechanism for the quarter indicated at the bottom of the figure. The histograms appearing below the horizontal line are multipliers including the price expectation mechanism. Finally, for each quarter, we exhibit two columns: the black column shows the multiplier for the full system, while the white column shows the multiplier *excluding* the wealth effect. Both multipliers were obtained from a policy simulation in which real exports were increased by $10 billion beginning in the first quarter of 1967. Finally, the dashed vertical lines which appear for each quarter only on the upper left portion of the figure show the multiplier for a similar simulation beginning in the first quarter of 1962.

Examination of the black columns in the left top portion and comparison with Figure lb, which shows the "multiplier-interest-rate-given," brings out immediately some important facts. Taking money supply exogenous has very little effect on the multiplier M_y during the first year; in both cases, M_y begins just over one and reaches just below two by the end of the first year. Furthermore, excluding the wealth effect reduces the multiplier, but very marginally; in other words during the first year the wealth effect contributes but little to the size of the multiplier. But beginning with Q5 things look quite different. First, when M is given, M_y reaches its peak in Q5 as compared with three years when r is given, and the peak is very much lower, around two instead of three. Second, starting from Q6 the wealth effect actually *reduces* the multiplier and this unfavorable effect grows rapidly larger.

These results, are, at least qualitatively, very much in line with what one should expect. With M given, the increase in money GNP, shown in the right hand portion of the diagram, causes short-term interest rates to rise, which rise gradually communicates itself to long rates. The rise in long rates in turn tends to choke off some investment and also to reduce the value of corporate equity, choking off some consumption. This second effect, however, is absent when we exclude the wealth effect, and this explains why, with M given, the wealth link has eventually the effect of *reducing* the multiplier. On this ground, one would actually expect the multiplier cum-wealth to be lower than ex-wealth from the very first quarter rather than beginning with Q5 as in the graph. The reason why initially things work out the other way is that, while the higher interest rates do tend to increase the dividend price ratio, RDP, there is a small additional effect via the profit/dividend variable appearing in the RDP equation, which tends to lower RDP, and initially outweighs the interest effect.[8]

It is apparent from the graph in the right portion of the figure that the same general picture holds for the GNP$ multipliers, except that the increase in prices accompanying the increase in GNP leads to a higher multiplier, reaching a peak of 2.7 after six quarters (as compared with five for GNP). Of course, the very same price effect that bolsters the GNP$ multiplier contributes to reducing and turning around the GNP multiplier.

How sensitive are these multipliers to initial conditions? A rough qualitative answer can be obtained from the top left portion of the diagram by comparing the black histograms with the dashed line, showing the behavior of the multiplier in a relatively slack period, beginning in '62.1. It will be seen that the multipliers for the two

[8] As noted in I.3, the earning/dividend ratio enters with a negative sign; also, the increase in GNP through the multiplier increases corporate profits, while dividends are very sluggish; hence, the ratio rises, tending to reduce RDP and thereby having a favorable effect on wealth.

simulations are very close, indicating little effect of initial conditions. The earlier period multiplier is just a little higher and reaches a peak a little later because, through the curvilinearity of the Phillips curve, the multiplier effect on the rate of change of prices is a little lower in the early, slack period, which permits a little more growth in GNP. On the whole, this conclusion is qualitatively sensible; expenditure multipliers on real GNP are larger when there is more slack. Indeed, in the limit, if we started out with the labor force already at a very high rate of utilization, one would expect the real multiplier to dwindle toward zero as the government expenditure would have to crowd out rapidly other components of expenditure. The difference shown in the graph is perhaps smaller than one might expect; but, then it should be remembered that in 67.1 the rate of unemployment was still at 4.2, as compared with 5.5 in '62.

The fact that the GNP multiplier eventually decreases, both cum- and ex-wealth effects should not be regarded as surprising. Indeed, one can readily show that if our system is stable (as it seems to be at least with money supply given) then, in the longest run, the real multiplier, given M, must be zero. This is because as long as the multiplier is positive, prices must keep rising faster than in the base simulation (because of lower unemployment) and GNP$ must therefore be higher and so must interest rates. But the higher interest rate must tend to crowd out investment in any event, and consumption as well, if we allow for the wealth effect. In the longest run, therefore, the additional real exogenous increase in demand must displace an equal amount of other expenditure, leaving GNP unchanged. In this respect, our model should please the monetarists. But the relevant question is how long is the required run. It will be seen that for the simulation beginning in '67, the multiplier is negative by the twelfth quarter – crossing zero after about two and one-half years. For the earlier, slack period simulation, the zero crossing point is more like three and one-half years. Strictly speaking, of course, the zero crossing is not quite the end of the story, for, the response of the system to the shock is cyclical and, hence, the multiplier path will continue to oscillate around zero indefinitely. However, since the oscillations are quite damped, the first crossing point does provide a good fix as to the speed of the crowding-out effect. Using this criterion, the FMP model suggests that this effect occurs fairly fast, though much less so than the monetarists seem to hold.

What can we say about the longest run limiting value of the GNP$ multiplier? In contrast to the real multiplier we can be sure that in our model it will be positive. Indeed the limiting value of the interest effect must be positive in order for the exogenous increase to crowd out other components (and since, with GNP unchanged, real tax revenue must eventually also be unchanged if we assume real taxes to be a function only of real income, at least to a first approximation); but, with a higher r, there will be a higher velocity of circulation, which, with M constant, implies higher GNP$ through a higher price level.

Turning now to the lower half of the chart, we see that the price expectational mechanism considerably amplifies both multipliers, even with M given; the peak value of GNP is now around three and is reached after three years; the reason of course is that, at least for a while, the higher interest rates are offset by more bullish price expectations, which reduce pro tantum the "real" rate. Since this same expectation also tends to reduce RDP relative to the long rate, the wealth effect, at least initially, tends to amplify the multiplier. None the less, it is seen that eventually M_y reaches a peak and begins to decline rapidly, for with M given, eventually the increase in interest rates exceeds the increase in the expected rate of change of prices. In view of the low unemployment in the simulation period, the XOBE$ multiplier gets quite high; it reaches 6 by the end of our simulation and is still rising, though presumably it is not far from its peak.

Summarizing then, in the absence of price-expectational effects recognition of the wealth effect on consumption does not significantly affect our estimate of the real income multiplier in the first few quarters. But, eventually, it leads to a somewhat *lower* value, by contributing to the crowding out effect via consumption. With price expectations the wealth effect increases the multiplier somewhat over a period as long as three years, though again the effect is quantitatively modest.

III.3 Change in Money Supply (Demand Deposits)

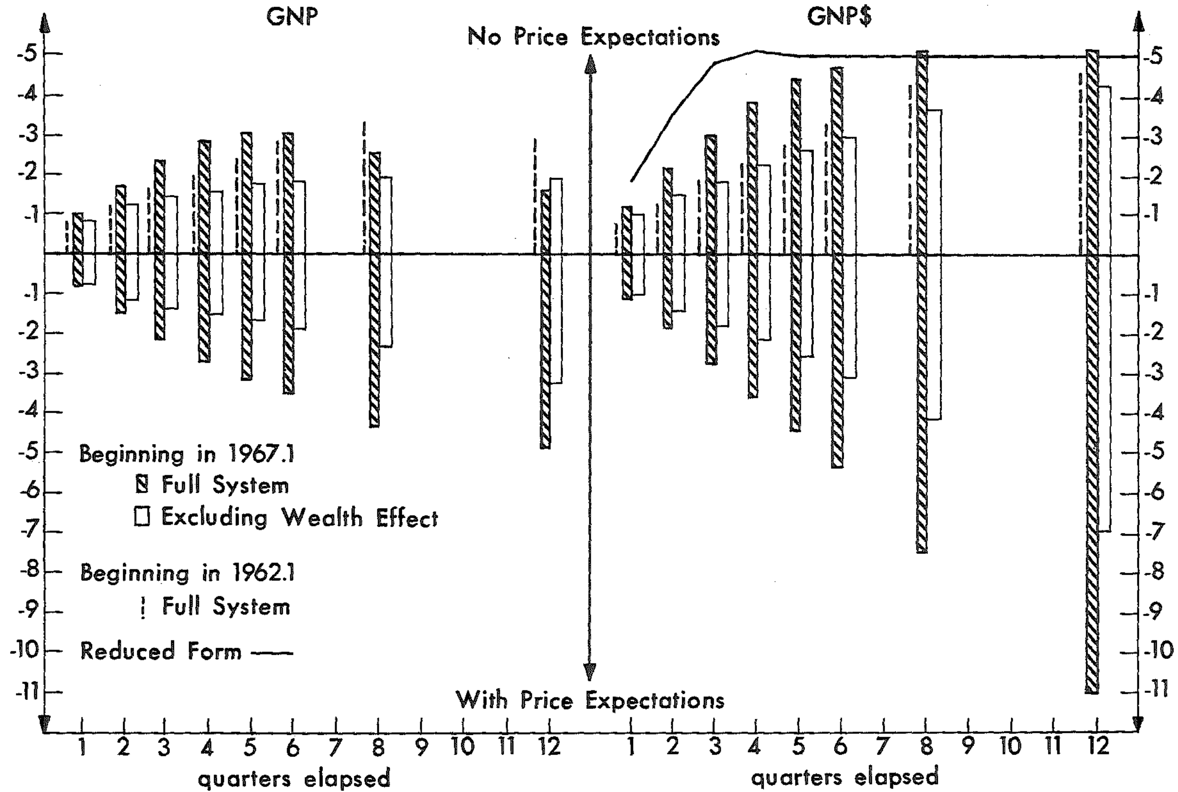
Figure III.2 summarizes our results concerning the effect of an exogenous change in the stock of demand deposits. The results shown in part A were obtained from a simulation in which demand deposits (MD$) were reduced by $1 billion in 67.1 and another billion in 67.2. The choice of this particular pattern was dictated by two considerations. On the one hand, we wanted the change in M to be large enough so that our multipliers would not be distorted by rounding off errors. On the other hand, we wanted to avoid a large

Figure III.2A

RESPONSE OF GNP TO AN EXOGENOUS CHANGE IN THE STOCK OF DEMAND DEPOSITS

Effect, per Billion, of a 2 Billion Decrease Spread Evenly Over 2 Quarters

[sign reversed]



sudden jump in M which, for reasons discussed in I.3 would produce a sharp transient change in the short rate and hence increase the "risk premium" component of the long-rate equation. Since the stock of demand deposits in '67 was around $140 billion, an increase of $2 billion in a single quarter would have represented an annual rate of increase of some 6 percent over and above the historical growth which was already in the order of 4 percent. By smoothing the $2 billion increase over two quarters we halved the annual rate of increase in M over the period in which the additional M was injected. The histograms in Figure III.2 show the effect of the change in demand deposits on GNP beginning with the quarter of the second of the two increments, namely '67.2, per billion change in M.

In some respects the result of simulation of changes in M, discussed in this section, may be regarded as the most relevant ones for the purpose of this conference. We must warn, however, that in the light of the view of the monetary mechanism that underlies the construction and estimation of our model, we regard these results as somewhat less reliable than those resulting from a change in unborrowed reserves, reported in the next section.

Before looking at the results, it may be useful to observe that, from knowledge of the structure of the model, we can again deduce the limiting value of the multipliers in the longest run. By a reasoning analogous to that developed in III.2, one can readily show that, given time enough, our model has very classical properties: to a first approximation, money is neutral (though not "superneutral") and the quantity theory holds. Hence in the longest run, neither GNP, nor interest rates, can be affected by the change in M while GNP$ must change by dM times the velocity of circulation computed at the value of r prevailing for the undisturbed system. For the period covered by our simulation the velocity of circulation of demand deposits is of the order of five to six. But once again, we must stress that these results are of little more than academic interest; what is really important is what happens in the "short run", especially the first four to eight quarters, and, for an answer, we now turn to Figure III.2A.

The first impressive result here is the very large contribution of the wealth effect both to the size and the timing of the multiplier. In real terms, we see that, if we ignore the wealth effect, the multiplier, represented by the white columns, is modest and slow; it reaches a peak of just about two, after two years, and tends to remain at that level one year later. By contrast when we allow for the wealth effect – black columns – the peak effect is reached in the fifth quarter and that peak is just over three. By that quarter, the *wealth effect via consumption accounts for nearly half of the total.* Thereafter the multiplier decreases fairly rapidly; by the end of three years it is less than 1.5 and is appreciably smaller than the multiplier ex-wealth.

The results are equally striking when we turn to the XOBE$ multiplier. Ex-wealth the multiplier is rather sluggish, though it eventually rises to nearly five by the end of three years. But cum-wealth it rises rapidly; it reaches almost four by the end of one year, of which again, half is accounted for by the wealth effect; it is close to five by Q 6 and over five by Q 8 when it reaches a flat peak.

One significant feature of these GNP$ multipliers cum-wealth is that they bear at least a family resemblance to the kind of numbers that have come out of the Monetarist analysis a-la-Federal Reserve Bank of St. Louis. From the well known "reduced form" equations of Andersen et al (see e.g., Andersen and Carlson) in which the change in GNP$ is regressed on a distributed lag of past changes in the stock of money and other variables, one can readily compute the cumulated effect of GNP$ of a two-step change in money supply which was used in our simulation. The solid curve plotted above the histograms in the top right-hand side panel shows the effect implied by their latest regression available to us, estimated through the third quarter of 1970.[9]

Although somewhat different results would be obtained if one used the coefficients reported in some other estimates, the broad picture would not be appreciably different. It is apparent that their response still rises faster and turns around earlier than ours; however, the differences are not terribly large. In particular, both estimates agree that most of the effect is reached by the fifth quarter, and that effect is very similar in magnitude. By contrast, the multiplier ex-wealth bears much less resemblance to theirs.

While the broad similarity is in some sense encouraging and suggestive we should warn the reader against making too much of it. For a number of reasons, discussed below, the similarity is less than might appear, and furthermore, we are not at all sure that it should be very close. First, since our multiplier is computed for a change in demand deposits, it should be really larger than theirs, by something like one-fifth. Second, as we have observed, our lag is really somewhat longer than theirs. Third, and most important, our

[9]These estimates were kindly supplied by Anderson in a letter dated February 3, 1971.

multiplier is significantly affect by *initial conditions,* and is *not symmetrical* with respect to expansion or contraction in the stock of money.

The effect of initial conditions is illustrated by the vertical lines drawn next to each histogram, which show the multiplier for a policy simulation beginning in the slack period – 1962.1-2. Because of the greater slack in the economy we find, as in the case of the expenditure multiplier, that the GNP multiplier reaches a peak which is both higher and later; and, by the same token, the GNP$ response is also slower, reflecting the smaller rate of change of prices. Again, our multipliers are somewhat different if we allow for the price expectational mechanism, as can be seen from the lower panels of Figure III.1. Interestingly enough, the differences are actually rather minor for the first five-six quarters, because the price expectational mechanism is rather slow in getting going. However, once it gets going, toward the end of the second year, it carries the multipliers to much higher levels. The larger GNP multiplier reflects the lower *real* rates of interest while the larger GNP$ response results from the higher *money* rates which cause an increase in velocity. Needless to say, we are inclined to think that the significant dependence of the multipliers on initial conditions implied by our model is more intellectually satisfying and a-priori credible than the independence implied by the reduced form estimates.

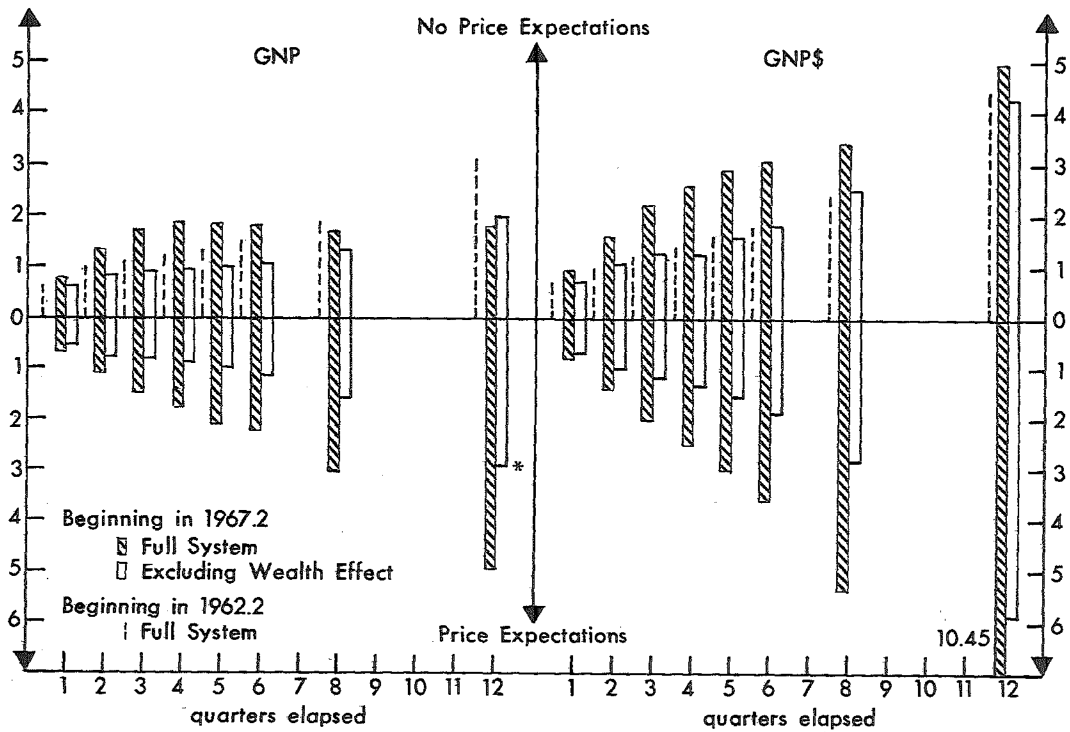
The asymmetry of expansionary versus contractionary policy is brought out rather dramatically by contrasting Figure III.2A with III.2B, which gives the results of a policy simulation in which the stock of demand deposits was *increased* by $2 billion distributed over 1967.1 and 2. As a result of the various mechanisms discussed in Part II, the multipliers here are considerably slower; in particular, the GNP$ multiplier does not reach its peak of around five until the third year.

How reliable and credible is this marked asymmetry in the response of changes in money supply? The notion that monetary policy is more powerful and faster in *reducing* than in *expanding* activity is of course a very old one, though our model accounts for this by a mechanism somewhat different from that traditionally visualized ("You can lead a horse to water but you cannot make it drink"). On the whole, we feel that the mechanism in our model is credible; it is possible, however, that it may be quantitatively overestimated. This possibility arises in part from the fact that in constructing and estimating our model we have assumed that the exogenous policy variable is primarily unborrowed reserves (or

Figure III.2B

RESPONSE OF GNP TO AN EXOGENOUS CHANGE IN THE STOCK OF DEMAND DEPOSITS

Effect, per Billion, of a 2 Billion Increase, Spread Evenly Over 2 Quarters.



*Wealth Effect Added

possibly short-term interest rates) but not the stock of money or demand deposits. For reasons noted in Part II, the asymmetry is especially marked when the policy variable is the stock of money. As will be shown in the next section, when the policy variable is for example, unborrowed reserves, the asymmetry is greatly reduced.

In the last paragraphs we have emphasized that the similarity between our money multipliers and those implied by St. Louis reduced form equations is really less close than might at first sight appear from the graphs in Figure III.2. Before moving on, we must, at least briefly, raise the other side of the question: should one really expect a close similarity? While this is not the place for us to engage in an extended criticism of the limitations of "reduced" form estimates, we must at least record here our serious misgivings about the reliability of the coefficients of St. Louis-type equations as a measure of response to exogenous changes in money supply. These misgivings are based on numerous considerations a few of which may be mentioned here.

i) In order for the reduced form to yield sensible estimates, it must be assumed that the response of the system to changes in money supply are reasonably stable in time. Yet both a priori considerations and the results of simulations presented above suggest that the response is instead significantly affected by such initial conditions as the slack in the economy, the general level of short-term rates, and the elasticity of price expectations.

ii) Of the other many exogenous variables that affect expenditure only some single measure of government expenditure is typically allowed for in the reduced form and the fiscal multiplier implied by the reduced form coefficients of these variables is patently absurd.

iii) There are ample grounds for doubting that as a rule and on the average the money supply can be regarded as exogenous over the period used in the tests. If, part of the time, the exogenous policy variable, at least in the short run, has been interest rates or unborrowed reserves, then one can expect the reduced forms to overestimate the size and speed of response of GNP to exogenous change in the money supply, and the bias will be compounded by failure to allow for the effect of other exogenous variables.

iv) Our grounds for doubt are also supported and reinforced by a number of empirical tests, a few of which are summarized in the epilogue to this paper. In particular, we provide there some empirical evidence that the reduced form coefficients can yield very unreliable and biased estimates of the response of the system to exogenous changes in money supply and, in particular, may tend to systematically overestimate the speed of response. We suggest, therefore, that, while the broad consistency between reduced form and simulation results is encouraging, the differences of detail do not deserve serious consideration, at least for the present.

We can now summarize the results of this section as follows.

(i) The multipliers generated by a contraction in the stock of demand deposits are quite substantial for the first two to three years both in real and in money terms; in particular, the GNP$ multiplier reaches a level of around five within 6 to 8 quarters; (ii) the wealth effect plays a major role in this result accounting for nearly half of the response in the first two to six quarters; (iii) if we sever the wealth effect the multiplier is much more sluggish and does not approach the steady state level until three years or so; (iv) the multiplier path depends non-negligibly on initial conditions; more slack in the economy leads to a larger response in real terms but the response is slower both in real and money terms; (v) the response to an *expansion* of the stock of money appears to be appreciably slower than the response to a *contraction,* but the difference may be overestimated by our model.

III.4 Effect of a Change in Unborrowed Reserves

The results of this experiment are reported in Figure III.3. The policy simulation consisted in increasing unborrowed reserves by $0.5 billion above the historical path, beginning in '67.1. In addition we aimed to prevent the initial fall in short-term rates, resulting from this action, from reducing the spread between market rates and the discount rate, which in turn would tend to reduce borrowing, offsetting in part the expansion of unborrowed reserves. In principle, this aim can be achieved by taking exogenous – that is, at the historical level – the spread between the discount and bill rate, thus making the discount rate endogenous. For purely technical reasons we have actually found it convenient to use an approximation which consists in making exogenous the spread between the discount rate and the average value of tthe bill rate in the previous two quarters.[10]

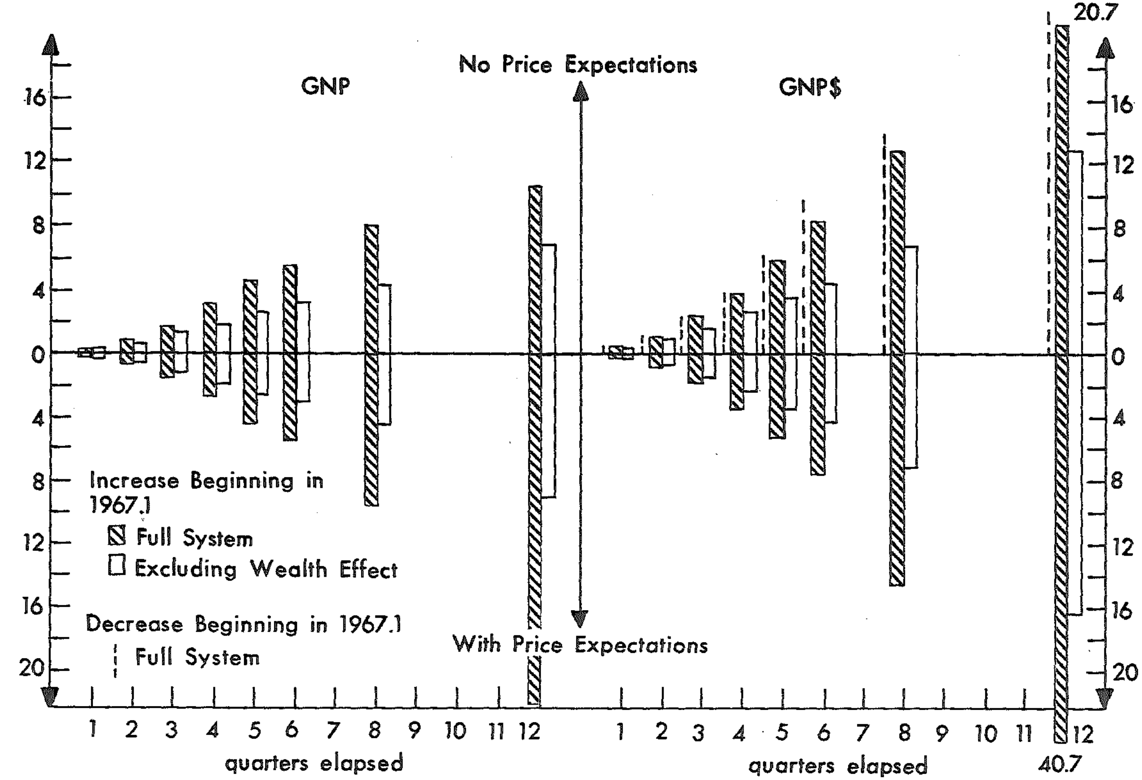
As background, we may note that a change in unborrowed reserves under these conditions should tend, in the longest run, to produce a change in the supply of demand deposits of roughly .5x7, or $3.5 billion. This change in turn should eventually lead to a change in GNP$ in the order of $20 billion. The longest run GNP multiplier, on the other hand, should still tend to zero.

We believe the picture emerging from Figure III.3 is self explanatory and, hence, shall limit ourselves to a few observations. (i) The response is clearly rather slow, as the money supply responds but gradually to the increase in reserves and in turn GNP responds gradually to the change in M. Still, by the end of the third year, the GNP$ multiplier seems to be close to its limiting value. (ii) The wealth effect again plays a major role in the response but only beginning with Q 4; between Q 4 and Q 8, it accounts for nearly half of the response. (iii) The price expectational mechanism makes again little difference for the first two years or so though it eventually becomes quite large. (iv) A *decrease* in unborrowed reserves has again a somewhat larger effect than an *increase* but the difference is now rather minor — the effect is very nearly symmetrical. This conclusion can be deduced from a comparison of the black columns shown on the upper right panel with the height of the vertical lines drawn next to each bar. These show the effect of a *decrease* in unborrowed reserves by .5 beginning again in '67.1 (with sign reversed). The reason for the far greater symmetry is that the response of short-term rates to a change in unborrowed reserves, in contrast to a change in M, is fairly smooth and, hence, does not significantly activate the variability effect in the term structure equation. To illustrate, for the simulation in which unborrowed reserves were increased in '67.1, one finds that the commercial paper rate declines fairly gradually throughout the first year to a maximum of some 60 basis points, and thereafter gradually moves back toward the original level. In the simulation cum-price-expectations, it actually eventually increases above the original level.

[10]The technical advantage of this procedure is that the discount rate in quarter t is then predetermined instead of simultaneous. There is nothing logically difficult about making the discount rate simultaneous, but it requires some changes in the simulation programs which have not as yet been readied.

Figure III.3

RESPONSE OF GNP TO A 0.5 BILLION CHANGE IN UNBORROWED RESERVES



III.5 Response to Change in Short-term Rates

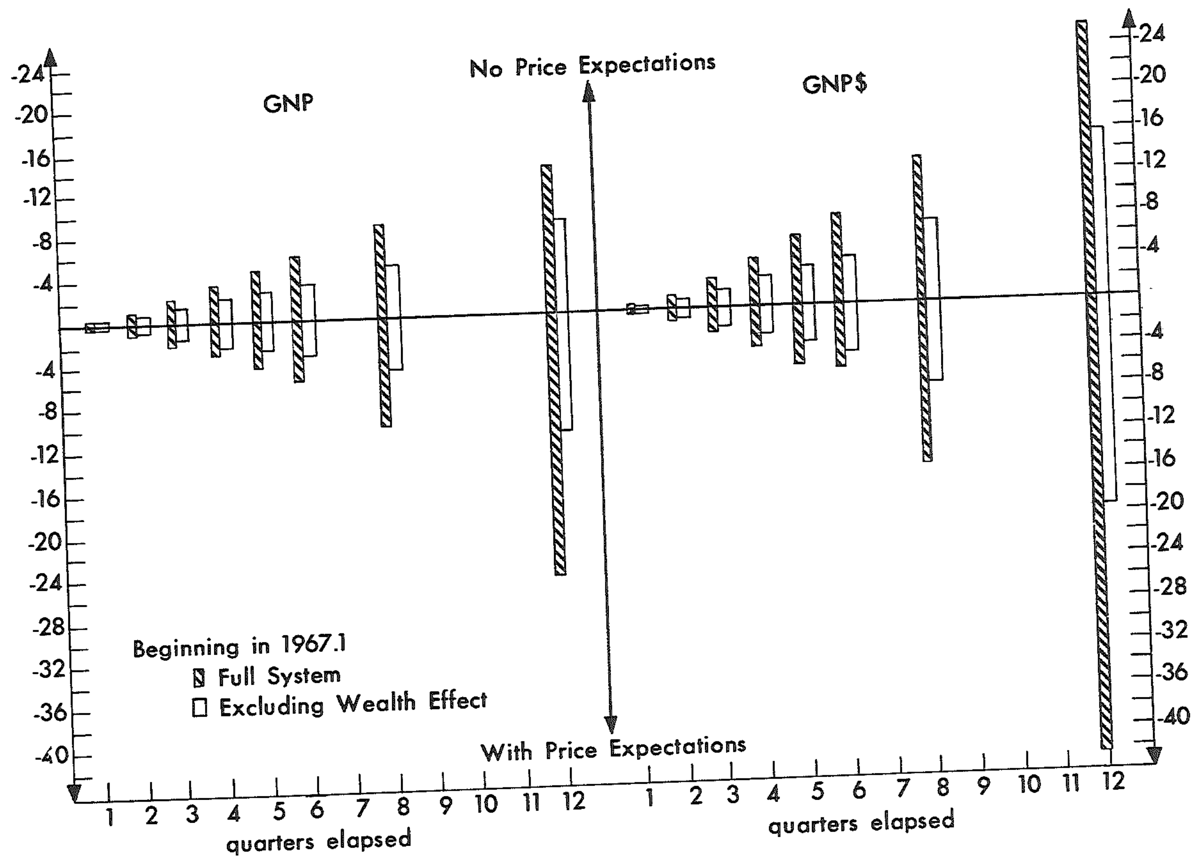
Figure III.4 reports the results of simulations in which the short-term rate – measured by the Treasury 3-month bill rate – was increased by 50 basis points beginning in '67.1. Again the figure should, by now, be self-explanatory. However, a few comments are appropriate about the reasonableness of the results and their implications.

In a sense, this simulation is of particular interest. Indeed, as we have pointed out repeatedly, in our model monetary policy works entirely through its impact on the short rate, – though the effects of the short rate on the system are to some extent different than is usually visualized. In particular, in our model these effects include the wealth effect through consumption and also a rather complex rationing effect on the housing market if, when market rates change, ceiling rates are kept unchanged and they are (or become) effective. Note here again a possible source of asymmetry, since a rise in market rates may produce effects (by making the ceiling effective) that a decline might not. However, interpretation of the results of this simulation is much more complicated because it is difficult to estimate the longest run multipliers as a guide to an understanding of the path and speed of response. Unfortunately, the causes of this difficulty can only be mentioned very briefly and superficially here.

The root of the problem lies in the fact that, in the longest run, our model tends to exhibit the characteristics of so-called "neo-classical" growth models. As in these models there exists also for our model – at least if we assume tax revenue approximately homogenous of first degree in money income and government expenditure proportional to income – a unique "natural real rate of interest" that is consistent with the model moving along a golden age growth path, with the natural rate of growth determined by technological progress and population growth. The natural real rate of interest is determined by the production function, the parameters of the consumption function, the natural rate of growth, and fiscal policy in the sense of the ratio of government deficit (or surplus) to GNP. Together with this real rate there is a "natural" money rate which equals the real rate plus the rate of change of prices, determined in turn by the rate of growth of the money supply (which must also be assumed constant on the golden age path). A policy of trying to force the interest rate away from this natural rate must eventually throw the system off the golden age path. In particular, holding the rate too low by an appropriate monetary

Figure III.4

RESPONSE OF GNP TO A CHANGE OF 0.5 IN THE TREASURY BILLS RATE



policy, must tend to cause inflation at an accelerating rate. More generally, when the price expectational mechanism is working, a policy of holding the money rate constant tends to make the system unstable. To illustrate, an initial disturbance that raises output and employment and, hence, the rate of change of prices, p, will cause a fall in the *real* rate, thereby increasing investment and consumption, and thus raising output and $\dot{p}$ further and causing still further excess demand. It is this mechanism that accounts for the quite explosive behavior of GNP and especially GNP$ in the lower panels of the figure, in which the price expectational mechanism is allowed to operate.

In view of the complexities outlined above and limitations of space, we shall make no attempt at a detailed interpretation of figure III.4. We will merely note that the response builds up slowly, but eventually gets quite large, even if the price expectational mechanism is suppressed, and that the wealth effect makes again a very significant contribution beginning in the second or third quarter and building up to a peak of over one-half by the end of two years.

EPILOGUE

SOME EVIDENCE OF THE MODEL'S ABILITY TO CAPTURE MONETARY EFFECTS ON CONSUMPTION AND ON THE RELIABILITY OF THE REDUCED FORM APPROACH

1. Review of Findings and Outline of Further Tests

In this paper we have endeavored to show that the consumption sector of the FMP model plays a critical role in the mechanism that translates changes in monetary variables into changes in overall economic activity. In particular, we have shown that roughly one-half of the response to a change in either the money supply or unborrowed reserves or short-term rates is accounted for by the effect of these variables on wealth and of wealth on consumers expenditure. This holds for several quarters following the initial change. Some additional effects occur through the impact of interest rates on consumer durable expenditures. We have also shown that, if, and only if, account is taken of the wealth effect, one obtains a path of response to changes in money supply which bears some resemblance in both pattern and magnitude to results obtained by the so-called reduced form approach. On the other hand, the response to government expenditure implied by the model remains absolutely irreconcilable with the reduced form estimates.

How relevant and reliable are these results as a description of the true mechanisms that have been at work in the U.S. economy in recent decades and will be in the near future? There is, of course, no conclusive answer to this question. In the last analysis the reader must ask himself whether he is prepared to accept the modeling of the individual sectors of the FMP model and their interrelation. Measures of closeness of fit provided in the Appendices, and the results of simulations of sectors and of various partial mechanisms are relevant, though obviously not conclusive evidence in reaching a final assessment.

In order to provide further help to the reader in forming his judgment, we briefly report here the results of two further sets of tests which may be of some value in bolstering confidence in the relevance of our results. The first set is designed to provide evidence on whether our model has succeeded in capturing the major systematic mechanisms through which monetary variables, and, in particular, the money supply, affect consumption, and more generally GNP The second set deals with the problem created by apparent discrepancies between the implications of our model and those of reduced form estimates. Those discrepancies are of some magnitude even with respect to the response to monetary variables, but are drastic when it comes to the response of fiscal variables. Our tests are designed to show why these discrepancies should not, at this time, be a serious source for concern as they reflect more on the reliability of presently available reduced form estimates than on the validity of the model.

2. "Reduced Form" Tests of the FMP Model Specifications of the Monetary Mechanism

As is well known, the monetarists have successfully shown that there is a marked correlation between the money supply and consumption expenditure. In particular, recent work of the monetarists at the Federal Reserve Bank of St. Louis has shown fairly impressive correlation between *changes* in consumer expenditures in current dollars and current and lagged changes of some measure of the money supply. These findings are confirmed by the results reported in the paper prepared by Meiselman and Simpson for this conference – see especially Tables 8 and 9, and 13 to 16.

Suppose now that we use the FMP model to carry out a long dynamic simulation; that is, we start the model at some point of time t, and let it generate all the endogenous variables up to the present, by providing no additional information other than the actual course of all the exogenous variables. The output of this simulation will then include a time series of consumer expenditure both in constant and in current dollars. Let us denote by $EPCE\$^c$ the computed value of consumption in current dollars, and by $\Delta EPCE\$^c$ the first difference of this series. Since our model does not track perfectly, especially in a simulation extending over a decade or more, there will be differences between $\Delta EPCE\$$ and $\Delta EPCE\$^c$. If our model fails to capture some of the systematic effects which generate the observed association between $\Delta EPCE\$$ and ΔM, current and lagged, then one should expect that the simulation error, $E \equiv \Delta EPCE\$ - \Delta EPCE\$^c$, should itself be correlated with a distributed lag of ΔM. Thus, our basic test consists in regressing E on a distributed lag of ΔM, or in estimating the regression equation:

$$(1) \quad E(t) = \sum_{\tau=0}^{m} v_\tau \, \Delta M(t-\tau) + V$$

where V is the constant term. If we have failed to specify adequately all of the channels through which M, current and lagged, affects EPCE\$, then we should expect to find that the distributed lag explains a significant portion of the error E, or, equivalently, that the multiple correlation coefficient, R, of the above regression equation is significantly different from zero.

The test just described admits of an alternative enlightening interpretation. Consider first the St. Louis type equation obtained by regressing ΔEPCE\$ on ΔM current and lagged

$$(2) \quad \Delta EPCE\$(t) = \sum_{\tau=0}^{m} a_\tau \Delta M(t-\tau) + A .$$

Suppose next we run the same type of regression, but using as the dependent variable ΔEPCE\$^{c}, or

$$(3) \quad \Delta EPCE\$^c(t) = \sum_{\tau=0}^{m} b_\tau \Delta M(t-\tau) + B .$$

It is then easy to establish, from well known properties of least squares estimates, that the coefficients of (2) and (3) are related to those of (1) by the equations

$$v_\tau = a_\tau - b_\tau \ , \ \tau = 0,\ldots,m, \ V = A-B .$$

It is apparent from the above that if, because of misspecification of the relevant channels, our model tended to *underestimate* the effect of ΔM on EPCE\$ than the individual coefficients v_τ or, at the very least, their sum, should be significantly positive. Conversely, a finding that the sum of weights is not significantly positive would enable us to reject the hypothesis that our formulation tended to underestimate systematically the cumulative effect of changes in M on consumption. More generally, if the multiple correlation R of Equation (1) is not significantly different from zero, then this would imply that the change in consumption-generated by the model bears a relation to ΔM current and lagged which is not significantly *different* from the relation exhibited by the actual change in consumption. Put somewhat loosely, such a finding would imply that our model is able to account, up to insignificant differences, for the observed pattern of association between ΔEPCE\$ and current and lagged values of ΔM.

Since the structure of our model implies that the money supply can affect consumption, as well as every other component of demand, only through its effect on the short-term rate, it would appear that the most effective way of testing whether our formulation captures all of the monetary effects is to take as the exogeneous monetary variable in our long-run dynamic simulation, not the money supply directly, but rather the pivotal short-term rate, namely the three-months Treasury bill rate, RTB. This approach eliminates possible errors due to errors in the money demand equation in computing the bill rate from the money supply. (These errors are typically small but could still produce irrelevant disturbances, especially since they are somewhat serially correlated.) Furthermore, it sharpens the test of our central hypothesis that the money supply has no effect on the system except through its impact on short-term rates. Other exogenous variables for our simulation include Federal government expenditures, transfers, grants-in-aid, tax rates, population, productivity trends, and a host of other minor variables which are described in the list of exogenous variables obtainable from Wharton EFA, Inc.[1] In all tests reported below, "computed values" were obtainable from a dynamic simulation beginning in 1958.I, and terminating in 1969.IV, and all "reduced form" equations were estimated over the same period, unless otherwise noted.

In carrying out our test, we still need to specify the nature of the distributed lag to be used in Equation (1). Unfortunately, quite a variety of specifications has been used by the St. Louis school at different times, both in terms of the length of the lag---running typically between four and eight quarters---and in terms of the method of estimating it---unconstrained least squares or Almon polynomial of different order and with a variety of a priori constraints. To conserve space we present here only results using an eight quarter lag and two methods of estimation: unconstrained least squares and third degree Almon polynomial, constrained to zero at the ninth quarter. We chose to focus on eight-quarter lags because the policy simulations reported in the text suggest that lags are typically quite long. We have however made a number of tests with shorter lags and

[1]In addition, one important adjustment we made in the stock market equation: Because the dividend yield equation makes some occasional non-negligible short-term error, and because we see no reason to let our failure to account fully for this variable control the quality of our simulation, we have taken as exogenously given the single equation error of this equation. Note that this procedure is not equivalent to taking the dividend-price ratio as exogenous for we still allow errors in other endogenous variables to produce errors in the dividend yield.

consistently found that minor differences in this specification did not materially affect the conclusions reported below.

Before proceeding to an analysis of the results we must call attention to one likely bias of our proposed test. It can be shown that if, at least some of the time, the policy target of the monetary authority were not directly the money supply but rather some variable such as unborrowed reserves, or free reserves, or interest rates, then the actual money supply would tend to be *positively* correlated with the error E, of the model, even if the model's specification were completely correct, or at least unbiased. Thus a finding that the sum of the coefficients of equation (1) is moderately positive would not justify rejecting the hypothesis that our specifications were unbiased, whereas a finding that the sum is negative would correspondingly strengthen the conclusion that the model's specifications were not systematically underestimating the magnitude of the response of the system to changes in money supply.

The results of our test are reported in Part A of Table E.1. In the first three columns, the coefficients are estimated by unconstrained least squares. The pattern of coefficients in Column (1), where the dependent variable is the change in *observed* value of Consumers' Expenditure, looks rather puzzling, especially the sharp whipsaw shape at the tail end (though this shape is preserved even if the period of fit is extended back to the beginning of 1952.) In Column (2) the dependent variable is the change in *simulated* rather than actual expenditure. It is apparent that the pattern of coefficients is rather similar, except that the coefficient of current ΔM is rather larger and the whipsaw at the end is attenuated. As a result, when the difference between actual and simulated change (the model error, E) is regressed on current and past values of ΔM in Column (3) the individual coefficients are mostly small and entirely insignificant, as evidenced by the t-ratio given below each coefficient. The portion of the error explained by the distributed lag is also entirely insignificant, as evidenced by the very low R^2 and by an entirely insignificant value of the F statistics. Finally the sum of the coefficients is seen to be *negative* rather than positive, despite the bias of the test mentioned earlier. We must therefore conclude that the results of this test unequivocally reject the hypothesis that our model systematically underestimates the impact of the money supply on consumption; more generally the results reject the hypothesis of any systematic misspecification.

As a check on these conclusions we present in Columns (4) to (7) the results obtained when the coefficients of the distributed lag are

TABLE E.1

REDUCED FORM TESTS OF THE FMP MODEL SPECIFICATION OF THE MONETARY MECHANISM

Independent Variables \ Dependent Variable	A: Based on Consumers' Expenditure[2] (EPCE$)						B: Based on GNP$		
	ΔEPCE$	ΔEPCE$^c	E ≡ ΔEPCE$- ΔEPCE$^c	ΔEPCE$	ΔEPCE$^c	E	ΔGNP$	ΔGNP$^c	E ≡ ΔGNP$- ΔGNP$^c
	Unconstrained L.S.			3rd Degree Polynomial Zero at t- 8			3rd Degree Polynomial		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔM(t)	0.75	1.17	-0.42	0.32	0.73	-0.41	0.68	1.06	-0.37
	(1.3)[1]		(0.7)	(1.0)		(1.3)	(1.6)		(0.9)
ΔM(t-1)	0.24	0.20	+0.04	0.62	0.71	-0.09	1.30	1.27	0.03
	(0.3)		(0.1)	(4.0)		(0.6)	(6.4)		(0.1)
ΔM(t-2)	0.60	0.71	-0.11	0.70	0.65	0.05	1.39	1.27	0.12
	(0.8)		(0.2)	(3.8)		(0.3)	(6.0)		(0.5)
ΔM(t-3)	0.90	0.62	0.28	0.62	0.56	0.06	1.13	1.12	0.01
	(1.1)		(0.4)	(3.6)		(0.4)	(5.4)		(0.1)
ΔM(t-4)	0.58	0.78	-0.20	0.44	0.44	0.00	0.66	0.87	-0.20
	(0.7)		(0.3)	(3.5)		(0.0)	(4.3)		(1.3)
ΔM(t-5)	-0.14	-0.08	-0.06	0.23	0.31	-0.09	0.16	0.58	-0.41
	(0.2)		(0.1)	(1.6)		(0.6)	(0.9)		(2.4)
ΔM(t-6)	0.98	0.33	0.65	0.05	0.19	-0.15	-0.23	0.30	-0.52
	(1.24)		(0.8)	(0.3)		(0.9)	(1.0)		(2.3)
ΔM(t-7)	-1.22	-0.02	-1.20	-0.05	0.09	-0.14	-0.33	0.09	-0.42
	(1.81)		(1.0)	(0.3)		(0.9)	(1.7)		(2.1)
Constant	2.94	2.27	.67	2.75	2.33	0.42	4.39	3.18	1.21
	(3.12)		(.72)	(3.0)		(0.5)	(4.4)		(1.0)
Summed Weights	2.70	3.72	-1.02	2.95	3.73	-0.78	4.77	6.54	-1.77
				(5.0)		(1.4)	(6.6)		(2.4)
Measures of Fit									
R^2	.55		.14	.48		0.06	.58		0.09
D.W.	2.9		2.7	2.9		2.7	1.81		1.84
F			0.69			0.87			2.5
F* (.05 Significance)			2.3			2.9			2.8

[1] t-ratio.

[2] Period of Fit: 1959.4 – 1969.4.

estimated using a third degree Almon Polynomial, a procedure that smoothes out the improbable jagged pattern of coefficients of Column (1). It is readily apparent that the results of this second test confirm and reinforce in every respect our earlier conclusion.

In Part B of the Table we have applied the same technique to test for evidence of bias in the model as a whole, by taking as dependent variable total GNP rather than one specific component of it. The similarity of the pattern of coefficients of Column (7), where the dependent variable is the actual change in GNP$, with that of Column (8), where it is the change in simulated GNP$, is again apparent. We also note again a tendency for the coefficients of Column (8) to *exceed* those of Column (7), especially for the current quarter and at the tail end. Accordingly, the coefficients of Column (9) are prevailingly negative and not altogether insignificant, though the overall correlation remains quite low, and the F statistic is again insignificant.

On the basis of these tests, whose power is of course hard to assess, we must conclude that there is absolutely no evidence that the specifications of the FMP model tend to underestimate systematically the impact of money on consumption, or more generally on money GNP. Indeed, they suggest that, if there is a misspecification, it is in the direction of *overestimating* the impact of money, although even this indication is by no means conclusive.

3. The Power of Reduced Forms As a Method of Estimating Structural Properties

The conclusions of the last paragraph, while reassuring in a sense, present us with somewhat of a puzzle, for they seem hard to reconcile with the findings reported in Section III.3. In that section we pointed out that the response of GNP$ to a change in money supply implied by the FMP model was in fact rather smaller and slower than one could infer from the coefficients estimated by the reduced form approach. This concluding section is designated to shed some light on this puzzle. We propose to show that the likely answer to the puzzle must be found in the fact that the coefficients of reduced form as estimated by the St. Louis group, or in the Meiselman paper for this conference, tend to be seriously biased in the direction of overestimating the response of GNP$ (and its major components) to changes in money supply.

The evidence to be presented is basically in the spirit of a Monte Carlo experiment. Clearly we can think of the FMP model as a description of a possible economic system, regardless of whether it provides, in fact, an adequate operational description of the American economy in recent years. We can, therefore, regard the time series of GNP$ and its components generated by the dynamic simulation described in the previous section as representing the response of this economic system to the path of the exogenous variables used in the simulation. Furthermore, from the demand equation for demand deposits and the simulated value of other relevant variables, we can compute the time series of the money supply needed to produce the given path of the short-term rate. We can then ask the question: suppose an observer who did not know the structure of the FMP model tried to infer the response of GNP$ to changes in the money supply by the reduced form approach; how far and in what direction would his estimate differ from the true response implied by the structure of the model?

We begin by observing that if the model were linear there would be a true reduced form equation relating GNP (or any component thereof) to all the exogenous variables assumed in the simulation, including the money supply in place of the bill rate, since the bill rate could itself be expressed in terms of the money supply and all other exogenous variables. The coefficients of the money supply (current and lagged as far as necessary) in the last mentioned reduced form would measure the response of the system to an exogenous change in the money supply and would coincide with the response estimated by a policy simulation of the type underlying the results presented in Section III. But clearly the results could be quite different if the coefficients were estimated from a misspecified reduced form, e.g., using as independent variable only the money supply, with an arbitrarily chosen lag, and neglecting all other exogenous variables. Further difficulty would arise with a non-linear system, for then the true response to changes in M would vary with initial conditions.

One obvious and simple way to assess the size and direction of bias is to actually carry out the experiment. To this end we have estimated a reduced form by regressing the change in simulated GNP, $\Delta GNP\$^c$ on the simulated change in the stock of demand deposits $\Delta MD\$^c$. We use demand deposits rather than the total stock of money to make the results comparable with those of the policy simulations reported in Section III.2. The coefficients obtained using again a third degree Almon Polynomial are reported in Column (1), Table E.2. For comparison we report in Column (2) the coefficients estimated from a regression of actual changes in GNP$ on actual

TABLE E. 2

SIMULATION TEST OF REDUCED FORM ESTIMATES OF TRUE STRUCTURE

A - Reduced Form Coefficients

Quarter	$\Delta GNP\$^{c}$ on $\Delta MD\$^{c}$ (1)	$\Delta GNP\$$ on $\Delta MD\$$ (2)
t	1.85 (3.5)	0.79 (1.6)
t-1	1.45 (7.0)	1.51 (6.1)
t-2	1.20 (4.5)	1.68 (6.2)
t-3	1.05 (4.1)	1.45 (5.9)
t-4	0.95 (5.3)	0.99 (5.1)
t-5	0.86 (4.6)	0.45 (2.0)
t-6	0.70 (2.8)	-0.02 (0.0)
t-7	0.43 (2.0)	-0.21 (0.9)
Sum	8.49	6.67
Constant	3.47 (3.8)	4.07 (3.4)
R^2	.73	.55
D.W.	1.05	1.71
S.E.	3.46	4.27

B - Response of GNP$ to a 2 Billion Change in Demand Deposits, Spread Over Two Quarters

Quarters Elapsed from First Change	True Causal Effect from Policy Simulation (1)	Based on Reduced Form Coefficients, Estimated on: Simulated Values (2)	Actual Values (3)
0	0.9	1.9	.8
1	2.4	5.2	3.1
2	4.3	7.8	6.3
3	6.1	10.1	9.4
4	7.7	12.1	11.9
5	8.8	13.9	13.3
6	9.4	15.4	13.8
7	10.0	16.5	13.5
8	10.2	17.0	13.3
9	10.1		
10	10.1		

changes in demand deposits. Once again the patterns of coefficients in Columns (1) and (2) are fairly close, but with the sum of weights again somewhat higher for the simulated values, largely because of the appreciably higher coefficient of current ΔM. It is also worth noting that, as expected, the sum of weights in Column (2) exceeds by some 25 percent the corresponding sum in Column (7) of Table E.1, in which the regressor was the total stock of money. Otherwise the pattern of coefficients is fairly similar and R^2 is only slightly lower. Note also that R^2 is larger in Column (1) than in Column (2); this is as one should expect since the computed values are not affected by the errors terms which attentuate the correlation of actual values. Indeed, reduced form estimated on computed values should tend to yield a perfect fit were it not for misspecifications in the reduced form used in the estimation.

We can now use the coefficients of Column (1) to derive an estimate of the response of GNP$ to a $2 billion change in demand deposits spread evenly over two successive quarters – the change which was used in our policy simulations. The result is shown in Part B of the Table, Column (2). For comparison, Column (3) shows the response implied by the reduced form coefficients estimated from the regression of *actual* values given in Part A, Column (2). The entries of the two columns can be compared with those of Column (1) which shows the true response of GNP$ to the stated exogenous change in demand deposits as obtained from the policy simulation. As we have seen, because of nonlinearities, this true response is somewhat dependent on initial conditions and the direction of the change in money supply; the figures we report are those corresponding to a *decrease* in M beginning in 1967.1, i.e., those corresponding to the policy simulation that produced the largest and fastest response among those tested. Even so, the response is strikingly smaller and slower than the response implied by the reduced form coefficients, shown in Column (2): in the first three quarters the latter response is larger than the true response by a factor of two, and eventually the overestimate settles down to about 70 percent.

The experiment of Table E.2 has also been repeated for individual components of GNP and while the results cannot be reported here in detail, it is worth noting that one finds a broad similarity between the *patterns* of response implied by reduced forms computed on actual and on simulated values, and the patterns obtained from policy simulation. In particular one finds, as in the Meiselman-Simpson paper, that for such components of GNP as consumers' expenditure, non-durable consumption, and state and local government expenditure the response continues to build up to the very end, while the peak response occurs quite early for housing expenditure and somewhat later for inventories and then plant and equipment. However, one finds large and varying differences in the *size* of the response.

In any event, insofar as GNP$ is concerned, the conclusion of our Monte Carlo experiment is unequivocal: the reduced form coefficients estimated on the time series generated by the model yield a severely upward biased estimate of the magnitude and speed of response of GNP$ to an exogenous change in the money supply.

It is unfortunately not possible to enter here into a detailed analysis of the causes of this bias. We can merely state that in our view the major source of bias lies in the fact that the computed money supply series is strongly positively associated with the movement of other variables which were taken as exogenously given in the simulation (including fiscal as well as other exogenous variables), and which, in terms of the model's specifications, account for a substantial portion of the simulated change in GNP$. The omission of these other variables in the reduced form gives rise to an error term which is positively correlated with the change in M, and hence produces an upward bias in the estimated coefficiencies of ΔM. To put the matter somewhat loosely, the reduced form attributes to ΔM part of the effect of changes in other omitted exogenous variables. Note also that the positive association with the omitted exogenous variables may be expected to hold not only for the computed, but also for the actual money supply, which is highly correlated with the computed one. And indeed if one regresses the simulated change in GNP on the actual rather than the computed change in demand deposits, one obtains coefficients which are quite close to those shown in Column (1) of Part A or Column (2) of Part B; in fact, the upward bias turns out to be even a little larger – the sum of weights being, for example, 9.3 instead of 8.5 as reported in Column (1).

Clearly this "Monte Carlo" experiment does not entitle us to conclude that the coefficients of the reduced form computed on actual values are a biased estimate of the true response of GNP$ to an exogenous change in the stock of money for the U.S. economy. Yet the fact that the figures of Columns (2) and (3) are fairly similar while both sets are quite different from the figures of Column (1) is quite suggestive; it provides at least a strong prima facie case for the hypothesis that the difference between the response as estimated from the FMP model and reported in Section III.3 and the response estimated from the standard reduced forms, reflects in good measure an upward bias of the latter. Note also that the size of this bias would depend on the specific circumstances of the period used in estimating the reduced form (i.e., on the degree of association between changes in the money supply and changes in the omitted exogenous variables over that period). This consideration might help to account for the instability of reduced form coefficients as evidenced, for example, by the result reported by Meiselman and Simpson for different periods (c.f. their Tables 3 and 9). Finally, the above mentioned biases could be further increased if and when the variable directly controlled by the monetary authority was, for example, unborrowed or free reserves or interest rates, a "crime" of which the Federal Reserve has been frequently accused by the monetarists.

There remains one significant puzzle to clear up. The argument developed in the previous paragraphs would imply that the major source of bias in the reduced form coefficients can be traced to failure to include in the regression other major exogenous variables beside a money measure. Yet in reduced form estimated by the St. Louis group, including such fiscal variables as government expenditure, deficit, or tax receipts, it is consistently found that the effect of these other variables is insignificant and/or extremely short-lived, while the coefficients of the monetary variable are hardly changed. These findings are confirmed by Table E.3 which reports the coefficients of a reduced form estimated by regressing the change in GNP$ on the change in money and in government expenditure on goods and services (ΔG$), over eight quarters, using again third degree polynomial. Column (1) reports the coefficients of ΔM and Column (2) those of ΔG$. It is apparent that the coefficients of ΔM are highly significant and almost identical with those reported in Table E.1 Column (7), estimated omitting the expenditure variable. On the other hand, the coefficients of the expenditure variable are small and insignificant, except possibly for the first, and turn quickly negative beginning with the third quarter. The implied expenditure multiplier, obtained by cumulating the coefficients of Column (2) and shown in Column (3), bears no resemblance to the multiplier implied by the FMP model and reported in Figure III.1.

In our view, however, these results as well as similar ones reported by other investigators are of very little relevance because of the serious misspecifications of the fiscal variable used, to which attention has been called by deLeeuw and Kalchbrenner, and especially by

Gramlich. In particular, Gramlich has pointed out the serious shortcomings of government expenditure, especially in a period in which changes in that variable are dominated by changes in defense procurements. As explicitly recognized in the FMP model, the stimulating effects of such procurement begin when the orders are placed and lasts while they are being processed, through their effect on inventory investment, while very little effect occurs in the quarter in which the goods are delivered and the expenditure is recorded, for the expenditure is then largely offset by a decline, or negative investment, in inventories.

The contention that, because of misspecifications, the coefficients of Columns (1) and (2) provide a totally distorted measure of the money supply and expenditure multiplier can again be at least indirectly supported by a "Monte Carlo" experiment. In Columns (4) and (5) of Table E.3 we report the coefficients of a reduced form estimated by regressing the simulated change in GNP$ on the simulated change in money supply and the simulated change in government expenditure – the latter variable being obtained as the product of the exogenously given real expenditure, used in the simulation, and the endogenously computed price index. In the absence of bias the coefficients of Column (4) should come close to those implied by the policy simulation of Figure III.2. Similarly, the expenditure multiplier of Column (6), obtained by cumulating the coefficients of Column (5), should come close to that reported in Figure III.1. What we find instead is that the coefficients of Column (4) are again hardly different from those obtained without the expenditure variable and reported in Column (7), and also very similar to those of Column (1), which we know appreciably overstates the magnitude and speed of response of GNP$ to change in M. Similarly, the expenditure coefficients of Column (5) and the implied multiplier of Column (6) closely resemble those of Columns (2) and (3), but bear no recognizable relation to the multiplier of Figure III.1.[2]

[2]It should be noted that Figure III.1 gives the response of GNP to a change in exports and therefore also to a change in government purchases of goods which do not go through the order process applying to defense procurement. The response to a change in real purchase of services is somewhat faster but not otherwise significantly different, as can be seen from the figures reported below, obtained from a simulation in which real expenditure on services was increased by $5 billion beginning in 1967.1. For reference the second row reproduces the multiplier underlying the black histograms in the upper right quadrant of Figure III.1.

MULTIPLIER RESPONSE OF GNP$
TO A CHANGE IN REAL GOVERNMENT EXPENDITURE

Quarters Elapsed

	1	2	3	4	5	6	8	12
On Services	1.47	1.92	2.20	2.43	2.67	2.80	2.57	1.57
On Goods (Based on Exports)	1.11	1.55	1.88	2.34	2.60	2.73	2.62	1.35

While this last experiment calls attention once more to the severe danger of bias in reduced form, it does not per se imply that reduced form could not possibly yield reasonable approximations to true response. What they rather imply is that one cannot expect to obtain reasonable estimates without painstaking attention to the specification of the variables to be used. It is at least suggestive in this context, that Gramlich (op. cit.), who gave careful consideration to the specification of both the monetary and fiscal variables, did obtain a set of estimates that appear *a priori* reasonable and are also roughly reconcilable with the results of the FMP policy simulations. This is especially true of the results reported in his Table 4, where the monetary variable is unborrowed reserves (which incidentally also yielded the lowest residual error variance.) In particular the sum of weights for unborrowed reserve, 25.7, which measures the cumulated effect of 1 billion change, after eight quarters, compares quite favorably with simulation results reported in Figure III.3 (12.6 per .5 billion implying 25.2 billions per billion for an increase, and -14, or -28 per billion, for a decrease). In the case of expenditure the agreement is not quite as good, though still reasonable (2.15 for Gramlich as compared with 2.62 for a simulation beginning in 1967.1 and 2.54 for one beginning in 1962.1).[3]

We thus feel entitled to close this epilogue on a somewhat cheerful note:

1. There is no evidence that the FMP model, according to which money affects economic activity only through the link of interest

[3]Although in the paper cited Gramlich reported only the sum of coefficients, the pattern of the individual coefficients, which he has kindly made available to us, also matches reasonably well the results of our simulation. For purpose of comparison with our Figure III.3 we give below the cumulated effect of a 0.5 change in unborrowed reserves implied by his coefficient for each of the eight quarters following the injection: -.8; -.1; 1.6; 4.0; 6.8; 9.4; 11.6; 12.8. Similarly the multiplier implied by his government expenditure coefficients are: 0.6; 1.1; 1.4; 1.7; 1.9; 2.0; 2.1; 2.2.

TABLE E. 3

SIMULATION TEST OF REDUCED FORM INCLUDING GOVERNMENT EXPENDITURE (G$) – DEPENDENT VARIABLE: CHANGE IN GNP$

	Estimated on Actual Values			Estimated on Simulated Values			
Lag	Coefficient of ΔM (1)	$\Delta G\$$ (2)	Expenditure Multiplier (Col. 2 Cumulated) (3)	Coefficient of ΔM^c (4)	$\Delta G\$^c$ (5)	Expenditure Using Multiplier (6)	ΔM^c Only (7)
0	0.70	0.86	0.86	1.29	0.66	0.66	1.31
	(1.6)	(2.2)		(2.9)	(2.1)		(2.8)
-1	1.42	0.14	0.99	1.40	-0.25	0.41	1.18
	(6.2)	(0.8)		(7.4)	(1.7)		(6.5)
-2	1.54	-0.24	0.75	1.30	-0.60	-0.19	1.03
	(6.9)	(1.1)		(5.6)	(3.4)		(4.3)
-3	1.25	-0.37	0.38	1.05	-0.57	-0.76	0.85
	(5.8)	(1.7)		(4.8)	(3.4)		(3.7)
-4	0.74	-0.33	0.05	0.73	-0.30	-1.06	0.67
	(4.5)	(1.9)		(4.4)	(2.3)		(4.2)
-5	0.17	-0.19	-0.13	0.39	0.05	-1.01	0.68
	(0.9)	(1.0)		(2.3)	(0.3)		(3.0)
-6	-0.26	-0.03	-0.16	0.12	0.32	-0.69	0.30
	(1.1)	(0.1)		(0.5)	(1.8)		(1.4)
-7	-0.37	0.06	-0.11	-0.04	0.35	-0.33	0.14
	(1.9)	(0.3)		(0.2)	(2.3)		(0.7)
Sum of Coefficients	5.2	-0.11		6.2	-0.33		5.9
Constant	3.95			3.62			3.73
	(3.7)			(4.9)			(4.6)
R^2	.61			.80			.75
DW	2.06			1.16			1.17

rates, significantly misspecifies the quantitative impact of money or its time path, though it may tend to *overstate* somewhat the long-run effect.

2. It may eventually be possible to reconcile the implications of a carefully specified structural model with those of carefully specified reduced forms, though much empirical, as well as theoretical, work remains to be done toward that highly desirable goal.

APPENDIX A

EQUATIONS OF THE CONSUMPTION SECTOR OF THE FMP MODEL

Key to symbols not explained elsewhere.

YD:	Real disposable personal income (billions of '58 dollars)
N:	Population (millions)
VCN$:	Consumers' net worth in current dollars ($, trillions)
PCON:	Consumption deflator (1958 = 100)
PCD:	Price index of consumers' durables (1958 = 100)
RCB:	Corporate bond yield
JIC:	Strike dummy
u:	Autocorrelated error term
e:	Residual error

The number in square brackets underneath each coefficient is the t-ratio. The number in parentheses above the coefficients is the identification number of that coefficient in the FMP model.

I.1 CONSUMPTION (CON, 4)

$$\frac{CON}{N} = \sum_{i=o}^{11} b_i\left(\frac{YD}{N}\right)_{t-i} + \sum_{i=o}^{3} c_i\left(\frac{VCN\$_{-i}}{.01*PCON_{-i-1}*N_{-i-1}}\right) + \overset{(480)}{.6098}u_{-1} + e$$

b_0 = (1) .1087 [4.72]	b_9 = (10) .0239 [3.35]	c_0 = (476) 27.0447 [4.16]
b_1 = (2) .0983 [6.10]	b_{10} = (11) .0157 [2.76]	c_1 = (477) 15.8710 [7.94]
b_2 = (3) .0882 [8.68]	b_{11} = (12) .0077 [2.33]	c_2 = (478) 7.6389 [2.03]
b_3 = (4) .0783 [14.41]	$\sum_i b_i$ = .672	c_3 = (479) 2.3486 [.68]
b_4 = (5) .0686 [23.04]	$\sum_i c_i$ = 52.9032	
b_5 = (6) .0592 [14.19]		$\bar{R}_e^2$ = .9982
		S_e = .0074
b_6 = (7) .0500 [8.28]		$\bar{R}^2$ = .9973
b_7 = (8) .0411 [5.65]		S_u = .0090
		d-w = 1.86
b_8 = (9) .0324 [4.23]		

SAMPLE PERIOD: 1954.I - 1967.IV

CONSTRAINTS:

b_i: 2nd degree polynomial; constrained zero at t-12

c_i: 2nd degree polynomial; constrained zero at t-4

NOTES: Estimated on July, 1970 National Income Accounts revisions.

I.2 EXPENDITURES ON CONSUMER DURABLES (ECD,6)

$$\frac{ECD}{CON} = \underset{[1.51]}{\overset{(493)}{.2402}} + \underset{[3.50]}{\overset{(491)}{.3265}} \left[\frac{YD}{CON}\right] - \underset{[-3.66]}{\overset{(17)}{.2291}} \left[\frac{N}{CON}\right] - \underset{[-2.52]}{\overset{(494)}{.0034}} \; JIC$$

$$+ \sum_{i=o}^{5} b_i \left[\frac{PCD}{PCON}\right] * \left[.22 + .01 * RCB - Q * \sum_{j=o}^{12} c^j \left\{ \frac{PCD_{-i-j+1} - PCD_{-i-j}}{PCD_{-i-j}} \right\} \right]$$

$$\underset{[-2.75]}{\overset{(492)}{-.2983}} \left[\frac{KCD_{-1}}{CON}\right] + \overset{(18)}{.6014} u_{-1} + e$$

$b_o = \underset{[-.87]}{\overset{(495)}{-.2164}}$

$b_1 = \underset{[-2.51]}{\overset{(496)}{-.1743}}$

$b_2 = \underset{[-1.10]}{\overset{(497)}{-.1316}}$

$b_3 = \underset{[-.55]}{\overset{(498)}{-.0883}}$

$b_4 = \underset{[-.36]}{\overset{(499)}{-.0445}}$

$b_5 = \overset{(500)}{.00}$

$\sum_{i=o}^{5} b_i = -.6551$

$c = .87$

$\bar{R}_e^2 = .9271$

$S_e = .0041$

$d\text{-}w = 1.75$

$\bar{R}_u^2 = .8877$

$S_u = .0051$

SAMPLE PERIOD: 1954.I - 1968.IV

$$Q = \begin{cases} 0.0 & 1954.I - 1966.IV \\ 4.0 / \sum_{j=o}^{11} (.87)^j & 1967.I - 1968.IV \end{cases}$$

CONSTRAINTS: b_i: 2^{nd} degree polynomial constrained to zero at t-5.

I.3 DEPRECIATION ON CONSUMER DURABLES (WCD, 7)

$$WCD = .05625*ECD + .225*KCD_{-1}$$

I.4 STOCK OF CONSUMER DURABLES (KCD, 8)

$$KCD = .25*(ECD\text{-}WCD) + KCD_{-1}$$

I.5 IMPUTED INCOME FROM CONSUMER DURABLES (YCD, 9)

$$YCD = .0379 \left\{ \left[\frac{ECD}{8.0}\right] + KCD_{-1} \right\}$$

I.6 PERSONAL CONSUMPTION EXPENDITURES (EPCE, 45)

$$EPCE = CON - WCD - YCD + ECD$$

FIGURE A. 1

DYNAMIC SIMULATION OF REAL CONSUMPTION (1958 DOLLARS) 1958.1 - 1969.4

Actual Value ($billions)	Computed Value ($billions)	Residual ($billions)	Period	
289.172	291.086	1.915	1958	1
292.255	292.075	0.180	1958	2
296.070	294.355	1.714	1958	3
298.450	297.479	0.971	1958	4
302.531	301.076	1.455	1959	1
305.636	305.190	0.446	1959	2
308.269	308.407	-0.138	1959	3
310.660	310.975	-0.315	1959	4
312.755	313.027	-0.272	1960	1
316.944	314.766	2.178	1960	2
316.670	316.721	-0.052	1960	3
318.478	317.979	0.499	1960	4
320.251	319.749	0.502	1961	1
323.199	322.727	0.472	1961	2
325.719	326.083	-0.364	1961	3
329.936	329.911	0.024	1961	4
332.447	333.044	-0.597	1962	1
335.338	335.658	-0.321	1962	2
338.699	337.508	1.191	1962	3
342.702	339.614	3.088	1962	4

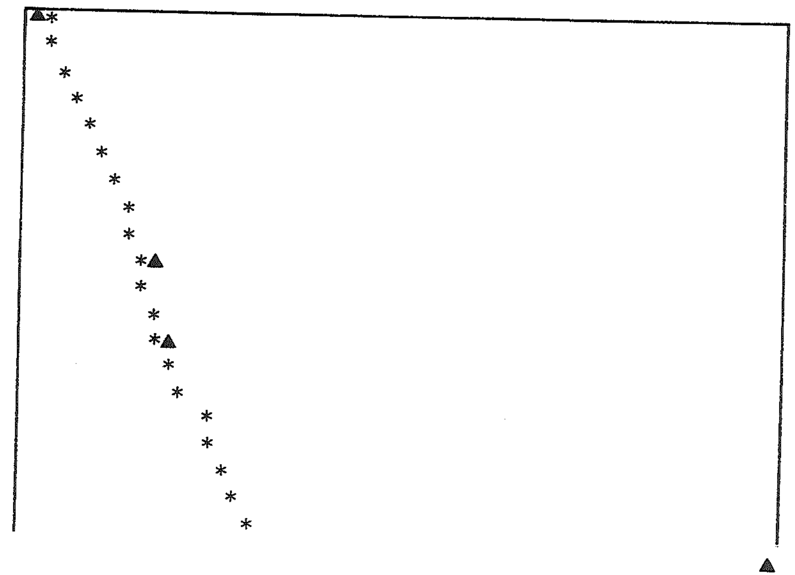
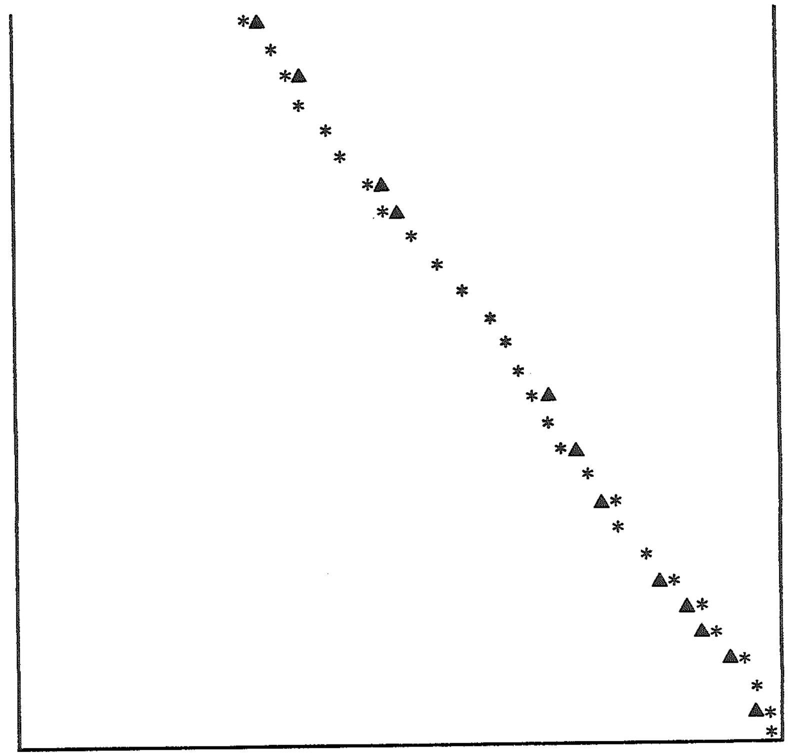


FIGURE A.1 (cont'd)

345.863	342.790	3.073	1963	1
348.140	346.893	1.247	1963	2
352.669	351.324	1.345	1963	3
354.118	355.545	-1.427	1963	4
361.269	360.066	1.203	1964	1
364.886	364.803	0.083	1964	2
372.626	370.129	2.497	1964	3
375.814	375.213	0.601	1964	4
379.141	380.135	-0.994	1965	1
386.485	385.590	0.895	1965	2
391.736	391.693	0.042	1965	3
399.201	398.110	1.091	1965	4
403.783	403.805	-0.022	1966	1
407.811	407.771	0.040	1966	2
412.527	410.865	1.662	1966	3
413.086	413.519	-0.433	1966	4
419.746	417.539	2.207	1967	1
423.080	423.106	-0.026	1967	2
426.125	429.213	-3.088	1967	3
429.150	429.150	0.000	1967	4
436.971	435.669	1.302	1968	1
439.570	441.519	-1.949	1968	2
446.631	447.655	-1.024	1968	3
449.083	453.177	-4.094	1968	4
453.960	457.598	-3.638	1969	1
458.316	460.823	-2.507	1969	2
462.702	463.445	-0.743	1969	3
466.063	465.025	1.038	1969	4



APPENDIX B.1

XVII DIVIDEND-PRICE RATIO AND VALUE OF CORPORATE SHARES

Key to symbols: YPCT$: Net corporate profits after taxes, current dollars.
YDV$: Net corporate dividends, current dollars.

XVII.1 DIVIDEND PRICE RATIO (RDP, 126)

$$RDP = \underset{[-3.45]}{\overset{(796)}{-.5964}} \left[\frac{YPCT\$}{YDV\$}\right] + \underset{[6.98]}{\overset{(795)}{.1205}} \max\,[53.0 - TIME, 0] + \underset{[1.63]}{\overset{(794)}{1.3602}}$$

$$\underset{[-4.42]}{\overset{(801)}{-.5299}} \; Q*W*400.0*.13\sum_{i=o}^{11} (.87)^i \left[\frac{PCON_{-i} - PCON_{-i-1}}{PCON_{-i-1}}\right] + \sum_{i=o}^{4} b_i RCB_{-i}$$

$$\overset{(800)}{+.6895} U_{-1} + e$$

$$b_o = \underset{[3.94]}{\overset{(802)}{.2350}}$$

$$b_1 = \underset{[3.94]}{\overset{(803)}{.1881}}$$

$$b_2 = \underset{[3.94]}{\overset{(804)}{.1410}}$$

$$b_3 = \underset{[3.94]}{\overset{(805)}{.0945}}$$

$$b_4 = \underset{[3.94]}{\overset{(806)}{.0471}}$$

$$\Sigma b_i = .7957$$

$R_e^2 = .946$

$S_e = .156$

$DW = 1.68$

$R_u^2 = .890$

$S_u = .223$

SAMPLE PERIOD: 1954.IV - 1969.II

$$Q = \begin{cases} 1.0 \text{ if } TIME > 80 \\ 0 \text{ if } TIME \leq 80 \end{cases}$$

$$W_t = \sum_{i=o}^{11} v_{t-i}, \qquad v_{t-i} = \begin{cases} (1/12) \text{ if } 400\left[\frac{PCON_{-i} - PCON_{-i-1}}{PCON_{-i-1}}\right] > 1.5 \\ 0 \text{ otherwise} \end{cases}$$

APPENDIX B.2

XVI.1 TERM STRUCTURE EQUATION FOR CORPORATE BOND RATE (RCB, 91)

$$RCB = \underset{[8.45]}{\overset{(890)}{.9004}} + \sum_{i=o}^{18} b_i RCP_{t-i} + \sum_{i=o}^{18} c_i \left(\frac{PCON_{-i} - PCON_{-i-1}}{PCON_{-i-1}} \right)$$

$$\underset{[3.80]}{\overset{(893)}{+.2736}} \sqrt{\frac{8 * \sum_{i=1}^{8} (RCP)^2_{-i} - \left(\sum_{i=1}^{8} RCP_{-i}\right)^2}{64.0}} + e$$

b_0 =	(891) .2116 [8.82]	b_{10} =	(906) .0637 [13.99]	c_o =	(892) -1.3036 [-.21]	c_{10} =	(924) -1.1480 [-.93]]
b_1 =	(897) -.0086 [-.69]	b_{11} =	(907) .0610 [13.10]	c_1 =	(915) 12.4900 [2.79]	c_{11} =	(925) -1.5020 [-1.35]
b_2 =	(898) .0101 [1.18]	b_{12} =	(908) .0568 [11.64]	c_2 =	(916) 9.8210 [3.14]	c_{12} =	(926) -1.6910 [-1.64]
b_3 =	(899) .0257 [4.30]	b_{13} =	(909) .0513 [9.98]	c_3 =	(917) 7.4840 [3.45]	c_{13} =	(927) -1.7360 [-1.74]
b_4 =	(900) .0384 [8.10]	b_{14} =	(910) .0446 [8.40]	c_4 =	(918) 5.4600 [3.37]	c_{14} =	(928) -1.6540 [-1.64]
b_5 =	(901) .0484 [10.84]	b_{15} =	(911) .0370 [7.04]	c_5 =	(919) 3.7310 [2.61]	c_{15} =	(929) -1.4640 [-1.45]
b_6 =	(902) .0559 [12.27]	b_{16} =	(912) .0285 [5.91]	c_6 =	(920) 2.2780 [1.60]	c_{16} =	(930) -1.1850 [-1.24]
b_7 =	(903) .0610 [13.14]	b_{17} =	(913) .0194 [5.00]	c_7 =	(921) 1.0820 [.75]	c_{17} =	(931) -.8353 [-1.05]
b_8 =	(904) .0638 [13.80]	b^{18} =	(914) .0098 [4.25]	c_8 =	(922) .1250 [.09]	c_{18} =	(932) -.4342 [-.89]
b_9 =	(905) .0650 [14.17]	Σb_i =	.94	c_9 =	(923) -.6122 [-.46]	$\sum_{i=o}^{18} c_i$ =	28.91

$\bar{R}^2$ = .9850
S_e = .0782
DW = 1.20

SAMPLE PERIOD:
1954.IV - 1966.IV

CONSTRAINTS: RCP_{-1}: 3rd degree polynomial constrained to zero at t-19

$\left(\frac{PCON_{-1} - PCON_{-2}}{PCON_{-2}}\right)$: 3rd degree polynomial constrained to zero at t-19.

BIBLIOGRAPHY

Andersen, L. C., and Carson, K. M. "A Monetarist Model for Economic Stabilization," *Federal Reserve Bank of St. Louis Review,* Vol. 52, No. 4, April 1970.

Ando, A., and Modigliani, F. "The Life Cycle Hypothesis of Saving: Aggregate Implications and Tests," *American Economic Review,* Vol. 53, May 1963, pp. 55-84, and Vol. 54, Part I, March 1964, pp. 111-113.

deLeeuw, F., and Kalchbrenner, J. "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization — Comment," *Federal Reserve Bank of St. Louis Review,* April 1969.

Fair, R. C. "Consumer Sentiment, The Stock Market, and Consumption Functions," Econometric Research Program Research Memorandum No. 119, Princeton University, January, 1971. (b)

Fair, R. C. *A Short-run Forecasting Model of the United States Economy,* D. C. Heath and Company, 1971. (a)

Friend, I., and Adams, G. "The Predictive Ability of Consumer Attitudes, Stock Prices and Non-attitudinal Variables," *Journal of the American Statistical Association,* LIX, December 1964.

Gramlich, E. M. "The Usefulness of Monetary and Fiscal Policies As Stabilization Tools," *Journal of Money Credit and Banking,* May 1971.

Houthakker, H. S. "On Some Determinants of Saving in Developed and Underdeveloped Countries," in *Problems in Economic Development,* edited by E. A. G. Robinson (London, MacMillan & Co., 1965), Chapter 10, pp. 212-224.

Hyman, S. H. "Consumer Durable Spending," *Brookings Papers on Economic Activity,* 1970.

Landsberg, M. "The Life Cycle Hypothesis: A Reinterpretation and Empirical Test," *American Economic Review,* LX, March 1970, pp. 175-183.

Leff, N. "Dependency Rates and Savings Rates," *American Economic Review,* Vol. LIX, No. 5, December 1969, pp. 886-896.

Lydal, H. F. "Saving and Wealth," *Australian Economic Papers,* December 1963, pp. 228-250.

Modigliani, F., and Brumberg, R. "Utility Analysis and Aggregate Consumption Functions: An Attempt at Integration," Unpublished.

Modigliani, F. "The Life Cycle Hypothesis of Saving, The Demand for Wealth and The Supply of Capital," *Social Research*, Vol. 33, No. 2, Summer 1966, pp. 160-217.

Modigliani, F. "The Life Cycle Hypothesis of Saving and Intercountry Differences in the Saving Ratio," in *Induction, Growth and Trade,* Essays in Honor of Sir Roy Harrod, Clarendon Press, Oxford, 1970.

Modigliani, F., and Sutch, R. "Innovations in Interest Rate Policy," *American Economic Review,* LVI, No. 2, May 1966, pp. 178-197.

Modigliani, F., Cooper, R., and Rasche, R. "Central Bank Policy, Interest Rates, and the Money Supply," *Journal of Money, Credit and Banking,* Vol. 2 (1970), pp. 166-218.

Singh, B., Drost, H., and Kumar, R. "The Postwar Theories of Consumption Function--An Empirical Evaluation," University of Toronto, Multilith.

Sprinkel, B. W. *Money and Stock Prices,* New York, Irwin, 1964.

Sutch, R. "Expectations, Risk and the Term Structure of Interest Rates," Ph.D. thesis, Department of Economics, MIT (1969).

Turnovsky, S. J. "Empirical Evidence on the Formation of Price Expectations," *Journal of the American Statistical Assoication,* Vol. 65, No. 332, December 1970.

Weber, W. R. "The Effect of Interest Rates on Aggregate Consumption," *American Economic Review,* LX, No. 4, September 1970, pp. 591-600.

DISCUSSION

JAMES S. DUESENBERRY

On behalf of the directors I am glad to welcome you aboard, and I am sorry our weather forecasters are not quite as good as our economic forecasters. You can see I was posed with a few problems here, and I made a couple of correct predictions to solve them. First, I looked at the program and noticed we had an hour and 15 minutes for the discussion. Franco was supposed to take only 15, and that seemed to give me a long time to comment on his paper. But I knew Franco would solve my problem. The second prediction was made when Franco was a little bit late this morning. I said to Jack Noyes, "Well, Franco is writing another paper." I didn't know he could turn out that kind of thing before breakfast. But it is still a little bit difficult to comment on such a wealth of thoughts and information.

I must say our conference is off to an impressive start with Franco's paper. I think we are going to have a tremendous demand for the publication of these proceedings because this is a very important paper. It is a little hard to know how to deal with it though, because there is so much in it.

Let me start way back. I think if you go through the literature of the past 30 years, you will find quite a number of places where the notion is put forward that there is a linkage from monetary policy to consumption through wealth effects. But in contrast with the work on investment, there has been relatively little work on that linkage. Mostly, people put it down as one of the items on their list of possible ways in which monetary policy might affect output, income

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and employment. There are a certain number of theoretical papers in which wealth effects appear, but a much smaller volume of empirical work. Now what Franco has done at one gulp is to bridge that gap by giving us in this paper a complete set of linkages. I think that term is appropriate because if you examine what Franco has done, you see that he has worked through a very long chain of effects. He begins with changes in open-market operations, or unborrowed reserves, and goes from that to short-term interest rates, to bond rates, and to stock prices. Then he proceeds to consumption in the sense of rate of consumption of services, then takes into account the capital acquisitions effects for durable goods and picks up all of the secondary effects after he has the consumer expenditure effects. He shows a long chain with many, many links in it, each one of which is spelled out in the model, but emphasizes only a couple of those links and passes over the others rather quickly.

It is a little difficult to know how to deal with that. One cannot deal with each one of those links without making a comment which would be at least as long as the paper itself and indeed, I am afraid that I have to say that each one of the links is subject to some controversy. All I can do is to raise a couple of questions, and I am afraid that I am somewhat in the position of John Williams, my predecessor at Harvard. I used to say when I was younger that John Williams made a great reputation by responding to every proposition by saying, "Well, it is more complicated than that." You get a great reputation for wisdom that way. I have a feeling now that maybe it was more than just a ploy.

Stock-price Explanations

But let me try to make just a few observations on the substantive points here, and let me take it in reverse order starting with the stock-price explanations which play a crucial role in the model. As I noted a mòment ago, that explanation begins with open-market operations and takes us to short-term rates and then to long-term bond rates and then finally to stock prices. The stock-price equation follows the basic logic that the value of stocks equals the discounted expected future dividends. That is the basic logic of stock pricing although it is a little bit hard to see that sometimes. In my course this year I went through that chain of reasoning, the sort of investment value approach to stock valuation, and my students said, "You mean that people buy stocks because they pay dividends?" I had to try to explain to them that each particular fellow may be mostly interested in the capital gain, but in the long run you have to conclude that if the stock doesn't have any hope of paying dividends, it isn't going to be worth anything. I had to tell them the story about the Chinese sardines. In a Chinese inflation, various commodities were used in lieu of money and one of them was a case of sardines that passed from hand to hand many times. Finally somebody opened it and discovered the sardines were bad. He went back to the guy he got them from and complained. The fellow said, "You're crazy! Why did you open them? Those sardines are for buying and selling, not for eating."

The stocks really are ultimately for eating and that is the basic logic of this model, and interest rates come in as the valuation factor, or at least as part of the valuation factor. And a rise in nominal or real interest rates ought to have an adverse effect on stock prices and vice versa. I think it is very important to get that effect in, but we do have to recognize that it entails a few problems. One of them is that the stock-price equations pay no attention to portfolio balance considerations. The implication is that the total value of equities in relation to other types of assets has no influence on the relative prices of stocks and bonds or anything else. While I think that would be a difficult effect to strain out, it is one aspect of the model that I think would bear further consideration.

Our second problem is that one would expect a very high variance about the equation because growth expectations and risk factors are subject to a good deal of change over time, so that for a given real interest rate and a given history of earnings, one still might expect to find a good deal of variation in stock prices. Indeed I think Franco has a little bit of a problem; if the stock-price equation in that model is very good, he is wasting his time being a professor at MIT.

Expectations Regarding Interest Rates

But there is a more fundamental problem from the standpoint of monetary policy. I would expect there would be some interaction among the risk factors, the growth expectations, and the monetary policy factors which are moving the interest rates. I would think that peoples' interpretations of the future of earnings and the nature of the risks to which they are exposed would depend on their interpretations of the reasons for a monetary policy which produces a particular level of interest rates at some point in time. And if they think that interest rates have gone up because there is a roaring boom ahead and the Fed may restrain it somewhat, that may, on one interpretation, lead you to think they would be very bullish about stocks. On the other hand it may be they conclude that ultimately this is going to produce a recession, and it makes them bearish. In any case it seems to me there is lots of interplay between monetary policy and the underlying growth and risk factors which enter into the valuation of stocks.

If you put those things together, I think one of the conclusions you have to reach is that if monetary policy works through this channel, then effects of monetary policy must be subject to an even greater degree of uncertainty and variation through time than we had expected from other types of approaches. Because we are after all pulling out one factor among a great many which affect the value of stocks, and if there is some interaction between our monetary policy and those other factors, then it is going to be very hard to predict its full effect.

Let me then pass on to the other leg of this operation--the effect of changes in wealth on saving and consumption decisions. Again the model is based firmly on some fundamental principles of economic theory. It starts from the proposition that saving and consumption choices are purposeful; people who save are doing so because they have some reason for wanting to accumulate assets--they want future consumption, or the income from wealth. Or they may wish to leave estates, or acquire a business or a house or something of that sort. They have some objective in failing to consume all their income at a particular point in time. The general proposition is that if they have some objective for sacrificing current consumption, and if through capital gains or some other route they acquire more wealth, then this weakens their desire for further accumulation somewhat and has a positive effect on their consumption and ultimately on their consumption expenditures. That is certainly a reasonable proposition. I think we have to exercise a little bit of care in the degree of our reliance of that basic logic because, as Professor Williams used to say, "Things are more complicated than that."

We must take into account the fact that wealth, and especially wealth in the form of equities which is emphasized in this paper, is held in extremely concentrated form. Only a very small fraction of the population holds any significant amount of equities. When we suppose that changing wealth in the form of equities changes aggregate consumption, we are placing a great deal of weight on the reactions of a relatively small part of the population, and a part of the population that is somewhat different from the rest. Oscar Wilde was asked whether he thought the rich were really different from other people and he said, "Yes, they've got more money." I am not sure that the logic of the life cycle kind of hypothesis applies particularly well to the very group which holds the most equity.

I suppose I can give you another classroom example. The man who is now the Aga Khan was a student at Harvard a number of years ago, and he took a course in economic theory in which he was exposed to the theory of indifference curves and the logic of consumer choice. When the lecture was all over, he went to the instructor and said, "That's very interesting. How does it work if there isn't any budget constraint?"

Motivations for Estate Building

I think that some of the holders of equity are in that position. To put it a little bit more concretely, the life cycle hypothesis leaves out of account the whole question of motivation of building estates. I think to some extent one can regard estate building as the continuation of the retirement problem. You can't take it with you, but you can leave it behind you. You can argue that the same kind of logic that makes you save during your working life in order to provide for retirement also makes you save to leave an estate. But I think that the estate motivation may be less tightly constrained and the notion that capital gains are going to result in more consumption--because people have already achieved a well-defined estate-building goal--is not quite so plausible as the logic that a man of moderate income who is trying to stretch out his consumption over his retirement will have to save during his working life. I think there is a good deal of room for play there, and I do not think we can expect very tight theoretical conclusions as to the effect of wealth on savings from that basic life cycle logic.

It is jumping the gun a little bit, but I think one can make some interesting comparisons with the Tobin paper, which are really favorable to the results which Franco has produced. If I read the Tobin-Dolde paper correctly, through capital gains they get rather larger effects of changes in wealth on consumption than Franco's coefficient of about .05. That makes sense to me if you suppose some people respond much more weakly than the life cycle hypothesis would indicate. When you take that into account, you get a smaller coefficient than the one calculated from the Tobin-Dolde simulations. In a way I think there is a certain consistency when you deal with a more complicated world than the Tobin-Dolde paper does; it is not surprising that Franco's coefficient is smaller than the one that they have. I think that lends some credence to the kind of coefficient that Franco obtained.

If his empirical coefficient had been as big as the simulated one in the Tobin model, which leaves a lot of things out of account--particularly estate building--I would be more skeptical than I am at its coming out this way. Nonetheless, we have tc regard these numbers as numbers which have a general theoretical rationale but which do not lead us to any tight numerical conclusion. We therefore must rest very heavily on the statistical procedures. Unfortunately, we are as usual dealing with a lot of statistical ambiguity, because these data are subject to many common trends and collinearity. I think it is more clear from the work that other people have done that one can get equally good estimates of consumer expenditure by other approaches which do not take the wealth effect into account as by those which do.

There is a paper by Saul Hyman in the Brookings Economic Activity Series which makes some comparisons between estimates of expenditure on durable goods with and without stock-price variables. It is a close race, but one cannot say there is a clear-cut effect here which can be explained only by the use of the stock-price variable. I think there is a great deal of reason to believe that that kind of effect does exist and one gets it out when one sets up the regressions in the appropriate way. However, we still have a good way to go in getting precise estimates of the exact magnitude of those effects.

Uncertain Policy Channels

That leads me to my final observation, which really is to repeat what I said before about the stock-price equations. If we believe that monetary policy has about half its effect through the channels which are delineated in this paper, then we have to conclude we are in the position of working monetary policy through a set of channels which one would expect to be very uncertain and changing. I spent the breakfast hour with Jack Noyes and Beryl Sprinkel kicking around the mysteries of why we got the peculiar combination of money supply and short-term interest rates that we got. When you pass from that to the bond rate, you get stuck in the morass of term structure and possible changes in the composition of the debt securities outstanding, with all kinds of complicated expectational effects. When you progress from the effects of bond yields to stock prices, you get yourself in another complicated chain of arguments, which suggests the possibility, as I said earlier, that the very changes in policy may create expectations which will produce uncertain results as to the outcome.

Finally, when you get from stock prices to consumption itself, you find yourself again in a situation in which there is a good deal of room for play as to what the magnitude and timing of the effects will be. I think this really does strengthen the case for the notion that the money supply-interest rate-value of assets-consumption channel is one of the channels through which monetary policy works. It does spell out a very reasonable set of hypotheses by which it can work. It also suggests that these channels are like Mississippi River channels which keep changing and make it very difficult to make monetary policy, particularly when you have to forecast a long way ahead. Nevertheless, I think it is a really very important contribution, particularly when this last bit--which I haven't had time to absorb--is added because it does suggest that there is some overall consistency between the different ways of judging the effect of monetary policy. Even though there is a great deal of uncertainty as to the timing and magnitude of the effect of any particular monetary action, I think this does help us make a lot more sense out of our notions of how monetary policy works than previously, when we had to rely much more heavily on the equally uncertain effects through housing and plant equipment investments. I end by congratulating Franco on his mighty work.

REBUTTAL

FRANCO MODIGLIANI

I am highly encouraged by Professor Duesenberry's comments, especially since I know from long experience that he is not an easy customer. My reply can be kept brief because I find myself in basic agreement not only with what he likes about the paper, but also with most of the questions he raises. His comments deal, in part, with some detailed criticism of individual channels and, in part, with the implications of the paper, and of his criticism, concerning the reliability of the timing and magnitude of response to monetary policy.

With respect to the determinants of market valuation of corporate equity he suggests that more explicit consideration should be given to the relative supplies of assets, particularly debt. Here we must distinguish between private and public debt. With respect to private debt, the model does rely on the Modigliani-Miller framework, according to which the total market valuation of firms is independent of the stock of debt outstanding except through tax effects. First, private debt cancels out and second, if the supply is excessive to suit portfolio preferences, individuals can always mix it with levered stock, while if they want more leverage than is provided by corporations they can lever their portfolio by borrowing on personal account.

As for the tax effect, we rely on the assumption that target leverage can be treated as a constant; this is not entirely satisfactory but does not seem to be grossly inconsistent with the facts. The situation is different with respect to public debt, which *is* a component of net wealth. In principle, one should expect that the risk premium commanded by risky assets, such as those of non-financial corporations, should tend to decline if the ratio of government debt to wealth rises, and, hence, the share of risky assets in the total declines. We have, at some point, made an attempt at tracking down this effect, but with little measurable success, in part perhaps because, in the relevant period, public debt has been a relatively small portion of wealth and has exhibited a declining, trend-like behavior.

Duesenberry also suggests that the impact of monetary policy on market valuation may not be stable. For instance, an increase in interest rates, which should tend to reduce market value, may fail to do so because it may support more bullish profit expectations, and thus would be accompanied by an offsetting increase in what is being capitalized. While the point is well taken it would seem that, in general, a rise in interest rates would be unlikely to trigger expectations of higher profits unless it was accompanied by a current increase in profits, in which case our equation would tend to capture the effect.

Concerning the links that go from wealth to consumption, he suggests that the effect of capital gain and loss must be weakened and made more uncertain by the heavy concentration of the ownership of stock. However, here one should recognize that the life-cycle model allows for a substantial concentration of wealth ownership in the older age group, and also suggests that these age groups should be more sensitive to variations in wealth. One should allow also for the indirect ownership of stock through pension funds. Nor do we wish to exclude some possible indirect effects through consumer sentiment. It might be added that, at one time, Frank de Leeuw, when he was still connected with the model, made an attempt at estimating separately the effect of changes in the value of corporate equity and that of changes in wealth from all other sources, on the hypothesis that the response to the first component might be smaller and, especially, more delayed. However, he was unable to find any convincing evidence that this was so, and the attempts were abandoned. Nonetheless, further probes in this direction would seem to be called for.

Unfortunately, *a priori* arguments as to whether the wealth effect should or should not be important cannot advance us very far and it would, therefore, be nice to be able to assuage the qualms of Professor Duesenberry and others by an appeal to empirical evidence. But he is quite right that this is a weak reed to lean on. Yet one can take some comfort from the fact that our consumption function does fit the data exceptionally closely and that the evidence for a significant role of wealth is overwhelming. It is true that when it comes to consumer expenditure, our model may not stand out equally well, but this is largely because our consumer durable equation does occasionally get into some trouble. That equation, incidentally, does not incorporate explicitly a stock market variable – except indirectly through consumption, which controls the desired stock of durable capital. Hence, the cited evidence of Hyman is not inconsistent with our model nor with our conclusion that wealth plays an important role in total consumption.

Despite this defense of individual links I must certainly agree with my critic that the linkages between monetary policy and consumption, traced out by the model, are extremely tortuous and fraught with possibilities for slippage. This holds at the very least with respect to the channels tying monetary policy with the market valuation of corporate equity. If it is true that something like a half of the average response to changes in money supply in the early quarters comes from this route, then there is justifiable ground for suspecting a good deal of variations around that average. In this sense, I can find little quarrel with Duesenberry's conclusion that while the FMP model has, hopefully, contributed a new understanding of the workings of monetary policy, it does not, at this stage, provide much ground for dispelling long-standing qualms about the reliability of the response.

Yet, what we have learned about the linkage mechanism, if valid, may still help improve policy making. For, in assessing whether a given policy is or is not having the intended restraining or stimulating effect, one can directly look at the behavior of the equity markets to see whether they are responding as intended and, if not, can take corrective action.

In concluding, it may be worth observing that the model also does not suggest any grounds for changing significantly our views of the channels or reliability of fiscal policy. Indeed, while the wealth effect may contribute some to an understanding of the monetarists' crowding-out effect, it appears to play but a very small role in the transmission mechanism. Unfortunately, this cheerful conclusion is somewhat marred by the fact that, to our knowledge, no one has yet been too sucessful in confirming these fiscal responses through reduced forms (though a good beginning has been made recently by E. M. Gramlich in the paper cited in the epilogue.

We have reason to believe that the kind of analysis touched on in the Epilogue holds good promise to help unravel this puzzle. In our view, this problem deserves high priority for one would feel much easier if one could obtain, in Duesenberry's words, "some overall consistency between the different ways of judging effects" as we hope we have succeeded in doing for monetary policy, at least partly, in our contribution to this Conference.