THE EARLY HISTORY OF THE REAL/NOMINAL INTEREST RATE RELATIONSHIP

Thomas M. Humphrey

The proposition that the real rate of interest equals the nominal rate minus the expected rate of inflation (or alternatively, the nominal rate equals the real rate plus expected inflation) has a long history extending back more than 240 years. William Douglass articulated the idea as early as the 1740s to explain how the overissue of colonial currency and the resulting depreciation of paper money relative to coin raised the yield on loans denominated in paper compared to the yield on loans denominated in silver coin. In 1811 Henry Thornton used the same notion to explain how an inflation premium was incorporated into and generated a rise in British interest rates during the Napoleonic wars. Jacob de Haas, writing in 1889, employed the real/nominal rate idea to account for the "third (inflationary) element" in interest rates, the other two being a reward for capital and a payment for risk. And in 1890, Alfred Marshall cited the interest-inflation relationship as the key component in his theory of the transmission mechanism through which variations in the value of money generate trade cycles. The relationship achieved its classic exposition in Irving Fisher's *Appreciation and Interest* (1896) where it was refined, restated, elaborated, and presented in the form in which it appears today.

Apparently, however, some modern economists are largely unaware of this earlier tradition. As a result, they erroneously see the real/nominal rate relationship as a recent rather than an ancient idea. Thus, for example, Lawrence H. Summers of the National Bureau of Economic Research contends "that it was not until the 20th century that the distinction" between nominal and real interest rates "was even introduced into economic analysis." [11; p. 48]

The purpose of this article is to show that the two-rate distinction long predates the 20th century. More precisely, this article demonstrates (1) that a rudimentary version of the real/nominal rate relationship had already been enunciated by the mid-1700s, (2) that the relationship was thoroughly understood and succinctly formulated by some of the leading 19th century classical and neoclassical monetary theorists, (3) that it was presented in its modern form by the end of the century, and therefore (4) that the notion that it is a 20th century invention is totally erroneous. In documenting these points, the article traces the pre-20th century evolution of the real/nominal rate analysis from its earliest origins to its culmination in Fisher's *Appreciation and Interest.* As a preliminary step, however, it is necessary to sketch the basic outlines of this traditional analysis in order to demonstrate how earlier writers contributed to it.

The author acknowledges the helpful comments of Timothy Q. Cook.

Key Propositions

As usually presented; the real/nominal interest rate relationship expresses the nominal rate as the sum of the real rate and a premium for expected inflation or, what is the same thing, the real rate as the nominal rate adjusted for expected inflation. In symbols,

$$(1)\quad n = r + p \quad \text{or} \quad r = n - p$$

where n is the nominal or observed market interest rate, r is the expected real interest rate associated with the holding of real commodities or capital goods, and p is the expected rate of price inflation or depreciation of the value of money.

Of these three variables, the real rate r is taken to be a fixed constant equal to the given marginal productivity of capital. To this real rate is equated n-p, the anticipated real (inflation-corrected) yield on money loans. The equality between these two real rates is maintained by arbitrage, the operation of which ensures that the expected real rates of return on all assets are the same. Note, however, that while *anticipated* real yields are continuously equalized, the analysis recognizes that inflation forecasting errors may cause the *realized* real yield on loans to deviate temporarily from its equilibrium level corresponding to the given real rate on capital. Such deviations will occur, for example, if people either neglect to predict inflation or predict it extrapolatively from past inflation rates so that it (predicted inflation) changes slowly when actual inflation changes. In either case, inflation will be underpredicted and therefore will not be fully incorporated into nominal rates. As a result, the nominal rate will not fully adjust for inflation and the realized real rate on money loans will fall below its equilibrium level. The fall in the realized real rate of course will produce windfall profits for borrowers and windfall losses to lenders. Assuming borrowers and lenders predict future profits extrapolatively from these realized windfall profits and losses and then act on the basis of these predictions, the subsequent corrective adjustment of loan demand and supply will tend to bid up the nominal rate by the rate of inflation. In this way the nominal rate eventually rises by the full amount of inflation, thereby restoring the realized real yield on loans to its equilibrium level.

From the foregoing analysis, earlier writers drew four conclusions. First, the equilibrium nominal rate fully adjusts for inflation leaving the realized real rate on money loans intact. Second, such equilibrium nominal rate adjustments render market rates high in periods of inflation and low in periods of deflation. Third, the same equilibrium nominal rate adjustments entail no real effects. By leaving the real yield on loans unchanged, they alter neither profits nor losses nor incentives to borrow and lend. Nor do they affect the distributive shares of borrowers and lenders. Fourth, during the transitional adjustment to equilibrium, however, incomplete nominal rate changes can have temporary real effects. These effects are of two kinds. First are the inevitable income distribution effects on borrowers and lenders owing to the incomplete adjustment of the nominal rate and the resulting change in the realized real rate. Second are possible output and employment effects stemming from changes in the volume of loans and business investment spending induced by the real rate change. As shown below, however, the occurrence of these output and employment effects was postulated to depend upon the questionable assumption of differential profit expectations as between borrowers and lenders. Constituting the essentials of traditional real/nominal interest rate analysis, the foregoing propositions originated with the 18th and 19th century writers discussed below.

William Douglass

William Douglass, an 18th century Scottish-born physician, pamphleteer, controversialist, and student of American colonial currencies was perhaps the first to distinguish between real and nominal interest rates.[1] He did so in an effort to refute the notion (as prevalent then as now) that easy money spells cheap money, i.e., that rapid monetary growth lowers market interest rates. To show that paper money expansion raises rather than reduces market rates, he defined the nominal rate as the rate measured in terms of paper currency and the real rate as the rate measured in terms of silver coin. That is, he identified the nominal rate with the yield on loans denominated in paper and the real rate with the yield on loans denominated in coin. Then, assuming the real (coin) rate fixed by law, he argued that an expansion of inconvertible paper currency would depreciate the paper money relative to coin and thus lower the real value of loans denominated in paper relative to those denominated in coin, This would induce lenders to demand a compensatory premium in the nominal rate, thereby raising the latter by the full amount of the depreciation. As summarized by him:

> The quantity of paper credit sinks the value of the principal, and the lender to save himself, is obliged to lay the growing loss of the principal, upon the interest. [5; p. 243]

In other words, lenders, foreseeing an inflation-induced depreciation in the value of their principal, will demand a premium equal to the expected rate of depreciation to protect them from the loss. This premium, when added to the rate of interest expressed in terms of coin, raises the nominal or paper rate by the full amount of the expected rate of depreciation. In short, the nominal rate adjusts for inflation to maintain equality between the real rate on paper and the given real rate on silver.

To illustrate this point, Douglass argued that if the rate of interest expressed in terms of coin were legally fixed at 6 percent while paper was depreciating relative to coin at a rate of 7 percent, then "the lender to save his principal from sinking requires a 13 percent" nominal interest rate for the period of the loan-this 13 percent nominal rate being the sum of the 6 percent real (coin) rate and the 7 percent rate of depreciation of paper with respect to coin. [5; p. 339] Similarly, he pointed out that when paper depreciates relative to coin at a rate of 22 percent per year the nominal (paper) rate corresponding to a legal real (coin) rate of 6 percent would be 28 percent per annum-this rate being the sum of the 6 percent real rate and the 22 percent rate of depreciation. In effect, he argued that the nominal rate equals the real rate plus the expected rate of

[1] On Douglass, see Dorfman [3; pp. 155-162].

inflation, the latter expressed as the rate of depreciation of paper relative to coin. Since he assumed that the rate of depreciation was fully foreseen and incorporated into yields expressed in paper, he also recognized that the equilibrium nominal rate fully adjusts for actual inflation, leaving the realized real rate unchanged. In this case currency depreciation has no effect on real economic variables since it leaves the real rate undisturbed.

From the foregoing propositions, Douglass concluded that the nominal rate varies equiproportionally with the rate of inflationary overissue of paper money such that

> . . . the larger the emissions, natural [i.e., nominal] interest becomes the higher; therefore the advocates for paper money (who are generally indigent men, and borrowers) ought not to complain, when they hire money at a dear nominal rate. [5; p. 340]

Accordingly debtors, he argued, have no grounds for complaining that they are injured by high nominal rates. For, with full adjustment of those rates with respect to inflation, realized real rates and hence the distribution of real income between creditors and debtors remains unchanged. Here is the proposition that equilibrium adjustments of the nominal rate are neutral in their impact on real economic magnitudes.

To summarize, not only did Douglass articulate the real/nominal interest rate relationship, he also originated (1) the notion that the equilibrium nominal rate must fully adjust for changes in the value of money so as to leave the real rate unchanged, and (2) the corresponding notion of the neutrality of equilibrium changes in the nominal rate with respect to distributive shares. This, plus his explanation of how expected inflation premia get embodied in market rates, marks him as an important early contributor to the two-rate analysis.

Henry Thornton (1760-1815)

The next writer to employ the real/nominal rate relationship[2] was Henry Thornton, the British banker, evangelist, philanthropist, member of Parliament, and the outstanding monetary theorist of the first half of the 19th century. Writing during the Napoleonic wars when Britain was off the gold standard and the Bank of England was released from its obligation to convert paper into gold at a fixed price upon demand, Thornton employed the relationship to explain how the suspension of convertibility and the resulting inflationary overissue of paper currency had raised market yields in Britain. That is, he sought to specify the mechanism through which an inflation premium becomes embodied in market rates. More precisely, he sought to show that the inflation premium enters the nominal rate even if nobody attempts to predict inflation. For according to him, it is profits and profit predictions rather than inflation predictions per se that drive up the equilibrium nominal rate. Tracing a chain of causation running from unpredicted inflation and sluggish nominal rates to realized real rates to profits both actual and expected, thence to loan demands and supplies and back again to nominal rates, he argued that unexpected inflation initially lowers the realized real loan rate below the given real yield on capital. The result is windfall realized profits for borrowers and windfall losses to lenders. Assuming borrowers and lenders predict future profits extrapolatively from realized past profits and then adjust their loan demands and supplies accordingly, the resulting rise in loan demand and fall in loan supply will bid up the nominal rate by the full amount of inflation, thereby eliminating the real rate differential existing between money loans and real capital investment. At this point the real loan rate is restored to its equilibrium level corresponding to full adjustment of the nominal rate.

> Accordingly, in countries in which the currency was in a rapid course of depreciation, supposing that there were no usury laws, the current rate of interest was often, as he [Thornton] believed, proportionably augmented. Thus, for example, at Petersburgh, at this time, the current interest was 20 or 25 percent, which he conceived to be partly compensation for an expected increase of depreciation of the currency. [12; p. 336]

Here is the first rigorous and systematic account of one version of the mechanism through which an inflation premium becomes incorporated into interest rates. And, although it conflicts with that part of his analysis that ignores anticipated inflation, here also is the first explicit acknowledgment that the premium refers to expected future inflation.

Thornton's contribution, consisting as it did of a fully-articulated theory of how inflation drives up

[2] Thornton expressed the relationship (albeit verbally, not algebraically) in the form $r = n - p$, where r is the realized real rate, n the nominal rate, and p the realized rate of inflation. He noted (1) that inflation had occurred at an average yearly rate of 2-3 percent over the period 1800-1810 and (2) that, as a result, if a man borrowed money at a 5 percent nominal rate in 1800 and paid it back in 1810, he would find that he had paid an actual real rate of only 2-3 percent and not 5 percent as he appeared to do. That is, he argued that p = 2-3 percent, n = 5 percent, and r = 3-2 percent. He also pointed out that when one borrows to finance the purchase of assets the price of which rises with the rate of inflation, the real cost of borrowing is only that part of the interest rate that exceeds the price gain.

interest rates, was a milestone in the evolution of the two-rate analysis. In terms of analytical insight, clarity, rigor, and completeness, it remained unsurpassed until Irving Fisher wrote his Appreciation *and Interest* in 1896. This of course is not to say that other economists did not discuss the real/nominal rate relationship during this time. On the contrary, over the 86 year interval separating Thornton and Fisher, at least four economists-namely John Stuart Mill, Alfred Marshall, the Dutch writer Jacob de Haas, and the American John Bates Clark-articulated the relationship. None of these writers, however, knew of Thornton's contribution and thus never referred to it. Even Fisher, who acknowledged the others as forerunners and cited them in his 1896 work, was apparently unaware of Thornton, whose 'work had largely fallen into oblivion. Thus despite its originality and insight, Thornton's contribution exerted little influence on the work of his 19th century successors, of whom Mill was the first.

John Stuart Mill (1806-1873)

Despite his ignorance of Thornton's contribution, John Stuart Mill nevertheless echoed the former's contention that interest rates include a premium for expected inflation. Thus, in the sixth (1865) edition of his *Principles of Political Economy*, Mill wrote that "the expectation of further depreciation" of the currency raises market yields

> because lenders who expect that their interest will be paid, and the principal perhaps redeemed, in a less valuable currency than they lent, of course require a rate of interest sufficient to cover this contingent loss. [9; p. 646]

Mill's contribution consisted of recognizing, first, that inflation reduces the real value of the interest as well as the principal of a loan, and, second, that lenders will therefore demand an inflation premium to cover both types of expected loss. This was a new insight : earlier writers had concentrated solely on the expected loss of principal and had said nothing about the corresponding loss of interest. Mill's insight was later formalized by Marshall and Fisher, both of whom added a cross-product term to the real/nominal rate equation to account for inflation's impact on the real value of interest receipts.

Jacob de Haas

After Mill came the Dutch economist Jacob de Haas. Writing in 1889, he argued that the expected rate of change of the value of money constituted the "third element" in market interest rates, the other two being a payment for capital and a payment for default risk, respectively. That is, he claimed that the first element consists of "the remuneration for abstinence, i.e., the hire of capital," the second "the insurance against loss or remuneration for risk," and the third "the expected change in the purchasing power of money." [2; pp. 110-111, 107] Since the first two elements taken together comprise the real rate of interest while the third element is the price expectations term, de Haas's formulation amounts to the expression $n = r + p$ where n is the nominal or market rate, r the real rate, and p the expected rate of price change. Depending upon whether prices were expected to rise or fall, this latter variable, he noted, could be either positive or negative, adding to or subtracting from the given real rate as the case' might be. The implication, he said, was that market rates tend to be high during periods of inflation and low in periods of deflation.

Finally, like Thornton, he contended that inflation expectations get incorporated into market rates via loan demand and supply. More precisely, he argued that expected inflation causes lenders, who anticipate a depreciation in the real value of their principal and interest, to contract loan supply. Conversely, borrowers, who anticipate repaying debts in depreciated dollars, expand their loan demands. The resulting fall in loan supply and rise in loan demand acts to raise market rates.

All in all, de Haas contributed little new to the analysis of real and nominal interest rates. His work, despite its apparent originality, contains nothing that cannot be found in Thornton, although Fisher, being unaware of this, thought highly of him.[3] Marshall too knew of his work and cited it in the first edition of the *Principles*.

Alfred Marshall (1842-1924)

Marshall's discussion of the real/nominal rate relationship appeared in the first (1890) edition of his *Principles of Economics* in a section entitled, appropriately enough, "Note on the Purchasing Power of Money in Relation to the Real Rate of Interest." He was the first to use the words real and nominal to refer to interest rates-his predecessors having used one but not both of those expressions. He was also the first to compute real rates taking account of

[3] In the preface to his Appreciation and Interest, Fisher says that, of all the writers who considered the real/nominal rate relationship, "Mr. Jacob de Haas, Jr., of Amsterdam, seems most fully to have realized its importance."

inflation's erosion of the real value of interest as well as the principal of a loan. Specifically, he correctly computed the annually-compounded realized real rate (r) as the difference between the nominal rate (n), the rate of inflation (p), and the cross-product (np) of those two latter rates-this cross-product measuring the effect of inflation on the real value of interest receipts. That is, although he did not state the formula

$$(2) \quad r = n - p - np$$

he was the first to compute the realized real rate according to it. He did so when he stated that a 5 percent nominal rate is equivalent to a minus 5½ percent real rate after correction for a 10 percent rate of inflation. He did so again when he said that a 5 percent nominal rate translates into a 15½ percent real rate when prices are falling (the value of money is rising) at a rate of 10 percent. In both cases, the ½ percent refers to the effect of changes in the value of money on the real value of interest receipts. In so doing, he improved upon the work of his predecessors, all of whom, with the exception of John Stuart Mill, computed the real rate according to the approximation $r = n - p$ that neglects the rate of depreciation of interest payments.

Finally, although Marshall did not explain how inflation expectations are formulated and embodied in market rates, he did suggest that expectational (i.e., inflation forecast) errors and the resulting deviations of the realized real loan rate from its equilibrium level might, when borrowers and lenders hold different expectations, generate trade cycles. Said he, "When we come to discuss the causes of alternating periods of inflation and depression of commercial activity we shall find that they are intimately connected with those variations in the real rate of interest which are caused by changes in the purchasing power of money." [8; p. 628] Marshall's statement implies (1) that inflation expectations are formed extrapolatively from realized past rates of inflation such that expectations adjust slowly to actual changes in inflation, and (2) that expectations differ between borrowers and lenders so that loan demands respond disproportionally to loan supplies when expectations change. Of these two ideas, the first ensures that expected inflation lags behind actual inflation causing incomplete adjustment of the nominal rate and a corresponding change in the realized real rate. The second ensures that loan demand curves shift disproportionally to loan supply curves when expectations change, thereby resulting in alterations in the volume of loans. Assuming these loans are used to finance business investment projects, real investment spending and thus the level of real economic activity will be affected. Taken together, the assumptions of extrapolative expectations and differential expectations as between borrowers and lenders are sufficient to generate the real economic disturbances Marshall had in mind. This is what he meant when he suggested that fluctuations in the value of money could generate trade cycles via the interest-inflation relationship. Marshall's suggestion was later developed into a full-scale model of the trade cycle by Irving Fisher.

J. B. Clark (1847-1938)

As indicated above, Marshall largely treated the nominal rate as given and examined the impact of observed inflation on the realized real loan rate. By contrast, his contemporary John Bates Clark treated the real loan rate as a constant and examined the impact of anticipated inflation on the nominal rate. Thus, in his 1895 article on "The Gold Standard of Currency in the Light of Recent Theory," Clark argued that a perfectly foreseen inflation would be "unerringly corrected" by equiproportional variations in the nominal rate of interest so as to maintain the real loan rate intact. To illustrate this, he said that upon the anticipation of a negative 1 percent rate of inflation, the nominal rate would immediately fall from a 5 to a 4 percent level so as to keep the realized real loan rate equal to the given 5 percent real yield on capital. That is, he articulated the relationship $r = n - p$ according to which the nominal rate n must vary in step with the inflation rate p to keep the real loan rate fixed. Regarding this nominal rate adjustment, he noted that it would have no effect on real variables including the distribution of income since "a debtor does not suffer nor a creditor gain by a change in the purchasing power of coin, provided that the change is generally anticipated." [1 ; p. 393] Here is the notion of the neutrality of equilibrium nominal interest rate changes, In restating these old propositions regarding nominal interest rate adjustment and neutrality, Clark set the stage for Fisher's *Appreciation and Interest.*

Fisher's Appreciation and Interest **(1896)**

The notion that real/nominal interest rate analysis is a 20th century phenomenon originating with Irving Fisher is disproved in his *Appreciation and Interest* (1896) where he makes it clear that he was by no means the first to present that analysis. As proof, he cites the earlier contributions of Douglass, Mill, de Haas, Marshall, and Clark-all of whom helped lay the groundwork for his own analysis. Containing the earliest complete account of his theory of inflation and interest, *Appreciation and Interest* constitutes the high water mark in the pre-20th century development of the subject. In it Fisher made at least four advances over the work of his predecessors. First, he derived the formula $r = n - p - np$, or alternatively, $n = r + p + rp$ relating annually-compounded inflation and interest rates. Second, having derived the formula, he discussed the limit values and behavior of its constituent variables under conditions of perfect and imperfect foresight, respectively. Third, he confronted the perfect foresight (complete adjustment) hypothesis with empirical data, and, when the facts failed to confirm the theory, he constructed an alternative theory of sluggish nominal rate adjustment under imperfect foresight. Finally, he employed 'this imperfect foresight theory to explain how price changes generate trade cycles by altering realized real loan interest rates.

Derivation of Formula

Regarding his derivation of the formula $n = r + p + rp$ he argued as follows: Suppose loan contracts can be written either in terms of money or in terms of goods. As mentioned above, let n be the nominal or money interest rate and r be the real or commodity interest rate. Also suppose that prices rise at the expected rate p over the year, so that what costs a dollar at the beginning of the year will cost (1+p) dollars at year's end. Assuming that at the start of the year one dollar will buy one basket of commodities, a person has the option of borrowing, say, one dollar at money rate n for a year or, alternatively, one basket of commodities at real rate r for a year. If he chooses the first, he must pay back (1+n) dollars principal and interest when the loan expires. If he chooses the second, he must pay back (1+r) baskets of commodities which he can purchase at a price of (1+p) dollars per basket when the loan comes due. This price, when multiplied by the number of baskets required to liquidate the loan, results in a total dollar outlay of (1+p) (1+r). In short, the costs of liquidating the loans expressed in a common unit of account are (1+n) and (1+p) (1+r) dollars, respectively. Now it is clear that, with perfect arbitrage, equilibrium requires that these two money sums be equal, i.e.,

$$(3)\quad (1+n) = (1+p)(1+r),$$

such that the maturity values of both loans are the same when expressed in terms of a common unit of account. For if, say, commodity loans were cheaper than money loans (i.e., the right side of the equation was smaller than the left), then a profit could be made by borrowing commodities, converting them into dollars to be lent out at the money rate n, and subsequently using the proceeds received from the maturing money loan to purchase commodities with which to retire the commodity debt. Given these conditions, everyone would want to borrow commodities and 'to lend money. The resulting increased demand for commodity loans and the corresponding increased supply of money loans would raise the commodity rate of interest and lower the money rate until the foregoing equality was restored. Expanding equation 3 and solving for the nominal rate yields

$$(4)\quad n = r + p + rp$$

where p, the rate of price inflation, is the rate of depreciation of money relative to goods-which means of course that goods are appreciating in value relative to money. On the basis of this equation Fisher concluded that,

> The rate of interest in the (relatively) depreciating standard is equal to the sum of three terms, viz., the rate of interest in the appreciating standard, the rate of appreciation itself, and the product of these two elements. [6; p. 9]

Limiting Values of the Variables

Having derived the formula, Fisher next commented on the plausible values of its component variables. He noted, first, that the nominal rate could never be negative in a world in which money can be costlessly held. That is, he contended that because people would hoard money rather than lending it at a negative rate, the money rate of interest can never be less than zero. And if the nominal rate cannot be less than zero, it follows, he said, that prices can never fall at a fully anticipated rate greater than the real rate of interest-as can be seen by setting the nominal rate at zero and solving the formula for the resulting rate of price deflation.[4] In short, he argued that the costless storage of money sets lower and

---

[4] The fully anticipated rate of deflation cannot exceed the real rate of interest because, if it did, the real rate of return on hoarded money would exceed the real cost of commodity loans. Given this opportunity for profitable arbitrage, everyone would want to borrow commodities for conversion into cash. The resulting excess demand for commodity loans would immediately bid up the real (commodity) rate into equality with the price deflation rate, thereby restoring parity between the two.

upper limits, respectively, to the nominal rate and the fully anticipated rate of price deflation.

Empirical Tests

Fisher's third contribution was to state and empirically test the perfect and imperfect foresight interpretations of the formula.[5] In this connection he noted that if perfect foresight exists, then price changes are accurately predicted and fully incorporated into nominal rates. As a result, these rates fully adjust for inflation leaving the realized real loan rate unchanged. Thus if perfect foresight prevailed, one would expect to observe virtual constancy of the realized real rate and one-for-one variations between nominal rates and the rate of inflation. By contrast, in the imperfect foresight case price changes are incompletely anticipated and therefore are not fully incorporated into nominal rates. As a result, the latter do not fully adjust for inflation and consequently the realized real loan rate changes. In this case one would expect to find realized real rates varying inversely with nominal rates and the latter varying less than one-for-one with inflation rates.

Putting the perfect and imperfect foresight interpretations to the empirical test, Fisher found that the data largely contradicted the former interpretation and confirmed the latter. That is, he found that while nominal rates tended to move with inflation and deflation, they did not move sufficiently to offset these price changes and consequently realized real rates changed. In particular, he found (1) that realized real rates moved inversely to nominal rates, (2) that they exhibited roughly 3½ times the variability of nominal rates, and (3) that they were often negative during periods of rapid inflation. Evidently price changes drove a wedge between real and nominal rates with the former bearing most of the adjustment -an outcome clearly at odds with the perfect foresight (constant realized real rate) hypothesis. On the basis of this evidence, Fisher concluded that, contrary to the perfect foresight model,. nominal rates adjusted slowly and incompletely to inflation and deflation because these phenomena were inadequately foreseen.

Lagged Adjustment Mechanism

Fisher's fourth contribution was to outline an alternative theory of interest rate adjustment consistent with the facts. Abandoning the perfect foresight framework for an imperfect foresight one, he presented a model in which transitory changes in real variables play a key role in the adjustment process and in which inflationary expectations are incorporated into nominal rates with long lags. He employed the model for two different purposes. He used it, first, to show how the nominal rate reaches its equilibrium level consistent with full adjustment to inflation. He used it, second, to show how price changes generate trade cycles.

Regarding the first use of his model, he explained the process or mechanism through which an inflation premium gets embodied in nominal rates. Employing the assumptions (1) that firms are net borrowers, (2) that firm owners by virtue of being entrepreneur: possess foresight superior to that of lenders, and (3) that entrepreneurs forecast profits extrapolatively, he traced a chain of causation running from rising prices and lagging nominal rates to falling real rates to rising profits both actual and expected, then to increasing loan demands and 'thence back again to nominal rates. More precisely, he argued that unexpected inflation and sluggish nominal rates produce falling real rates and hence windfall profits to borrowers. The latter then forecast future profits extrapolatively from those realized windfall profits and adjust their loan demands accordingly. The resulting rise in loan demand bids up the nominal rate by the rate of inflation. He said :

> Suppose an upward movement of prices begins. Business profits (measured in money) will rise, for profits are the difference between gross income and expense, and if both these rise, their difference will also rise. Borrowers can now afford to pay higher "money interest". If, however, only a few persons see this, the interest will not be fully adjusted and borrowers will realize an extra margin of profit after deducting interest charges. This raises an expectation of a similar profit in the future, and this expectation, acting on the demand for loans, will raise the rate of interest. If the rise is still inadequate, the process is repeated, and thus by continual trial and error the rate approaches the true adjustment. [6; pp. 75-76]

In this way, the nominal rate eventually adjusts to inflation, albeit with some delay.

Price Movements, Real Rates, and The Trade Cycle

With respect to the second use of his imperfect foresight model, Fisher attempted to show how price changes generate trade cycles by altering realized real loan rates. His theory relied on the same assumption as before, namely that business borrowers, by virtue of being entrepreneurs, possess superior foresight and

[5] What follows draws heavily from Rutledge [10].

therefore anticipate and adjust to inflation faster than do lenders. Thus, according to him, when inflation occurs, borrowers, perceiving that they will be able to pay off their loans in dollars of lower purchasing power than they borrowed, step up their loan demands. Lenders, however: perceiving no such depreciation, maintain their loan supplies unchanged. As a result, the loan demand curve shifts upward in response to inflation whereas the loan supply curve remains comparatively fixed. Assuming an upward sloping loan supply curve, the result is a rise in the nominal rate but one that is insufficient to compensate for inflation, which means of course that the real loan rate falls. This realized fall in the real cost of borrowing manifests itself in the form of a windfall rise in borrower profits. Assuming borrowers predict future profits extrapolatively from realized past profits and make their investment decisions accordingly, the high realized profits will stimulate real investment and generate a business boom. Conversely, when deflation occurs, loan demands fall relatively to loan supplies. This causes nominal rates to fall but not sufficiently to offset the deflation. The resulting rise in the real cost of borrowing lowers profits and generates expectations of more of the same, thereby discouraging investment and depressing trade.

In short, inequality of expectations rather than imperfection of expectations constitutes the key to Fisher's cycle model. Only the former, he says, produce the disproportionate shifts in loan demand and supply schedules that affect loan volume and economic, activity. By contrast, imperfect (but equal) expectations produce insufficient but identical adjustments of loan demand and supply that affect nothing but the real rate and distributive shares. In his words:

> We see, therefore, that while *imperfection* of, foresight transfers wealth from creditor to debtor or the reverse, inequality of foresight produces over-investment during rising prices and relative stagnation during falling prices. [6; p. 78]

In so stating, he provided an explicit analytical model consistent with Marshall's conjecture that the trade cycle largely arises from "variations in the real rate of interest which are caused by changes in the purchasing power of money." [8; p. 628] He also showed how changes in nominal magnitudes can have temporary real effects.

Summary and Conclusions

This article has traced the development of the real/nominal interest rate relationship in pre-20th century monetary thought. The article shows that neither the relationship itself nor the analysis underlying it are of recent origin. On the contrary, the article documents (1) that several 18th and 19th century economists stated the relationship, (2) that at least some of them fully understood its implications for interest rate adjustment and neutrality, and (3) that they attempted to specify the mechanism or process through which an inflation premium gets embodied in market rates. From these findings at least four conclusions emerge.

1. The real/nominal rate distinction is of 18th rather than 20th century vintage.

2. Irving Fisher, now generally regarded as the father of real/nominal interest rate analysis, originated none of the concepts now bearing his name. Neither the so-called ***Fisher relationship*** (according to which the nominal rate equals the real rate plus expected inflation), nor the ***Fisher effect*** (according to which the nominal rate fully adjusts for inflation leaving the real rate intact), nor the ***Fisher neutrality proposition*** (according to which equilibrium nominal rate adjustments entail no real effects) originated with him. Rather they long predate him, having been enunciated by earlier generations of writers. Nevertheless, Fisher gave those concepts their classic exposition. For that reason his work is best regarded as the culmination rather than the origin of classical and neoclassical analysis of the real/nominal rate relationship.

3. Except for Douglass and Mill, all the writers surveyed above recognized the distinction between complete and incomplete adjustment of the nominal rate to inflation. The former they identified with the perfect foresight, constant realized real rate model and the latter with an imperfect foresight, lagged adjustment model. That is, they argued that while the nominal rate would fully adjust for inflation in steady state equilibrium, it would not do so instantaneously. During a temporary transition period it would exhibit lagged adjustment thereby producing deviations from equilibrium of the realized real rate. This was on the grounds that, because expectations are formed extrapolatively, changes in inflation are inadequately foreseen such that expected inflation lags behind actual inflation resulting in incomplete adjustment of the nominal rate.

4. Early writers stressed that these incomplete nominal rate movements would, by altering realized real rates, affect the distribution of income between borrowers and lenders. To these distributional effects Marshall and Fisher added the notions of differential expectations and unequal shifts in loan demand and supply curves to demonstrate how incomplete nominal rate adjustment could also affect real output and employment. Thus, although the early formulators of the real/nominal rate analysis postulated perfect foresight, complete adjustment, and nominal rate neutrality as necessary condi-

tions of steady state equilibrium, they did not assume that those conditions would hold continuously. That is, they did not adhere to the view that the nominal rate always adjusts fully and instantaneously to inflation so as to leave all real magnitudes-including distributive shares and real output-undisturbed.

In reaching these conclusions, they established most of the elements of modern real/nominal rate analysis. The main element missing from their analysis was the notion that people form expectations of future profits and inflation not so much from observed past values of those variables as from informed predictions of future events-e.g., prospective monetary growth-influencing them. Modern analysts have also abandoned the Marshall-Fisher doctrine of differential expectations. Except for these elements, however, the earlier analysis was much the same as today's.

References

1. Clark, John B. "The Gold Standard of Currency in the Light of Recent Theory." *Political Science Quarterly,* 10 (September 1895), 389-403.
2. de Haas, Jacob A. "A Third Element in the Rate of Interest." ***Journal of the Royal Statistical Society,*** Series A, 52 (March 1889), 99-116.
3. Dorfman, Joseph. ***The Economic Mind in*** American ***Civilization 1606-1865.*** Vols. l-2. New York: Augustus M. Kelley, 1966.
4. Douglass, William. "An Essay Concerning Silver and Paper Currency" (1738). In Colonial Currency Reprints ***1682-1751.*** Vol. 3. Edited by Andrew M. Davis. New York: Augustus M. Kelley, 1964.
5. ——— "A Discourse Concerning the Currencies of The 'British Plantations in America" (1740). In ***Colonial Currency Reprints 1682-1751.*** Vol. 3. Edited by Andrew M. Davis. New York: Augustus M. Kelley, 1964.
6. Fisher, Irving. ***Appreciation and Interest.*** New York : 1896.
7. ——— ***The*** Rate ***of Interest. New*** York: Macmillan, 1907.
8. Marshall, Alfred. ***Principles of Economics.*** London : Macmillan, 1890.
9. Mill, John Stuart. ***Principles of Political Economy.*** 6th ed. London: Longmans, Green and Co., 1865.
10. Rutledge, John. "Irving Fisher and Autogressive Expectations." ***American Economic Review, 67*** (February 1977), 200-5.
11. Summers, Lawrence H. "The Non-Adjustment of Nominal Interest Rates: A Study of the Fisher Effect." National Bureau of Economic Research (NBER) Working Paper Series, no. 836, January 1982.
12. Thornton, Henry. Two Speeches of Henry Thornton on the Bullion Report, May 1811. Reprinted as Appendix III to his ***An Enquiry Into the Nature*** and ***Effects of the Paper Credit of Great Britain (1802).*** Edited with an Introduction by F. A. von Hayek. New York: Rinehart and Company, Inc., 1939

THE RELATIONSHIP BETWEEN MONEY AND EXPENDITURE IN 1982

Robert L. Hetzel

Introduction

The behavior of the money supply and the relationship between the money supply and the public's expenditure have recently been the subject of considerable interest. The interest in the behavior of the money supply is explained below by a discussion of the relationship between money growth and inflation. Other things equal, an increase in money growth will cause an increase in the inflation rate. The monetary acceleration that began in 1982 can then in time be expected to reverse the post-1979 trend toward a lower inflation rate. The inflationary implications of the behavior of the money supply must, however, be assessed in relation to the behavior of the public's demand for money. It has been argued that the relationship between the money supply and the public's expenditure in 1982 indicates that the public's demand for, money increased in 1982 by an abnormal extent. The high rate of growth of money that began in 1982 does not, therefore, presage higher inflation. This argument is appraised in the body of the paper through an examination of whether the recent behavior of expenditure and money is consistent with their past behavior.

Money Growth and Inflation

A standard quantity theory explanation of inflation as a monetary phenomenon is offered in this section. It is assumed that the actions of the monetary authority determine the nominal quantity of money (the number of dollars in circulation). The public, however, cares about the real quantity of money it holds (the quantity of goods and services that the nominal quantity of money will purchase). The real quantity of money can be expressed as the ratio of the nominal quantity of money to the nominal (current dollar) expenditure of the public. The public's desire to control this ratio, given the determination of the nominal quantity of money by the monetary authority, causes nominal money to be stably related to nominal expenditure.

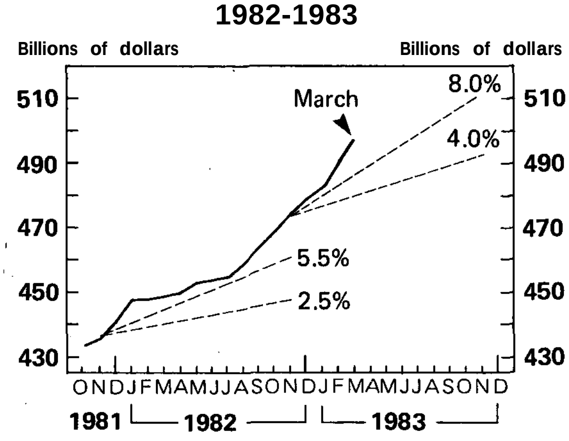
The nominal quantity of money does not affect tastes and preferences or natural resource endowments and technology. Ultimately, therefore, real expenditure is determined independently of the nominal quantity of money. Given that the nominal quantity of money determines nominal expenditure and that real expenditure is determined independently of nominal money, the nominal quantity of money determines the price level. The ratio of current dollar expenditure (determined by money) to constant dollar expenditure (determined independently of money) is a definition of the price level. The above relationships may require many years to work out, but ultimately the level of the nominal quantity of money determines the price level.

Recent Behavior of Money

The behavior of money (Ml,) in 1982 and early 1983 is displayed in Chart 1. The cones show the four quarter target ranges set by the Federal Reserve System for 1982 and 1983. The rapid growth of Ml

Chart 1

MI GROWTH COMPARED TO TARGET RANGES 1982-1983



over this period has been watched by individuals contracting to receive nominal dollars in the future. In itself, the rapid growth of M1 suggests a future reversal of the post-1979 trend toward lower inflation. This result, however, need not pertain if an unusual increase in the public's demand for real M1 balances has occurred. In the succeeding section, evidence is examined bearing on the possibility that the ratio of M1 to expenditure desired by the public has increased.

Methodology

The ratio of M1 to expenditure did rise in 1982 relative to its trend. This rise suggests an unusual increase in the demand for real M1 balances desired by the public. The ratio of contemporaneous money to contemporaneous expenditure is, however, a misleading indicator of the public's demand for real money balances. Changes in money do not affect expenditure immediately, but rather with a long lag, the effect of which is distributed over time. In order to assess the stability of the relationship between money and expenditure, it is necessary to consider the stability of the distributed lag relationship between them. This consideration motivates the approach used below. A historical distributed-lag relationship between expenditure and money is calculated. The ability of the historical relationship to explain the recent behavior of expenditure is then examined.

Regression Analysis

The results of regressing expenditure on a distributed lag of past values of money are presented in this section. M1 is included as a right hand variable with six lagged terms. The contemporaneous and lag one term for M1 are omitted in an attempt to reduce the correlation that does not reflect causation running from M1 to expenditure, but rather reflects, reverse or simultaneous causation.[1] Inclusion of M1 beginning with a two quarter lag corresponds to Milton Friedman's estimate that two to three quarters elapse before a change in money affects expenditure [3, p. 22].[2]

Experimentation with alternative forms of regression equations indicates that the relationship between money and expenditure appears more clearly when an interest rate is included as a right hand variable. The interest rate is included with six contemporaneous and lagged terms. The estimated coefficient on the contemporaneous term is positive. The positive sign suggests the common influence on expenditure and the interest rate of nonmonetary forces. The sum of the estimated coefficients on the contemporaneous and lagged terms of the interest rate variable is negative, however. The negative sign on the sum of the estimated coefficients suggests that the predominant role of the interest rate term is to capture the effect of shifts in the demand for money.

The regression equation described above is not a reduced form derived from a model. Its justification is that it appears to offer a useful way of organizing a review of the data pertaining to the relationship between money and expenditure. It is offered as a superior alternative to the common practice of looking at the behavior of the ratio of contemporaneous expenditure to contemporaneous money, the contemporaneous velocity of money.

"Shift-adjusted" M1 is used. This series, constructed by the staff of the Board of Governors, is the current M1 series adjusted to account for the shifts into ATS and NOW accounts from nonmone-

[1] In a regression of quarterly percentage growth rates of GNP on a constant and a simple distributed lag of contemporaneous and past values of quarterly percentage growth rates of M1, the sum of the estimated coefficients on M1 for the three quarters of lag 0 through lag 2 is 1.22. This value is implausibly large if it is considered to reflect the causal effect of money on expenditure.

[2] Including more lagged terms does not reduce appreciably the sum of the squared residuals of the regression equations estimated here. The true distributed lag relationship between money and expenditure is summarized only approximately by the estimated relationship for many reasons. The true lags, for example, are longer than the ones shown here. Consider, say, an increase in money that causes an initial rise in real expenditure. This rise, in time, will be reversed. At this point, the fall in real expenditure appears to offset the concurrent rise in the price level, so the impact of money on nominal expenditure is negligible. Beyond this point, however, the initial increase in money will cause the price level, and thus nominal expenditure, to rise. The data appear to be too noisy to allow estimation of distributed lags long enough to describe the full working out of a change of money on the price level. (The author estimates that about four years are required for the price level to reflect fully a change in money [5].)

Another reason why the causal relationship running from money to expenditure is obscured is that the estimation does not allow for any possible consistent pattern in the way in which the monetary authority varies money in response to changes in nominal expenditure. The estimation procedure also obscures variation over time in the nature of the lag relating money to expenditure. For example, anticipated changes in money might affect nominal expenditure more rapidly than unanticipated changes.

tary assets that occurred at the time of the introduction of these accounts in 1981.[3]

Two left hand variables are considered, final sales to domestic purchasers and gross national product. As implied by the quantity theory of money discussed above, individuals vary their rate of expenditure in response to discrepancies between their actual and desired holdings of cash balances. The immediate impact of these variations in expenditure is captured by final sales to domestic purchasers. GNP is a measure of production rather than spending. (GNP minus the change in business inventories equals final sales. Final sales less net exports equals final sales to domestic purchasers.) The expenditure and M1 series are expressed in per capita form, although this form does not affect the results.

Table I displays the results of regressing annualized percentage changes in final sales to domestic purchasers on a constant and on annualized percentage changes in the commercial paper rate and M1, employing the simple distributed lag relationships discussed above. The regression employing GNP as the left hand variable is very similar, apart from a higher standard error for the estimated residuals, which reflects the volatility of inventories and net exports. The magnitude of the sum of the estimated coefficients on the interest rate term is small. The individual coefficients considered collectively are, however, statistically significant. The coefficients on

Table I

REGRESSION OF FINAL SALES TO DOMESTIC PURCHASERS ON AN INTEREST RATE AND MONEY, 1952Q1 TO 1982Q4

Lag	Constant		R		M	
0	3.41	(.45)	.021	(.0067)	—	
—1			—.011	(.0081)	—	
—2			—.014	(.0090)	.33	(.13)
—3			—.007	(.0097)	.02	(.13)
—4			—.021	(.0091)	.33	(.15)
—5			.002	(.0081)	.26	(.15)
—6					.04	(.15)
—7					—.02	(.12)
Sum			—.030	(.013)	.96	(.13)

NOB = 124 NOV = 13 RSQ = .47 SER = 3.1 DW = 1.8

Notes: Standard errors ore in parentheses. NOB is number of observations and NOV number of variables estimated. R is the 4-6 month commercial paper rats and M is per capita shift-adjusted M1 (see footnote 4). Observations represent annualized percentage changer. Simple distributed lags are used.

M1 considered collectively are also very significant statistically.[4]

The estimated residuals for the regression equation displayed in Table I, plotted in Chart 2, measure the difference between the actual and predicted quarterly percentage growth rates of final sales to domestic purchasers. An examination of the estimated residuals indicates that they do not, in general, fall randomly. The relative weakness of growth rates of nominal expenditure shown in interval 1, 1953Q2 to 1954Q2, derives from an autonomous decline in the inflation rate following an earlier autonomous rise at the onset of the Korean War. (When the war began, consumers ran their cash balances down in anticipation of shortages of consumer durables. When the shortages did not materialize, they returned their holdings of cash balances to normal levels. This behavior was reflected in the behavior of expenditure and inflation,) In interval 2, the residuals appear to fall randomly.

Beginning in the early 1960s the estimated residuals display a wave-like appearance. Long periods during which the actual growth rate of expenditure persistently exceeds the predicted growth rate by a moderate amount are followed by offsetting periods

[3] The Board staff estimated that in 1980 the growth rate of M1, defined to include NOW and ATS accounts, should be lowered by about half a percentage point in order to account for transfers into these new accounts from nonmonetary sources. (This figure is the lower bound of the range given in the notes to the table "Growth Ranges and Actual Monetary Growth" in the Appendix contained in [6, p. 100]. See also [6, pp. 69 and 72] and the references in [2, p. 149].) No quarterly breakdown is given for this figure, so growth of M1 in each quarter of 1980 is lowered by .125 percent in order to arrive at the shift-adjusted series. For 1980, shift-adjusted M1 is thus derived by multiplying M1 for quarters one through four, respectively, by .99875, .99750, .99625, and .995. For 1981, the ratio of the Board staff's shift-adjusted M1 (shift-adjusted M1-B) to M1 (M1-B) is calculated (both series use the 1981 seasonal adjustment factors). These ratios for quarters one through four are respectively, .986, .978, .976, and .973. For 1981, shift-adjusted M1 is thus derived by multiplying M1 by .995 times the appropriate preceding ratio. The factor multiplying the 1981 Q4 observation is used with the M1 observations in 1982. In 1982, shift-adjusted M1 is about three percent below M1, (The Board staff's shift-adjusted M1 series for 1981 is contained in [1].)

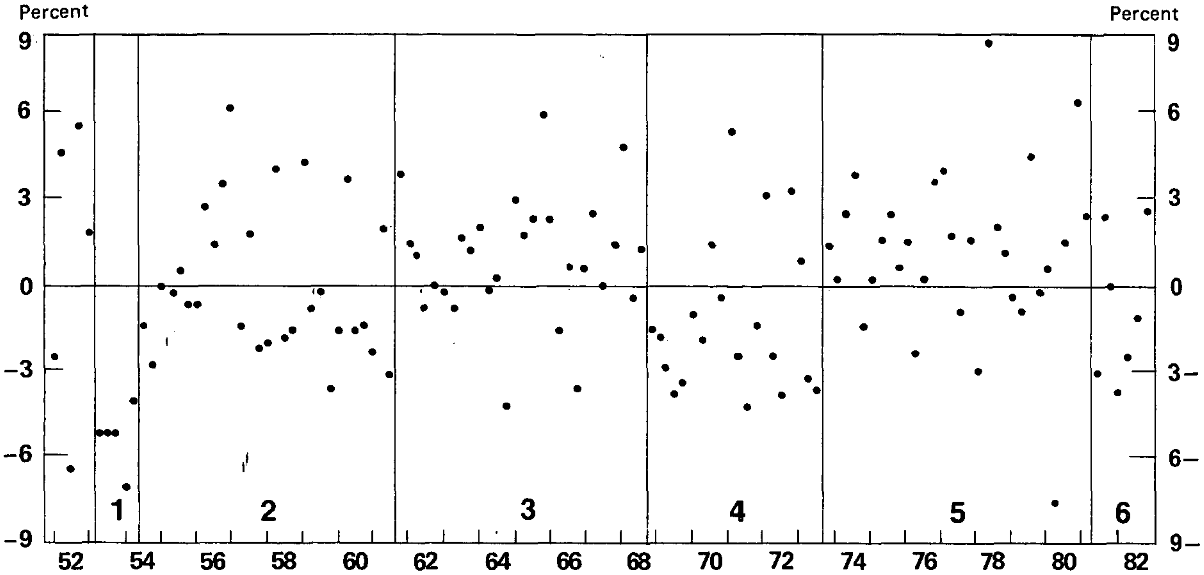
A discontinuity arises in the M1 series in 1959 due to the exclusion at this time of demand deposits of foreign commercial banks and official institutions. Post-1959 M1 was spliced with pre-1959 M1 by multiplying pre-1959 M1 by the ratio of the two series in 1959 excluding and including these, deposits (.987).

[4] The null hypothesis that the coefficients on the interest rate term are all zero is rejected by an F-test at the .99999 confidence level. The null hypothesis that the coefficients on the money term are all zero is rejected by an F-test at the .9999 confidence level. An examination of the estimated residuals of the regression equations used in calculating the statistics for these F-tests shows them to be approximately white noise. (The calculations referred to in this footnote are for the regression shown in Table II. which differs from the one in Table I by the addition of 'three dummies to capture intercept shifts.)

Chart 2

ERRORS IN PREDICTING EXPENDITURE

Residuals from a Regression of Final Sales to Domestic Purchasers per Capita on M1 per Capita and the Paper Rate



Note: Tick marks indicate first quarter of year.

during which these positive prediction errors are offset by negative errors. In interval 3, 1961Q4 to 1968Q3, the residuals are generally positive. Chart 3, which displays quarterly growth rates of M1, shows that this interval is characterized by a monetary acceleration. Examination of interval 3 thus suggests an overshooting of expenditure in response to monetary acceleration; the rate of growth of money rose, while the rate of growth of nominal expenditure rose even more. (Friedman and Schwartz [4, p. 68] discuss one possible cause of such overshooting.) The strength in the growth of nominal expenditure appeared to a significant extent in the growth of real expenditure, rather than in the inflation rate in this interval. In interval 4, 1968Q4 to 1973Q3, the estimated residuals are generally negative. The prior overshooting of expenditure then was followed in this interval by an offsetting period of undershooting.

In interval 5, 1973Q4 to 1981Q1, the residuals are generally positive. This underprediction of nominal expenditure may have been caused by the positive impact on prices of the rise in the price of oil that occurred near the beginning and end of this interval. Interval 5 is also characterized by a monetary acceleration. The positive residuals beginning in 1977 may indicate an overshooting in expenditure as a consequence of this monetary acceleration. In interval 6, 1981Q2 to 1982Q4, the estimated residuals are generally negative. Again, the prior interval of overshooting in expenditure is followed by an offsetting period of undershooting.

The regression shown in Table II employs intercept-shift dummies in order to capture the effect of the overshooting and subsequent undershooting described above. DO, the post-Korean War dummy, is set equal to one for interval 1 and zero elsewhere. D1, the "overshooting" dummy, is set equal to one for intervals 3 and 5 and zero elsewhere. D2, the "undershooting" dummy, is set equal to one for intervals 4 and 6. Otherwise, the specification of the regression equation in Table II is identical to that of

Table II

REGRESSION OF FINAL SALES TO DOMESTIC PURCHASERS ON AN INTEREST RATE AND MONEY, 1952Q1 TO 1982Q4

$$SAL = 3.52 - 5.86\,D0 + 1.12\,D1 - 1.13\,D2 - .039\,R + .93\,M + \hat{u}$$
$$(.48) \quad (1.4) \quad (.83) \quad (1.05) \quad (.012) \quad (.17)$$

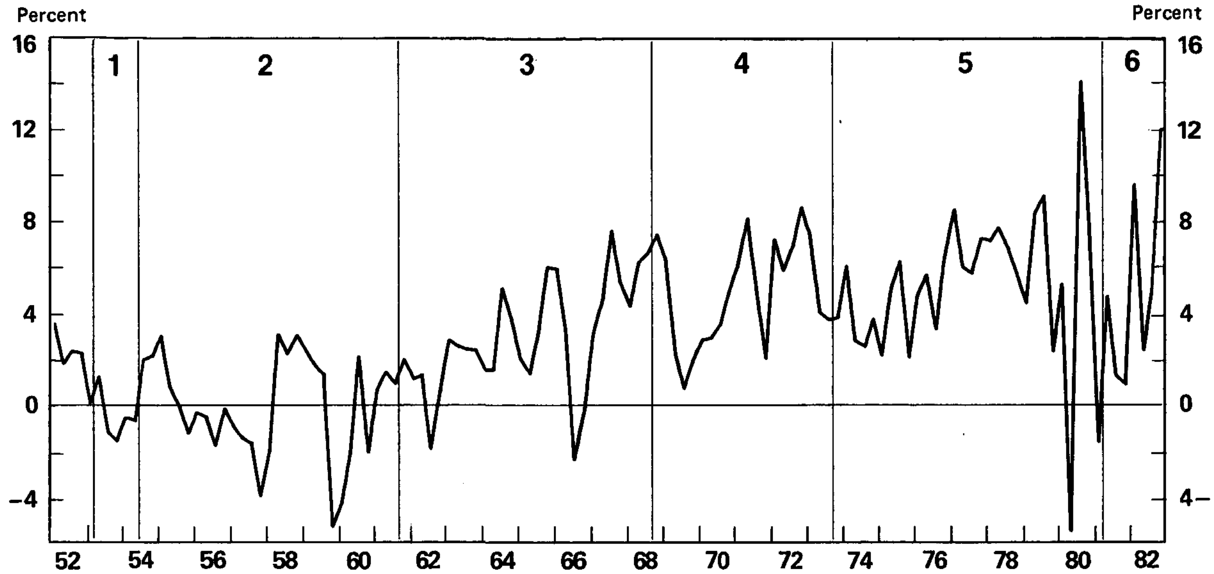
NOB = 124 NOV = 16 RSQ = .60 SER = 2.8 DW = 2.2

Notes: SAL is final sales to domestic purchasers per capita. Coefficients on the R and M terms are the sum of the coefficients estimated with the simple distributed lags shown in Table I. D0 is one from 1953Q2 to 1954Q2 and zero elsewhere. D1 is one from 1961Q4 to 1968Q3 and 1973Q4 to 1981Q1 and zero elsewhere. D2 is one from 1968Q4 to 1973Q3 and 1981Q2 to 1982Q4 and zero elsewhere. Otherwise, see *notes to Table I.*

Chart 3

M1 GROWTH

Quarterly Annualized Percentage Growth Rates
Continuously Compounded in Per Capita M1



Note: Tick marks indicate first quarter of year.

Table I. (Again, the use of GNP as the left hand variable results in a regression equation similar to the one shown in Table II.)

The. presence of the intercept-shift terms, which capture successive periods of underprediction and overprediction of expenditure, indicates that the relationship between money and nominal expenditure may require a period of time as long as a decade in order to work out fully. The importance of this phenomenon of overshooting should not be exaggerated, however. The magnitude of the estimated coefficients on these intercept-shift terms is about one percentage point. This number is small relative to the magnitude of the variation in percentage growth rates in money and in nominal expenditure. The variation in quarterly growth rates of nominal expenditure is significantly affected by nonmonetary forces, as indicated by the size of the standard error of the estimated regression residuals shown in Table II, 2.8 percent. This variation in quarterly growth rates is perhaps also affected by shifts in the demand for money, as suggested by the negative sign on the estimated sum of coefficients on the interest rate variable. The magnitude of the estimated sum of coefficients on the money variable, about one, is, nevertheless, consistent with the quantity theory proposition that, over long periods of time, the major determinant of nominal expenditure is the money supply.

Simulation

Results of predicting final sales to domestic purchasers and GNP out of sample are presented in this section. Regression equations, specified as shown in Table II, are estimated over the interval 1952Q1 to 1973Q3. The end date was chosen in order to incorporate a complete cycle of overshooting and undershooting in expenditure. For purposes of simulation, it was considered desirable that a one percentage point change in the rate of growth of money generate a one percentage point change in the rate of growth of expenditure. For this reason, the estimated coefficients on M1 are constrained to sum to one. The estimation results are shown in Tables III and IV.

The results of predicting final sales to domestic purchasers and GNP in the out-of-sample period are shown in Charts 4 and 5, respectively. The percentage error in the level of the actual, relative to the predicted, series is shown. Because the phenomenon of overshooting is not accounted for by intercept-shift dummies, the level of the actual series rises, in each

Table III

REGRESSION OF FINAL SALES TO DOMESTIC PURCHASERS ON AN INTEREST RATE AND MONEY, 1952Q1 TO 1973Q3

Constant		D0		D1		D2	
3.56	(.45)	−6.26	(1.28)	.86	(.66)	−1.50	(.72)

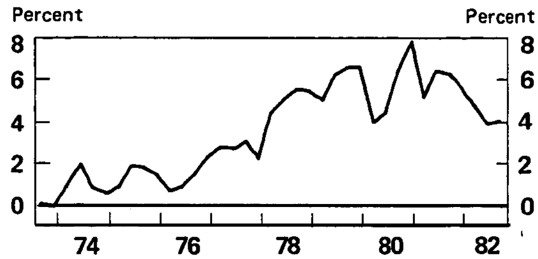
Lag	R		M	
0	.010	(.007)	—	
−1	−.011	(.008)	—	
−2	−.004	(.010)	.21	(.17)
−3	−.013	(.010)	.20	(.19)
−4	−.022	(.009)	.05	(.20)
−5	−.006	(.008)	.34	(.20)
−6			−.01	(.19)
−7			.21	(.15)
Sum	−.046		1.0	

NOB = 87 NOV = 15 RSQ = .60 SER = 2.5 DW = 2.2

Notes: See Tables I and II.

Chart 4

ERRORS IN PREDICTING FINAL SALES TO DOMESTIC PURCHASERS



Note: Percentage error in the level of actual, relative to predicted, final sales to domestic purchasers 1973Q4 to 1982Q4. Predictions from regression equation estimated from 1952Q1 to 1973Q3.

case, relative to the level of the predicted series through 1981Q1, where the underprediction of the actual series is about eight percent. This underprediction then lessens during the subsequent period of undershooting of expenditure until by 1982Q4 the level of final sales to domestic purchasers and GNP are underpredicted by 4.1 and 2.8 percent, respectively.

Money Demand in 1982

M1 has grown from its average value for the four weeks ending August 25, 1982, to its average value for the four weeks ending May 25, 1983, at an annualized rate of 14.4 percent. It has been asserted that the observed relationship between M1 and expenditure in 1982 indicates a rightward shift in the public's demand for M1. Consequently, it is concluded, the current high rate of growth of M1 will not be inflationary. This assertion can be evaluated with the aid of the simulations reported in the previous section,

First, a benchmark is required as to how well money can be expected to predict expenditure over a four-quarter period. This benchmark was derived as follows. The regression equation in Table I, with final sales to domestic purchasers as the left hand variable, was estimated over the interval 1952Q1 to 1981Q4. This estimation produces predictions of percentage growth rates of expenditure over the four quarter intervals ending in the fourth quarter of each year from 1952 through 1981. Errors in predicting

Table IV

REGRESSION OF GNP ON AN INTEREST RATE AND MONEY, 1952Q1 TO 1973Q3

Constant		D0		D1		D2	
3.41	(.55)	−6.42	(1.56)	.86	(.80)	−1.31	(.88)

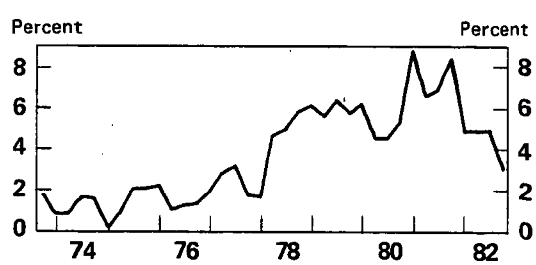
Lag	R		M	
0	.034	(.008)	—	
−1	−.035	(.010)	—	
−2	−.001	(.012)	.20	(.21)
−3	−.013	(.012)	.20	(.24)
−4	−.037	(.011)	.33	(.24)
−5	.008	(.010)	.05	(.24)
−6			.17	(.24)
−7			.05	(.18)
Sum	−.044		1.0	

NOB = 87 NOV = 15 RSQ = .61 SER = 3.1 DW = 1.9

Notes: See Tables I and II.

Chart 5

ERRORS IN PREDICTING GNP



Note: Percentage error in the level of actual, relative to predicted, GNP 1973Q4 to 1982Q4. Predictions from regression equation estimated from 1952Q1 to 1973Q3.

calendar year percentage growth rates of expenditure are then calculated as the actual percentage growth rates of expenditure over the four quarter intervals ending in the fourth quarter of each year minus the corresponding predicted growth rates. Finally, the root-mean-squared value of these yearly errors is calculated. This number measures how well in an average sense money can be expected to predict expenditure over a calendar year. Its value is 1.5 percentage points.

The regression in Table III, estimated from 1952 to 1973, was used to predict the percentage growth rate in 1982 of final sales to domestic purchasers. (This prediction corresponds to the simulation reported in Chart 4.) The predicted growth rate was 7.0 percent, compared to an actual growth rate of 5.0 percent, continuously compounded, an error of two percentage points.[5] The magnitude of this error, 2.0 percentage points, is only slightly larger than the value of the benchmark error, 1.5 percentage points. It is concluded that expenditure in 1982 is predicted about as well as in other calendar years. The evidence necessary to support the hypothesis that a significant rightward shift in the public's demand for M1 occurred in 1982, that is, the existence of an unusually large overprediction of the growth rate of expenditure, appears to be lacking.

The percentage growth rate of GNP in 1982, measured from fourth quarter to fourth quarter, was 2.5 percentage points less than the corresponding growth rate of final sales to domestic purchasers. The smaller growth in output than in final sales to domestic purchasers derives from the adverse movements in the change in business inventories series primarily, and in the net exports series secondarily. These last two series are highly volatile and their own movements cancel out over time. Their behavior is little susceptible to control by monetary policy.

It is concluded that the relationship between money and the public's expenditure in 1982, while not tight, is consistent with the relationship that existed prior to 1982. The assertion that a rightward shift occurred in the public's M1 demand function generally derives from the observation that the ratio of contemporaneous M1 to contemporaneous output (GNP) was high relative to trend in 1982. This ratio offers misleading evidence for three reasons.

First, it fails to take account of the lag with which money acts on expenditure. The simulation results of the previous section indicate that the major factor in the decline in the growth rate of expenditure in 1982 was the monetary deceleration of 1981. (From 1980 to 1981 the percentage growth rate of shift-adjusted M1, continuously compounded and measured from fourth quarter to fourth quarter, fell from 6.5 to 2.3 percent.) The sharp deceleration of M1 in 1981 depressed expenditure, and thus output, in 1982. The denominator of the ratio of contemporaneous M1 to contemporaneous output therefore fell in 1982 relative to trend. The sharp acceleration in 1982 of M1 raised the numerator of this ratio relative to trend. Consequently, the high value of the ratio of contemporaneous M1 to contemporaneous output in 1982 represents, to a significant degree, a statistical artifact.

Second, converting nominal M1 to a real M1 series by use of the ratio of M1 to GNP introduces noise into the real M1 series because of the volatility in changes in business inventories and net exports. The ratio of M1 to final sales to domestic purchasers does not possess this source of noise. In particular, in 1982, sharp declines in the change in business inventories and net exports series caused growth of GNP to be weak relative to growth of final sales to domestic purchasers.

Third, in accounting for the lagged effect of M1 on expenditure, it is necessary to account for the introduction of ATS and NOW accounts in 1980 and 1981. Shifts of funds from nontransactions sources like time deposits into these new accounts distorted the meaning of M1 by causing actual growth of M1 to appear more expansionary than it was in reality. It is for this reason that the Federal Reserve System targeted the shift-adjusted M1 series used in this paper.

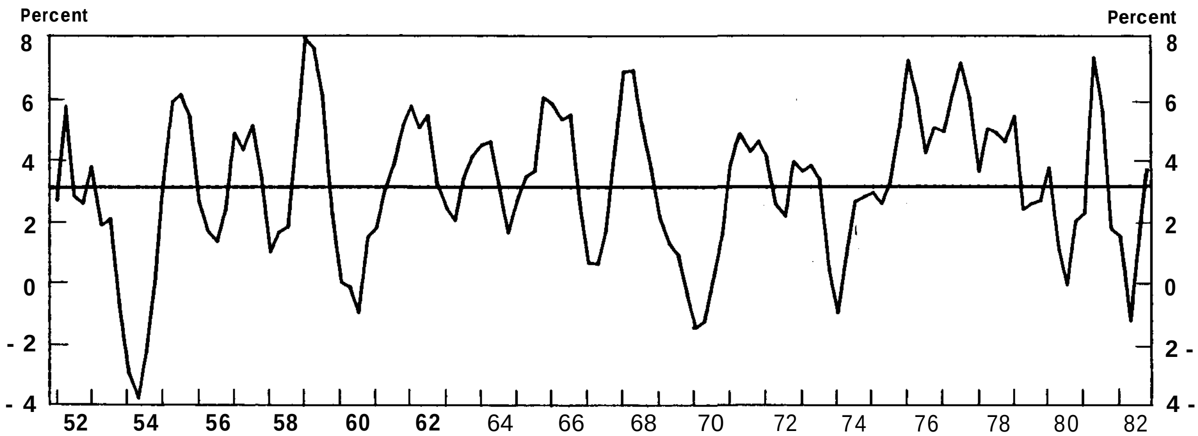
The importance of these factors is illustrated in Chart 6. Quarterly observations of four-quarter percentage changes in velocity are displayed in Chart 6. Velocity is defined as the ratio of contemporaneous final sales to domestic purchasers to M1 (shift-adjusted) four quarters in the past. The expenditure series is divided by M1 lagged four quarters because four quarters is the approximate mean lag associated with the distributed lag of expenditure on M1 estimated in the regression shown in Table II. The solid line shown in Chart 6 is the average value of quarterly percentage changes in the velocity series from 1952Q1 to 1982Q4. An examination of the velocity series shown in Chart 6 does not suggest that the behavior of velocity in 1982 was unusual.

[5] The behavior of the interest rate is such that it exerts practically no net effect on predicted expenditure in 1982.

Chart 6

THE BEHAVIOR OF VELOCITY
1952Q1 To 1982Q4

Quarterly Observations of Four-Quarter Percentage Changes in Velocity. Velocity is the Ratio of Contemporaneous Final Sales to Domestic Purchasers to M1 Shift Adjusted Four Quarters in the Past.



Note: Tick marks indicate first quarter of year.

Conclusions

The simulation results indicate that the reduction in the growth rate of expenditure in 1982 was caused primarily by the reduction in the growth rate of M1 in 1981. The reduction in the growth rate of M1 from 1980 to 1981 (4.2 percentage points using the shift-adjusted series) has been offset by the increase in the growth rate of M1 from 1981 to 1982 (5.9 percentage points using the shift-adjusted series). Given that this offset has already, occurred, further stimulus of expenditure does not require high rates of growth of M1 in 1983.

The evidence examined here does not support the assertion that the public's M1 demand function shifted rightward in 1982. This evidence does not take account of the effect of the introduction of the new deposit accounts in late 1982 and early 1983. The distorting effect on M1 associated with the introduction of these new accounts, however, appears to be small.[6]

M1 affects expenditure with a long lag, and it affects inflation with an even longer lag. Also, the relationship between M1 and expenditure over one, or even four, quarter periods is loose. For these reasons, it is tempting to ignore its behavior. The evidence examined in this paper, however, reveals no reason to believe that high rates of growth of M1 will not be inflationary. A key prediction of the regression analysis in this paper is that the public's expenditure will increase dramatically in the third quarter of 1983. If this increase does not occur, it can be concluded that the public's M1 demand function did shift rightward in 1982. If the increase does occur, then it can be concluded that the public's M1 demand function has remained stable and that M1 remains a good predictor of the inflation rate.

[6] Money market deposit accounts (MMDAs) were introduced in December 1982 and Super NOWs in January 1983. MMDAs can be used to a limited extent to effect transactions. To the extent that the growth of MMDAs has come out of transactions accounts in M1, this growth causes the actual growth of M1 to understate the effect of monetary policy on expenditure. Super NOWs, on the other hand, pay a market rate of interest. To the extent that the growth of Super NOWs has come out of nontransactions accounts, this growth causes the actual growth of M1 to overstate the effect of monetary policy on expenditure.

The growth of MMDAs increases the level of a shift; adjusted M1 series relative to the actual series. Given the significant amount of MMDAs now outstanding ($360.3 billion on May 25, 1983), and the meager amount of Super NOWs ($30.3 billion on May 25, 1983), it seems unlikely that actual M1 growth is understating the impact of monetary policy. Many observers believe that the biases currently distorting the meaning of M1 are washing out, so that the introduction of the new deposit accounts has not significantly affected the usefulness of actual M1 as an indicator of the stance of monetary policy.

References

1. Bennett, Barbara A. "'Shift-Adjustments' to the Monetary Aggregates." *Economic Review*, Federal Reserve Bank of San Francisco (Spring 1982).

2. Board of Governors of the Federal Reserve System. *67th Annual Report.* "Record of Policy Actions for Meeting Held on October 21, 1980." Washington, 1980.

3. Friedman, Milton. "The Counter-Revolution in Monetary Theory." Institute of, Economic Affairs Occasional Paper 33. Great Britain, 1970.

4. Friedman, Milton and Anna J. Schwartz. Monetary *Trends in the United States and the United Kingdom*. Chicago: University of Chicago Press, 1982.

5. Hetzel, Robert L. "The Behavior of the Demand for Money in the 1960s and 1970s." Unpublished paper in process, Federal Reserve Bank of Richmond, April 1983.

6. Monetary Policy Report to Congress. In *Federal Reserve's First Monetary Policy Report for 1981*. U. S. Congress. Senate. Committee on Banking, Housing, and Urban Affairs. Hearings. 97 Cong. 1 Sess. Washington : Government Printing Office, Feb. 25 and March 4, 1981.

7. Simpson, Thomas D. and John R. Williams. "Recent Revisions in the Money Stock." Federal *Reserve Bulletin*, 67 (July 1981), 539-542.