Economic Review

The Federal Reserve Discount Mechanism

Are Exchange Rates Determinate?

Surveys of Consumer Attitudes and Spending on Durable Goods

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Contents

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The Federal Reserve Discount Mechanism

by Lorraine E. Duro

Introduction

Two recent developments have significantly altered the financial environment of this nation's depository institutions. On October 6, 1979, the Federal Open Market Committee (FOMC) initiated a change in its operating procedures to place primary emphasis on the control of bank reserves. The new procedure permits greater fluctuations in the federal funds rate, as the System provides the requisite reserves to achieve monetary-policy objectives. On March 31, 1980, President Carter signed the Depository Institutions Deregulation and Monetary Control Act of 1980. This law requires all depository institutions to maintain reserves against transaction accounts or nonpersonal time deposits at Federal Reserve Banks and provides that any depository institution that holds these accounts is entitled to the same discount and borrowing privileges as member banks.

These developments have led to a renewed interest in the methods by which the Federal Reserve System provides reserves. While the buying and selling of securities through open-market operations is a known and accepted procedure, the lending of reserves through the discount mechanism of the Federal Reserve Banks is less familiar. There are questions both as to why the mechanism exists and how the mechanism functions.

Since its institution as the nation's central bank in 1913, the Federal Reserve System has been a source of credit for the commercial banking system. However, changes in commercial practices, economic conditions, and System statutory responsibilities and implementation techniques have altered the terms and conditions under which commercial banks may borrow from their Reserve Banks. The most recent change, which affects all depository institutions, is but one of many that has altered the role of the discount mechanism. It is a logical step to facilitate one of the most important functions of a central bank, namely, being *the lender of last resort.*

The purpose of this article is to examine the evolution of the discount mechanism in response to varying circumstances. The initial problem for the System's discount operation was the difficulty of determining the *quality* of the commercial paper that would be purchased (discounted) or would serve as collateral for the lending activities of the District Banks and the monitoring of the use of the proceeds. Since the Treasury-Federal Reserve Accord of 1951, the Reserve Banks have had recurring problems with the difficulty of controlling the *quantity* of lending to individual banks at particular times when the discount rate is not used as a rationing device. A brief review of the Federal Reserve Act, relevant statutory changes, and regulatory interpretations will explain the evolving role of the discount mechanism.

The Founding Doctrine of the Federal Reserve Act

The specifications of the original Federal Reserve Act derived from the belief that the United States had experienced frequent periods of economic distress because of the excessive expansion and contraction of credit. The original

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act was designed to eliminate financial panics and disruptive speculation by providing a means for commercial banks to replenish or increase their lending power to meet the needs of commerce, industry, and agriculture. The act was based on the principle known as the *real-bills doctrine* and provided that Federal Reserve credit would be based only on short-term, self-liquidating commercial paper.[1] Such paper represented the actual borrowing of business enterprises from commercial banks; that is, it presumably represented the financing of a distinct step in the productive or distributive process from producer to consumer. The issuance of Federal Reserve notes was to be secured by this self-liquidating paper. Since it was assumed that the flow of paper reflected the actual expansion and contraction of commercial and agricultural enterprises, Federal Reserve credit based on such paper was to ensure an elastic currency and adequate liquidity for commercial banks and the overall economy.

The original Federal Reserve Act imposed a number of limitations deemed to be consistent with the real-bills doctrine:[2]

- ☐ Any Federal Reserve Bank could discount notes, drafts, and bills of exchange arising out of actual commercial transactions, that is, paper issued or drawn for agricultural, industrial, or commercial purposes.

- ☐ A Federal Reserve Bank could discount bank acceptances based on the importation or exportation of goods.

- ☐ The Federal Reserve Board of Governors was given the right to determine or define the character of the paper eligible for discount. Such definition was not to include paper issued or drawn for the purpose of carrying or trading in stocks, bonds, or other investment securities, except bonds and notes of the government of the United States.

- ☐ All discounted paper was to have a maturity of not more than 90 days at the time of discount, with the single exception that agricultural paper was permitted to have a maturity of not more than six months.

- ☐ No member bank was permitted to act as the medium or agent of a nonmember bank in applying for or receiving discounts.

- ☐ Every Federal Reserve Bank was mandated to extend to each member bank such discounts, advancements, and accommodations as could be safely and reasonably made with regard for the claims and demands of other member banks.

The legislative intent was to restrict credit available for speculation in long-term securities and to prohibit Reserve Banks from providing long-term capital for member banks or their borrowing customers. This was presumed to be accomplished by the maturity limitation and commercial-transaction specifications of eligible paper. The selection of 90 days (six months for agricultural paper) was deemed sufficiently long for the proceeds to have been derived from the distinct step in the productive or distributive process. The selection of 90 days was derived from the practices of European discount banks: England, 28 days; France, 26 days; and Germany, 90 days.

The ability to discount paper at the Reserve Banks was seen as a benefit and, therefore, was restricted to member banks. A Senate debate took place on the right of a member bank to discount paper, but the vote on a compulsory discount provision was defeated. Discounting was to be a *privilege,* not a *right,* of a member bank. The discretionary lending power was perceived as necessary to permit the Reserve Banks to conduct their affairs on a sound basis and to meet their reserve requirements against Federal Reserve note issue. The act permitted the Board of Governors, under certain conditions, to require Federal Reserve Banks to rediscount paper of other Reserve Banks.

1. For a thorough discussion of the real-bills doctrine, see Howard H. Hackley, *Lending Functions of the Federal Reserve Banks: A History* (Board of Governors of the Federal Reserve System, 1973).

2. This listing reflects wording in the Federal Reserve Act of December 23, 1913, Section 13.

This provision supports the contemporary assessment that the framers of the act felt they were ensuring a mechanism to make available an elastic but limited pool of funds. The Federal Reserve System was to be the passive agent to supply funds on demand to the commercial banks within the constraint of the available pool of short-term, self-liquidating commercial and agricultural paper. A Reserve Bank, however, was not to be a passive agent of any individual member bank.

Subject to the review and determination of the Board, Reserve Banks would establish rates of discount for each class of paper in order to facilitate commerce and business. The establishment of fairly uniform discount rates by the Reserve Banks for each class of paper was expected to result in more nearly uniform interest rates on commercial paper classes throughout the United States.

Implementation Problems in the System's First Decade

Initially, few member banks used the discount privilege; most had liberal reserves based on the new act's requirements and the inflow of gold from overseas. Soon, however, the System was called upon to facilitate the financing of the nation's participation in World War I. In 1916, the Reserve Banks were given the statutory authority to make *advances* to their member banks on their promissory notes secured by paper eligible for rediscount or by the deposit or pledge of bonds or notes of the United States government for a period not exceeding 15 days. Advances on eligible paper, rather than direct purchases, were recommended as a more efficient means of accommodating the demand for credit by member banks. The System established a preferential interest rate on advances collateralized by government securities, and Federal Reserve lending grew rapidly. (In practice, all rates are called discount rates, regardless of discount or accrual procedure.)

Experience of the System during World War I and its postwar boom and recession proved that the quality and type of paper discounted or pledged against advances did not regulate the use of the borrowings. Many member banks expected their Reserve Bank to act as a correspondent, that is, to be a source of short-term funds to cover a reserve deficiency arising from the sum of their transactions. The ineffectiveness of eligibility requirements to confine the proceeds of Reserve Bank credit to productive and distributive uses or even to borrowers from member banks presented a problem to System officials.

In 1918, the Board considered the establishment of progressive rates on increments of borrowing to prevent a member bank from obtaining more than its proportional share of discount lending. The Board recommended legislation in 1919, and the act was amended in April 1920 to permit progressive discount rates on the *amount* borrowed by a member bank. A 50-basis-point penalty was allowed for each 25 percent of a member bank's borrowing exceeding a basic line. The Board recommended the basic line should represent the member bank's contribution to the lending resources of the Reserve Bank, consisting of a member bank's reserve deposit and its paid-in capital.

Four Reserve Banks instituted a progressive rate schedule. Three of these Reserve Banks tied their basic lines to a multiple of a member bank's reserve deposit and paid-in capital. One Reserve Bank determined the basic line to be a multiple of a member bank's combined capital and surplus. Advances secured by government securities were excluded from progressive rates. Widespread criticism erupted, including the allegation that penalty rates raised commercial-bank customers' rates and caused a damaging restriction of credit. It was a short-lived experiment. One Reserve Bank retrenched in the latter part of 1920; the other three, in 1921. The amendment was repealed in 1923.

There was some belief that the experiment had failed because a proper base had not been selected. However, there were more fundamental problems encountered in rate discrimination (or, by inference, different administrative procedures based on amounts borrowed). Borrowing beyond a base amount soon carried the presumption that it was unwarranted. Discrimination against banks with large, unpredicted reserve drains, regardless of circumstances or management, inevitably occurred. Borrowing within a base amount also was sanctioned, regardless of the reason for borrowing. With discount rates being essentially administered rates, opportunities for "retailing" Reserve Bank credit inevitably arose. Other means of influencing member-bank borrowing were tried. Some Reserve Banks required additional collateral to discourage excessive borrowing.

Most Reserve Banks, through circular letters and interviews, urged member banks not to make loans for speculative purposes or *nonessential* uses.

Some System officials felt, however, that any attempt to classify uses as essential or nonessential was arbitrary and futile. They disagreed with the use of direct pressure on members; they preferred rationing credit by the discount rate. They argued that rates were impersonal, applicable to all borrowers, suitable for *regulating* the total volume of bank credit, and reflective of the willingness of individual banks to borrow. Others, using the real-bills rationale, questioned the System's authority to attempt to limit total quantity. They feared that the use of rate policy to discourage habitual borrowers or credit for speculative use would restrict borrowing for productive purposes and violate the original act's intent to accommodate commerce, industry, and agriculture.

On the record the Board did not consider the discounting authority of the Reserve Banks as a means of controlling the credit policies of member banks. In 1921, the Board pointed out that "There is nothing in the Federal Reserve Act which gives either the Federal Reserve Board or a Federal Reserve Bank any control over the loan policy of any member bank."[3] Within two years, however, some shift in opinion was evident within the System, as reported in the Board's 1923 *Annual Report*: "By maintaining constant, close, and direct contact with the loan policies and operations of its member banks, through examination or otherwise, a Reserve Bank can do much by other means than changes in discount rates to establish an effective supervision and control of the credit released by it to its member banks."[4] Some System officials rejected the real-bills doctrine and promoted instead the concept that Reserve Bank credit should foster sound credit conditions in the economy as a whole. The System made a fundamental break from the philosophy of the original act with the establishment in 1923 of the non-statutory Open Market Investment Committee, which effectively injected or withdrew reserves on the initiative of the Reserve Banks.

3. Board of Governors of the Federal Reserve System, *Eighth Annual Report, 1921* (1922), p. 95.

4. Board of Governors of the Federal Reserve System, *Tenth Annual Report, 1923* (1924), pp. 3-4.

A Period of Transition: 1923–1933

The period that began with the formation of the Open Market Investment Committee and ended with the statutory creation of the FOMC was a time of conflict, stress, and change in the Federal Reserve System. One economist described this span of years as a time of "pioneering in policy."[5] A harsher critic questioned why "an active, vigorous, self-confident policy in the 1920s was followed by a passive, defensive, hesitant policy from 1929 to 1933."[6]

Alteration of the Discount Function. In 1922, a number of Reserve Banks began to make joint purchases and sales of securities to enhance their earnings, and the impact on reserves of the banking system became evident. Subsequently, sales or purchases appear to have been synchronized with increases and decreases in the discount rates. Loans represented a smaller share of Federal Reserve credit than in the formative period, as illustrated in table 1. Coordination was jeopardized, however, by growing disagreement among policymakers in the latter half of the 1920s. The policymakers wanted to provide an adequate amount of credit at a reasonable cost for business and agricultural uses; at the same time, they wished to prevent the use of credit for investment speculation. Although united in purpose, they were in substantial disagreement as to the means of achieving the goal. One group favored direct pressure in administration, reasoning that effective regulation of the quality of paper discounted would result in the right quantity of credit (real-bills doctrine again), and that a high discount rate would harm business and agriculture. Some System officials and outside economists also alleged that "open market operations undertaken on the initiative of the Federal Reserve were unnatural, artificial, and likely to lead to later trouble."[7] Disagreeing with the selective administrative approach on both theoretical and

5. Clay J. Anderson, *A Half-Century of Federal Reserve Policymaking, 1914-1964* (Federal Reserve Bank of Philadelphia, 1965), chapters 4 and 5.

6. Milton Friedman and Anna Jacobson Schwartz, *A Monetary History of the United States, 1867-1960* (Princeton University Press, 1963), p. 411.

7. Lester V. Chandler, "Some Issues in Federal Reserve Discount Policy," in C.R. Whittlesey and J.S.G. Wilson, eds., *Essays in Money and Banking in Honour of R.S. Sayers* (Oxford: Clarendon Press, 1968).

Table 1 Federal Reserve Discount Loans

Year	Percent of Federal Reserve Bank Credit	Percent of Required Reserves	Year	Percent of Federal Reserve Bank Credit	Percent of Required Reserves
1918	70.70	111.42	1950	0.30	0.41
1919	67.28	121.57	1951	0.08	0.10
			1952	0.60	0.76
1920	80.09	--	1953	0.10	0.14
1921	73.19	69.17	1954	0.55	0.77
1922	43.99	--			
1923	58.40	38.38	1955	0.41	0.57
1924	24.58	14.81	1956	0.19	0.26
			1957	0.21	0.29
1925	44.07	28.50	1958	0.23	0.35
1926	46.13	28.31	1959	1.59	2.46
1927	35.17	24.01			
1928	58.38	43.44	1960	0.11	0.17
1929	39.92	26.03	1961	0.42	0.65
			1962	0.11	0.19
1930	18.28	10.57	1963	0.17	0.31
1931	34.43	32.00	1964	0.47	0.86
1932	11.00	12.16			
1933	3.65	5.24	1965	0.32	0.60
1934	0.28	0.31	1966	0.37	0.71
			1967	0.27	0.54
1935	0.21	0.18	1968	0.33	0.68
1936	0.12	0.07	1969	0.29	0.65
1937	0.38	0.17			
1938	0.15	0.07	1970	0.49	1.12
1939	0.27	0.11	1971	0.05	0.12
			1972	2.52	6.18
1940	0.13	0.04	1973	1.46	3.57
1941	0.13	0.03	1974	0.32	0.81
1942	0.09	0.05			
1943	0.04	0.04	1975	0.21	0.60
1944	0.41	0.63	1976	0.02	0.70
			1977	0.22	0.71
1945	0.99	1.72	1978	0.89	2.75
1946	0.68	1.05	1979[a]	1.03	3.29
1947	0.37	0.52			
1948	0.93	1.16			
1949	0.40	0.50			

a. Preliminary data.

SOURCE: Percentages are calculated from Board of Governors of the Federal Reserve System, *Sixty-fifth Annual Report, 1978* (1979), table 18, pp. 414-17.

practical grounds, other System officials pointed out the impracticality of direct pressure and argued that the ultimate use of borrowed reserves could not be regulated. They favored discount rate changes to restrain total credit, since too much credit, regardless of use, could lead to an inflationary boom. This serious disagreement over means fostered indecision and, predictably, led to growing periods of watchful waiting.

Relative Decline of Reserve-Bank Policy Authority. The emergence of open-market operations and the relative decline of discount policy were accompanied by a shift in the System's locus of power, illustrated by the transfer of control of open-market operations. In May 1922, the Reserve Banks organized a committee to make joint purchases and to sell securities; this committee consisted of the presidents (originally called governors) of the five eastern Reserve Banks. Within one year, this committee was superseded by the Open Market Investment Committee for the Federal Reserve System, with the same five members but now appointed by the Board. In March 1930, this policy group was broadened to include one representative from each Reserve Bank and was renamed the Open Market Policy Conference of the Federal Reserve System. By the Banking Act of 1933, this group became the Federal Open Market Committee, receiving statutory authority for the first time. The FOMC was reorganized in 1935 to include members of the Board of Governors (then six) and five Federal Reserve Bank presidents. Most important in this reorganization was the removal of the Reserve Banks' power to buy and sell government securities for their own accounts. Clearly, the Reserve Banks' independence and dominance of policy within the System had ended.

Changes in the Discount Authority. The statutory changes in the discount mechanism in the 1920s and 1930s mirrored the strains and, to some degree, the conflicting viewpoints within the System and the nation.

Legislation that was designed to aid particular sectors of the economy also broadened the lending authority of Reserve Banks. Paper that was drawn to finance the production and domestic shipment of agricultural goods was made eligible for discount or for collateral against advances. The System's operating rule that prohibited credit for the purpose of lending to some other borrower was superseded. Reserve Banks were authorized to discount the paper of federal intermediate credit banks, setting the precedent for credit availability to other than member banks, particularly to federal agencies. Maximum maturities for agricultural paper were extended on the basis that particular production cycles involved longer time periods (again the real-bills doctrine). Under certain conditions, and regardless of technical eligibility, any satisfactory assets of member banks could be pledged for credit at a penalty rate. Under unusual and exigent circumstances, individuals, partnerships, and corporations could receive discounting privileges. The System thus was authorized to be the *lender of last resort* to all segments of the economy under justifiable circumstances.

Another amendment extended the System's authority to suspend discount privileges of a member bank for certain asset expansion, such as loans on stock or bond collateral. Such legislation explicitly established that the System was to monitor the use of bank credit to achieve the maintenance of sound credit conditions.

Regulation A, which governs the implementation of the discount mechanism, was revised in October 1937 to establish the advancement of the public interest as the guiding principle of discount policy and administration.

Relative Dormancy. The role of the discount mechanism was permanently altered by the formalization of open-market operations and the statutory changes from 1933 through 1935. Loans would remain a minor portion of Federal Reserve credit to the banking system and a possible but uncertain source of funds to individual banks.

For the next 17 years, however, the altered mechanism had limited use, and discount officials had few opportunities to formulate administrative guidelines. From 1934 to 1942, member banks held excess reserves acquired largely from gold inflows from Europe and therefore made minimal use of the discount window. From March 1942 to the Treasury-Federal Reserve Accord of 1951, the System once again adjusted to the financing requirements of a nation at war and its aftermath; the System purchased, at relatively stable prices and yields, all Treasury securities offered to it.

Post-Accord Period: The 1955 Revision of Regulation A

The Treasury-Federal Reserve Accord of 1951 led to renewed interest in the administration of the discount mechanism. There had been little need to formulate discount policy for almost 20 years. Few System officials had any practical experience in discount administration under normal conditions. The rate had been almost constant since 1934 (1.5 percent from 1934 to mid-1937, then 1.0 percent until 1948, and a three-increment rise to 1.75 percent in 1950).

The economic and System milieu was entirely different from the previous period of strong discount activity in the 1920s. Through the Employment Act of 1946, the System was authorized to undertake stabilization policy. The System had three major tools—open-market operations, reserve-requirement flexibility, and the discount function—with which to regulate the total quantity of bank credit and the money supply. Some of the issues of the System's earlier years were no longer pertinent, although vestiges of the rhetoric remained. The problem of the definition of the legal eligibility of paper for discount was of minor practical importance, with government securities representing 46.4 percent of the total loan and security assets of commercial banks. In 1951, most Reserve Bank loans were made in the form of advances against government securities. The problem in the 1950s was the coordination of the tools of the System to achieve the desired policy goals.

In April 1953, the Board of Governors authorized a comprehensive study of the discount function in order to revise Regulation A to reflect its altered role. A survey of the 12 Reserve Banks showed that four factors were considered in credit applications—purpose, size, maturity of the loan, and continuity of the borrowing record of the applying bank. The System committee recommended the adoption of a statement of principles regarding the appropriate use of discount credit.

The 1955 revision of Regulation A emphasized that "access to Federal Reserve credit facilities is a privilege of membership." Appropriate uses of Federal Reserve credit were enumerated as follows:

1. Extension of credit on a short-term basis to adjust to "a sudden withdrawal of deposits or seasonal requirements for credit beyond those which can be reasonably met by use of the bank's own resources."

2. Extension of credit "for longer periods when necessary in order to assist member banks in meeting unusual situations, such as may result from national, regional, or local difficulties or from exceptional circumstances involving only particular member banks."

The revision in Regulation A largely reaffirmed the guidelines for discount policy and administration that had evolved from System experience of the 1920s and the legislative changes in the 1930s. Although Reserve Banks had statutory authority for 90-day advances, the revision emphasized the very short-term nature of discount lending. The revision specified that the maturity for advances secured by eligible paper, other than direct obligations of the United States, was for short periods; the maturity for advances against government securities was for periods not exceeding 15 days.

In the ensuing decade, commercial banking practices changed rapidly. Facing strong credit demand from a growing economy, banks developed market sources for funds and refined methods for the efficient employment of reserve balances.

1965 to 1968: A Time of Reappraisal

In mid-1965, the Board authorized a special study of the discount mechanism in view of the changed financial environment. The study commission found that large commercial banks had few liquid assets and relied increasingly on interest-bearing deposits and borrowed liabilities. The commission also found that smaller banks still held a sizable proportion of their assets in liquid form, and "as a result [were] providing less credit to their communities than would be desirable." A prevalent reluctance to borrow from the Federal Reserve, the study concluded, was "no longer consistent with optimum performance of the banking system." The System committee recommended that the discount mechanism "be modernized and redesigned . . . to play a significant role in the changing financial environment."

On September 11, 1968, Governor George W. Mitchell presented the proposed revision to the Joint Economic Committee of Congress; a summary of the proposed redesign is shown in table 2. The proposed basic borrowing privilege was seen as a means of achieving more objectively defined terms and conditions for member-bank borrowing. The proposed seasonal credit accommodation was designed to offer longer-term credit to smaller banks with limited access

Table 2 Summary of Proposal for Redesign of Discount Mechanism

	Basic Borrowing Privilege	Other Adjustment Credit	Seasonal Borrowing Privilege	Emergency Credit to Member Banks	Emergency Credit to Others
1.	**Definition:** Member bank access to credit upon request, within precisely stated limits on amounts and frequency and on specified conditions	Supplemental discount accommodation, subject to administrative procedures, to help a member bank meet temporary needs that prove either larger or longer in duration than could be covered by its basic borrowing privilege	Member bank access to credit on a longer-term and, to the extent possible, prearranged basis to meet demonstrable seasonal pressures exceeding minimum duration and relative amount	Credit extended to member banks in unusual or exigent circumstances	Credit extended to institutions other than member banks in emergency circumstances in fulfilling role as lender of last resort of the economy
2.	**Rate:** Discount rate	Discount rate	Discount rate	Discount rate	Significant penalty above discount rate
3.	**Quantity Limitations:** (20 to 40) percent of first $1,000,000 capital stock and surplus plus (10 to 20) percent of next $9,000,000 plus 10 percent of remainder	None specified	Seasonal needs in excess of (5 to 10) percent of average deposits subject to reserve requirements in preceding calendar year	None specified	None specified
4.	**Frequency or Duration Limitations:** (6 to 13) of any (13 to 26) consecutive reserve computation periods	None specified	Need and arrangement must be for more than four weeks. Maximum nine consecutive months	None specified	None specified
5.	**Administrative Procedures:** None other than general discouragement of net selling of federal funds by borrowing banks	Appraisal and, where necessary, action broadly similar to procedures developed under existing discount arrangements	Prearrangement involves discussion between discount officer and bank management concerning amount, duration, and seasonality of need. Administrative review maintained during borrowing to prevent abuse or misuse	Continuous and thorough-going surveillance. Require that bank develop and pursue workable program for alleviating difficulties	Continuous and thorough-going surveillance (may have to be through conduit). Require that institution develop and pursue workable program for alleviating difficulties
6.	**Other Restrictions:** Must not have been found to be in unsatisfactory condition	None specified	None specified	None specified	Required to use all other practicable sources of credit first
7.	**Method of Provision:** Direct	Direct	Direct	Direct	(1) Through control agency; (2) direct; (3) conduit through member bank

SOURCE: *Federal Reserve Discount Mechanism,* Hearings before the Joint Economic Committee, 90 Cong. 2 Sess., September 11, 1968, p.9.

to market sources of funds. Also advocated was the consistent maintenance of the discount rate at a level reasonably close to rates on alternative instruments of reserve adjustment. In summary, the proposed revision was intended to make the discount window a more accessible, useful source of funds to member banks.

The response to the proposed redesign of the discount mechanism ranged from approval to disapproval to disdain. Bankers' associations essentially supported the proposal. Spokesmen for thrift institutions, on the other hand, stated that their operations were threatened unless the wider provision of discounts was coupled "with a proscription against providing such discounts at below alternative market rates."[8] The academic consultants who had been involved in the proposed redesign applauded the recommendation of using the discount rate as a means of rationing credit.

In historical perspective, the proposed revision did not appear consistent with the evolution of the role of the discount mechanism. The basic borrowing privilege would be a reversal of the dominance of open-market policy and relative decline of discount policy for monetary and credit management. The proposed revision appeared to deviate from the legislative authority to make lending of the Federal Reserve Banks discretionary; it also departed from the provision of credit to meet temporary reserve deficiencies. The seasonal borrowing proposal would remove the necessity for small banks to meet seasonal requirements that could reasonably be met by use of the bank's own resources. The proposed liberal stance toward discount credit appeared to represent an effort to compensate for the disparate costs of membership.

Developments since the Proposed Revision of 1968

Regulation A was amended in 1968 to de-emphasize the restrictive tone of the 1955 revision regarding the very short-term nature of discount lending; however, it did not yet reflect the major proposals of the System committee.

In 1973, the Board revised Regulation A to make specific provision for seasonal credit for small banks, to remove certain technical eligibility requirements, to reaffirm emergency credit assistance for member banks, and to recognize explicitly the System's role as the lender of last resort to member banks and others. The revision also contained a dramatic shift in tone and style. The phrase so characteristic of the 1955 revision–"access to the discount facilities is granted as a privilege of membership"–was removed. The new general principle section emphasized the phrase "Federal Reserve credit is available . . . ." Public information releases at the time denoted the revision as a further step in the Board's program to implement recommendations of the System committee's 1968 proposal and to provide assistance to smaller banks.

In commenting on the evolving posture of the System, Hackley stated:[9]

> The 1968 Report of a System Committee evidenced a subtle change in attitude. It began with a statement that the redesign of the discount window proposed by that committee had as its chief objective 'increased use of the discount window'. . . . In brief, the 1968 proposal, as well as the 1973 revision of the regulation, reflected an intent to encourage greater use of the discount window.

The basic borrowing privilege proposed in 1968, however, has not been implemented.

Conclusion

The change in the operating procedures of the FOMC since October 6, 1979, has focused new attention on the discount mechanism. Viewing the discount window as a service facility for member banks would not be compatible with effective implementation of monetary policy. The enactment of the Depository Institutions Deregulation and Monetary Control Act of 1980 has negated the historical compromise that gave us a unique central bank dependent on voluntary membership. During the next eight years, reserve requirements will be phased in for all depository institutions with transaction account balances and/or nonpersonal time deposits. These institutions will have the same privileges at the discount window as member banks. Once again, the role of the discount mechanism may require redefinition.

8. *Federal Reserve Discount Mechanism,* Hearings before the Joint Economic Committee, 90 Cong. 2 Sess., September 11, 1968.

9. Hackley, *Lending Functions of the Federal Reserve Banks: A History,* pp. 194-195.

Are Exchange Rates Determinate?

by Steven E. Plaut

The decision-makers of the world have apparently never felt very comfortable with the idea of floating exchange rates. The current floating-rate system was not cooperatively planned and carefully introduced; rather, it was created through default as the Bretton Woods system fell apart in 1971-1973, with one country after another abandoning fixed parities. Numerous countries, however, continue to maintain fixed parities with respect to some major currency (or currencies). The repeated attempts to form a European Monetary System, or "snake" of fixed intra-European exchange rates, can be interpreted as a sign of mistrust of floating rates. So, too, can the periodic proposals for creation of a modified Bretton Woods system.

Decision-makers are not the only skeptics. There has been an increasing trend among economists in recent years to reject as unworkable and ineffective those institutions that do not perform well. This is, of course, most apparent in the new backlash against the profession's romance with Keynesian ideas. It is also apparent in an increasing number of papers that critically view the current floating exchange-rate regime and endorse some form of return to governmental intervention in the foreign exchange market (which could include a return to fixed parities).

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One of the most interesting and imaginative of these recent positions is found in the work of Professor Neil Wallace.[1] Wallace views foreign exchange markets as unstable and defective, because exchange rates are, by their very nature, indeterminate. His argument rests on the fact that exchange rates represent the relative prices of *fiat currencies,* that is, currencies not officially backed by any commodity, worthless in and of themselves (or valuable only because of their liquidity), and costless to produce.

While markets can successfully and optimally price apples in terms of oranges, they cannot price fiat dollars in terms of fiat francs. To demonstrate this, Wallace asks whether a market could determine the relative price between Susan B. Anthony dollar coins and Lincoln five-dollar bills—if the exchange ratio were not dictated by government. That is, imagine that neither currency had any number on it and that both were accepted as money. The overall "price level" in terms of some average of the two currencies might be a function of the total supply of the two monies and

1. Neil Wallace, "Why Markets in Foreign Exchange Are Different from Other Markets," *Federal Reserve Bank of Minneapolis Quarterly Review,* vol. 3, no. 4 (Fall 1979), pp. 1-7; John Kareken and Neil Wallace, "International Monetary Reform: The Feasible Alternatives," *Federal Reserve Bank of Minneapolis Quarterly Review,* vol. 2, no. 3 (Summer 1978), pp. 2-7. See also Gerald Nickelsburg, "On the Multiplicity of Stochastic Dynamic Exchange Rate Equilibria" (Mimeographed, University of Minnesota, 1980).

aggregate production. The price level in terms of Lincoln dollars or in terms of Anthony dollars, or the rate of exchange between them, would be indeterminate.

The indeterminacy argument may be represented formally as follows (although this does not follow the same line as Wallace's own presentation). Imagine a closed economy producing only one good in quantity Q. Let M_1 be the first kind of fiat money. The price of a unit of Q in terms of M_1 is P_1. Similarly, let M_2 be the second kind of fiat money, with P_2 being the number of units thereof required to buy a unit of Q. Assume that both monies are perfect substitutes.

Imagine a simple world where the quantity theory of money always applied. If there had been only one currency, the economy could have been described as:

$$\frac{MV}{P} = Q \quad ,$$

where V is velocity. In our case we have two currencies; the quantity identity is:

$$\frac{V_1 M_1}{P_1} + \frac{V_2 M_2}{P_2} = Q \quad , \qquad (1)$$

where V_i is the velocity of the i^{th} currency. Let R be the exchange rate between the two currencies. Assuming no government exchange intervention, it must be that in equilibrium $R = P_1/P_2$. Moreover, let us assume that both currencies are identical in terms of liquidity and rates of return. This would seem to imply that velocity would be the same for both currencies, V. Equation 1 may then be rewritten:

$$\frac{Q}{V} = \frac{M_1 + M_2 R}{P_1} \quad . \qquad (2)$$

Let us make the monetarist assumption that Q and V are exogenous. Equation 2 then represents one equation in two unknowns and is therefore indeterminate. In particular, R could be any number whatsoever.

In effect, this monetary system may be compared to a perfectly balanced seesaw. The seesaw can be moved to any position, and it would stay there indefinitely. There is no such thing as an "equilibrium" position, however, and even the smallest breeze could drive one of the two ends of the seesaw down to the ground level (that is, one currency could easily become worthless). The fulcrum of the seesaw is analogous to equation 2, reducing one degree of freedom. That is, one cannot simultaneously raise P_1 and P_2—or both sides of the seesaw. There remains one degree of freedom.

Now imagine that this economy were the entire world and that both M_1 and M_2 were two currencies that were legally and socially accepted as fiat money in all countries. Wallace asserts, "Without government intervention in foreign exchange markets and without binding restrictions on currency holdings, exchange rates, price levels, and in general all prices are indeterminate." During every actual experiment with floating rates, Wallace argues, exchange rates were in fact determined only by explicit or implicit current or expected future governmental intervention.

Could the market price Susan B. Anthony coins in terms of Lincoln dollar bills if the numbers on each were erased?

Why is this argument valid for fiat currencies, but not for other forms of money? Wallace is less clear about this. Production of gold and silver is not costless, but then neither really is the production of dollars. Nothing "backs" dollars, but then again nothing really "backs" gold and silver, except for the fact that they are easily convertible into other goods and services. It is true that gold and silver are more aesthetically pleasing than American currency (although the case is less clear for some foreign currencies), but surely gold and silver theoretically could have played their historical roles even if both were insipid green and had the texture of peanut brittle. Gold and silver have some alternative uses (although in the past these were almost entirely decorative), but does this really explain the determinacy of their rate of exchange?[2]

Wallace's conclusion is based on the assumption that the two (or more) fiat currencies are perfect substitutes. If

2. Actually, governments under bimetallism often did intervene to fix their price ratios.

they are anything less than perfect, the indeterminacy disappears. This is the real reason that a determinate gold/silver exchange rate may exist, but it is also the reason that an Anthony/Lincoln or a dollar/franc exchange rate may exist. Formally, any case where the currencies are less than perfect substitutes adds a second equation to 2, and therefore determines the system.

Suppose that equation 2 were in stochastic form:

$$\frac{Q}{V} = \frac{M_1 + M_2 R}{P_1} + \varepsilon , \qquad (2)$$

and suppose that some of the elements in equation 2 were random variables, for example, R, P_1, and P_2 (with all the other variables constant). Assume that for any M_1 and M_2 an a priori joint probability distribution of P_1 and P_2 is held by market participants. Then portfolio maximization would lead to selection of an optimal R (or path of R), and the system would be determinate.

To illustrate, imagine that, regardless of which M_1 and M_2 were selected, $\hat{P}_1$ always had zero variance and $\hat{P}_2$ always had very high variance, where $\hat{P}_1$ and $\hat{P}_2$ are logs of P_1 and P_2. Then risk-averse portfolio holders would always prefer M_1 to M_2, and the optimal R would be infinite. Alternatively, if both $\hat{P}_1$ and $\hat{P}_2$ had identical variances and correlation of minus one, then the optimal portfolio would consist of a combination of M_1 and M_2 such that $M_1/P_1 = M_2/P_2$ and the optimal R would be M_1/M_2. That P_1 and P_2 may have different stochastic properties is as reasonable as the assumption that the prices of gold and silver had different stochastic properties under bimetallism. In effect, by having different stochastic properties, the currencies are no longer perfect substitutes—even though they are in all other ways alike.

It would only be the case that exchange rates were indeterminate if all currencies had exactly the same stochastic properties.

This solution becomes more relevant if we drop the assumption of one aggregate good. If different goods are produced and if different people consume different goods, then R may not be independent of other prices. Portfolio optimization behavior would lead to a determinate exchange rate. If the Lincoln/Anthony exchange rate tended to rise with the price of oranges, then orange producers might prefer "Lincolns," and orange consumers "Anthonies," as hedges. Moreover, if there were many untraded goods, region-specific currencies could emerge.

A floating-rate regime should not be automatically ruled out as indeterminate; it should be judged on the basis of its benefits and costs, which include the least costly way of establishing determinacy.

Alternatively, it might be that the sources of "noise" in equation 2 are the supplies of currencies. It is likely that M_1 and M_2 are never determinate, but rather stochastic. Suppose that the nominal supplies of M_1 and M_2 fluctuate randomly on a day-to-day basis (as is surely the case for all fiat currencies, even if government intentions are to hold them fixed). It seems unlikely that the P_i would be independent of the M_i, if for no other reason than because people expect this to be so. This would mean that for any Q and V, the joint probability distribution of P_1 and P_2 would be known and a function of the stochastic characteristics of M_1 and M_2. The same conclusion results if ε (in equation 2) would have covariances with P_1 and P_2 that were not identical.

Other circumstances could also lead to determinate exchange rates. Wallace seems to mean paper cash and coins when he speaks of fiat currency, but most "fiat currency" consists of bank liabilities. Wallace assumes the nominal rate of return on fiat currency is zero, and, therefore, the expected change in the exchange rate must be zero.

Suppose, however, that this were not the case.[3] Suppose that nominal returns on currency need not be zero. Then the nominal and real rates of return would reflect the underlying stochastic properties of P_1 and P_2 and may

3. It is obviously not the case for definitions of money that include savings accounts or checking accounts that bear interest.

themselves be stochastic. They would certainly not have to be the same for the two currencies. The two currencies would thus be imperfect substitutes, and portfolio behavior would determine the exchange rate. Even more likely, suppose different debt instruments were denominated in different currencies. Then the demand functions for the currencies would be dependent upon the demand for the different debt instruments.

It would only be the case that exchange rates were indeterminate if all currencies had exactly the same stochastic properties. Currencies would be absolutely perfect substitutes only if this were the case. But if all currencies really were perfect substitutes, any small restriction or imperfection would make exchange rates determinate. Hence, even in this case, a floating-rate regime should not be automatically ruled out as indeterminate; it should be judged on the basis of its benefits and costs, which include the least costly way of establishing determinacy. Wallace seems to believe that the only way determinacy may be established is through restrictions on capital movements, which would, of course, imply high welfare costs; he thus concludes that fixed rates are preferable. This, however, is not the case.

One way determinacy could be established would be for the nominal price of one good to be artificially held constant for each currency (not necessarily the same good). This is equivalent to establishing "backing" for the money. The same result could be achieved, however, by merely setting "confidence bounds" on the possible extent of variation of the price of one good in each currency. This could perhaps be a nontradable good, even a public good or service. If all other considerations would indicate that a floating regime is preferable, then this would be a small price to pay for enabling the system to operate.

Alternatively, any change in the nature of the two currencies that would cause them to enter into utility functions differently would have the same result. If the two currencies featured reproductions of different works of art on their faces and if they could not be easily counterfeited, this would be the case.[4] Some might object that after holding one specimen of each bill, consumers might be indifferent between currencies. This need not hold. Bank customers often pay extra for aesthetically pleasing checks, even though they use them very often and see the same image repeatedly.

Finally, the argument made by Wallace that current exchange-rate volatility reflects underlying indeterminacy seems to be a non sequitur. All sorts of capital restrictions that he recognizes as devices that create determinacy are currently in effect. The volatility, therefore, must be caused by other factors.

A floating exchange-rate system may or may not be more stable or more efficient than a system of fixed parities, may or may not create macroeconomic independence, may or may not be trade-stimulating. It should, however, be judged by these criteria and not on the basis of theoretical indeterminacy that might exist under unrealistic assumptions.

4. Or, one currency could carry a picture of Bo Derek and the other of Burt Reynolds. Many transactors would not be indifferent between the two. This author predicts that the Derek currency would come to rest at an equilibrium par value of 10.

Surveys of Consumer Attitudes and Spending on Durable Goods

by Ziona Austrian and Michael L. Bagshaw

Introduction

Surveys of consumer attitudes attempt to measure shifts in attitudes, expectations, and intentions to purchase durable goods. Attitude surveys originated in the belief that changes in attitudes affect consumer behavior in the marketplace. Underlying these surveys is the supposition that attitudes and expectations are affected by a wide variety of changes, some of which may not be reflected in objective economic measures, such as income, unemployment, stock prices, or wealth. Proponents of consumer attitude surveys claim that past trends of income and prices do not adequately serve as proxies for income and price expectations. Consequently, attitude surveys reflect independent information that is not solely a function of objective economic variables. Moreover, most attitudes are not elusive, not dependent on the momentary mood of the respondents, and not cancelled out by changes in attitudes among different individuals. Consequently, it is argued that consumer attitude surveys are a reliable and meaningful measure of consumer attitudes and expectations and can be used in forecasting consumer spending.

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Consumer attitudes are believed to be intervening variables that modify the response of consumers to pure economic variables. Consumer behavior primarily affects purchases of durable goods, for which the demand is a function of both ability and willingness to buy. Durable goods serve as a proxy for discretionary spending, that is, nonessential or postponable expenditures. Most durable goods involve substantial expenditures and are infrequently purchased by individual households.[1] Attitudes and expectations indicate changes in willingness to buy; major developments in the ability to buy may either reinforce or counteract the indications derived from measures of attitudes and expectations. An example of the effects of consumer attitudes and expectations on consumption may possibly be seen in the change in consumers' reaction to inflation between earlier episodes of accelerating prices in the post-World War II period and the latest round of high inflation in the late 1970s. In previous years, U.S. consumers characteristically responded to rising prices by increasing savings and retrenching on spending. Current rates of inflation, however, may have caused consumers to continue borrowing and spending in anticipation of further price

1. Spending on vacations and luxuries is considered discretionary but is not included in the data.

increases. Consumers' advance purchases of large durable items have contributed to a decline in the saving rate to historically low levels.

Objectives and Procedures

The objective of this study is to examine the usefulness of attitudinal measures in forecasting consumer spending on durable goods. This study tests whether surveys of consumer attitudes can improve predictions of consumer spending compared with forecasts that use only objective variables.

Three methods are used to test the influence of attitudinal measures on durable goods spending. The first method is the commonly used descriptive historical approach, which charts the performance of attitudinal measures at turning points in past business cycles. While this method can show to what extent attitude surveys have predicted turning points in consumer spending on durable goods, it nevertheless lacks specificity. Regression analysis and the Box-Jenkins models, which are the other two methods used in this paper, provide actual numeric forecasts. An analysis of the empirical relationship between durable goods purchases and objective variables provides a benchmark against which the predictive value of attitudinal variables can be assessed. Attitudinal data are used here to compliment, rather than to substitute for, objective variables.

Measures of Consumer Attitudes

One commonly used consumer attitude survey has been conducted since 1969 by the National Family Opinion, Inc., for the Conference Board in New York City. This survey produces both the Consumer Confidence Index and the Buying Plans Index.[2]

The measure of consumer attitudes and expectations examined in this study is the Index of Consumer Sentiment (ICS), derived from the University of Michigan's Survey of Consumer Attitudes. The ICS was first constructed in 1952 and has been published at regular quarterly intervals since 1962. Conducted monthly from the beginning of 1978, the Survey of Consumer Attitudes samples 1,200–1,500 respondents with 20–25 questions designed to assess changes in consumer attitudes and expectations. The questions are constructed to determine whether consumers feel more or less confident, optimistic, or secure than in previous surveys. Expectations relating both to the respondent's own financial situation and to the economy as a whole reflect the respondent's sentiment. Past findings indicate that the attitudes and expectations of broad groups of people, unlike those of individuals, rarely change abruptly except under the impact of major events. The purpose of the survey is to increase understanding of why these changes in sentiment occur and how they affect consumer decisions about discretionary purchases.

The ICS, a summary measure, is calculated from responses to five identical attitudinal questions in each survey. The first two questions in the index relate to personal finances. They ask whether the family is financially better, worse, or in the same situation as one year earlier and whether the family expects to be financially better, worse, or the same one year later. Two other questions that relate to business trends ask whether the next 12 months and the next five years will bring good or bad times for the economy as a whole. A fifth attitudinal question is pointed at the durable goods market, asking whether it is a good or a bad time to buy major household goods. Similar questions are asked about automobiles and houses but are not included in the index.[3] The results of the survey are published as two indexes: for all families and for families with incomes of $15,000 and over. In this paper we use the index for all families as a measure of consumers' sentiments.

2. The Consumer Confidence Index combines answers to five attitudinal questions. Consumers are asked to appraise current business and employment conditions as well as their expectations concerning business conditions, employment, and their own personal income in the next six months. The Buying Plans Index is based on questions concerning six-month buying intentions for a selected group of major products that usually involve some planning before purchase, such as automobiles, houses, carpets, and major appliances.

3. To construct the ICS, the answers are grouped into three categories: a) up, better, or good; b) same, no change, or uncertain; c) down, worse, or bad. A relative score is calculated separately for each answer by taking the proportion giving favorable or optimistic answers (type a), subtracting the proportion giving unfavorable answers (type c), and adding 100 to avoid negative numbers. An average is taken over the five relative scores, and the result is then converted to an index in which the first quarter of 1966 is equal to 100.

Previous Empirical Studies

Since the 1950s, a number of studies have explored the usefulness of attitudinal data in consumer expenditure models for durable goods. These studies have followed two basic approaches. One approach has been to examine whether the inclusion of a consumer attitude index in an equation explaining consumer durable expenditures improves the model's ability to explain or forecast spending on consumer durables.[4] Attitudinal variables include a measure of consumer sentiment or confidence and a measure of consumer intentions to purchase. The second approach isolates a stable relationship between the ICS and other easily measurable variables of economic activity, such as changes in income, unemployment rates, inflation rate, or equity prices.[5] Such a relationship could then be substituted for the index itself or, more importantly, be used in forecasting the attitude index in econometric models.

This article represents a continuation of the former type of research; it investigates the effect of the attitude index, as distinguished from the intention to buy, on consumption of durable goods. In the late 1950s, while data on consumer buying plans were felt to have limited usefulness in predicting consumer purchases of durables, consumer attitudes were believed to be of insignificant value.[6] The first studies were based mainly on analysis of cross-section reinterview data, since information for time-series data was inadequate. In the 1960s, as more time-series data became available, studies by the University of Michigan's Survey Research Center and others consistently showed that attitudes made a statistically significant contribution in predicting fluctuation in consumer purchases of durable goods. However, these studies also concluded that buying intentions do not add significantly to the forecast once attitudes are included. Most of these studies used single-equation models with the dependent variable being automobile purchases and/or total durable goods purchases. The expectational variables typically used were the Index of Consumer Sentiment and sometimes an expected or planned buying variable. Burch and Werneke [5] tested the predictive value of the separate questions constituting the ICS versus the composite index itself in predicting consumer outlays on durable goods. The results of their study suggest that the separate questions may illuminate the attitude-spending relationship more clearly than the composite index alone.

The Index of Consumer Sentiment is viewed by the Survey Research Center as a measure of the willingness of consumers to make discretionary purchases. Mishkin [13] interprets the ICS as a measure of consumers' comprehension of the probability of financial distress—a decline in the ICS would indicate that consumers expect a rise in the probability of financial distress. When this occurs, consumers typically increase their holdings of liquid financial assets and restrict their purchases of durable goods. Mishkin shows that the ICS continues to be useful in predicting spending on consumer durables when used with balance sheet variables, although to a lesser extent compared with its usefulness when the financial assets and liabilities variables are excluded.

Historical Performance of the Index of Consumer Sentiment

Analyzing the ICS movements and their relationships to previous cycles provides some evidence of the predictive value of the ICS. In contrast to the econometric methods, which test the average predictive performance of the ICS, the descriptive method can be used to examine the predictive value of the ICS at particular times, such as turning points of economic activity. It can be used to analyze the performance of the ICS before, during, and after recessions and expansions. An examination of the index at turning points suggests that the ICS preceded downward turning points in consumption of durable goods by three quarters in three of the four post-World War II recessions (see chart 1). In upper turning points, the index preceded recovery in spending on durables only by one quarter in the first two cycles examined; it did not lead at all in the expansions in the 1970s.

4. See Adams [1], Burch and Stekler [4], Juster and Wachtel [11], Maynes [12], Mueller [14] and [15], Okun [17], and Tobin [19].

5. See Adams and Klein [2], Fair [7], and Hymans [9].

6. See Okun [17] and Tobin [19].

Sufficient ICS data based on the Survey Research Center's attitude surveys were first available before the 1958 recession. A substantial decline in the ICS occurred in the first half of 1957, followed by a further large decline in the second half of that year. The index served as a leading indicator as expenditures for consumer durable goods declined only slightly throughout the year in 1957 and fell significantly in the first quarter of 1958. The lead time of attitudes appears much shorter in the recovery phase than in the downturn phase. The next recession occurred between mid-1960 and early 1961. Unlike its experience in the previous recession, the ICS deteriorated sharply in the first half of 1960 and declined only moderately in the second half of that year. This suggested a more moderate downturn in consumer durables, which was the case, but the index underestimated the length of the downturn.

The next significant decline of the index occurred in 1966, with a sharper drop than that preceding the previous recession. This proved to be a false signal, however, as spending on durable goods remained flat during 1966 and 1967. The index declined sharply again in 1969, in contrast with other indicators of consumer activities. Real spending on durable goods remained at the same level throughout 1969 and 1970 and fell sharply only at the end of 1970. The performance of the index relative to the recovery from the recession was again less than satisfactory—the index advance did not begin earlier than the upturn in demand.

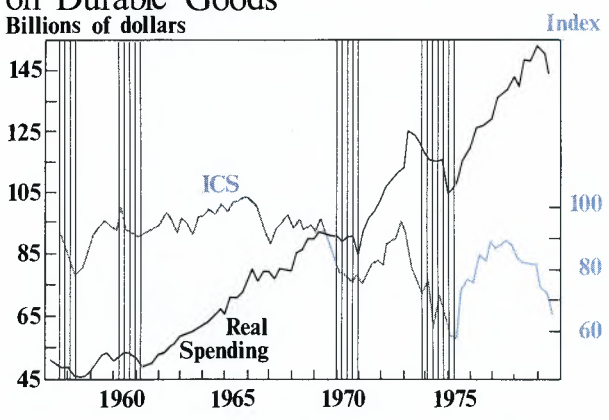
From the end of 1972 until the beginning of 1975, the index registered its sharpest decline since its inception in 1952. After a steady decline in 1973, it showed some zigzag movements during the oil-embargo period and resumed its sharp decline in the second half of 1974. The index reached its lowest point in 25 years in the first quarter of 1975. The sharp decline in the index pointed toward a deeper-than-before recession. Spending on durable goods began declining in the second quarter of 1973, leveled off for the first three quarters of 1974, then plunged in the fourth quarter of 1974. The index recovered only after the trough of the consumer durables cycle, recovering all through 1975 and the first half of 1976. From the middle of 1977, the index has been trending downward, which, according to previous experience, would have suggested a corresponding decline in consumer spending on durable goods in the second half of 1978. Though real spending did increase in the fourth quarter of that year, the fourth-quarter 1978 to fourth-quarter 1979 decline is now evident.

Analyzing the historical performance of the Index of Consumer Sentiment in predicting major turning points in business cycles indicates that, except for the 1960 recession, the index offered at least a two-quarter lead time before each of the previous recessions. However, it provided a strong false signal in 1966. For downward turning points in real spending on durable goods, the index provided at least a three-quarter lead time except for the 1960 downturn and the 1966 false signal. The index failed to predict the stable outlays in the first three quarters of 1974 that preceded the steep decline in the last quarter of 1974. In general, the index performed better in indicating the direction than the magnitude of spending on durable goods. However, the ICS lead time for recoveries was unsatisfactory.

Although the historical method of analysis indicates the usefulness of the index, it does not lead to a clear and general conclusion about the relation between the ICS and real consumption of durable goods. Quantitative methods, such as the regression and the Box-Jenkins methods, are required to study the predictive value of consumer survey attitudes.

Chart 1

The ICS and Real Spending on Durable Goods



SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Business Conditions Digest* (August 1978).

Shaded areas designate periods of economic recession.

Empirical Methods of Forecasting Usefulness of ICS

The Box-Jenkins and the regression model methods of forecasting are utilized to determine the usefulness of the Index of Consumer Sentiment (ICS) in forecasting real per capita expenditures on durable goods (CD72N). While the regression model method has historically been more widely used for forecasting than the Box-Jenkins method, the latter has become more popular in recent years. Consequently, both methods are used to evaluate the contribution of ICS to forecasting CD72N.

The regression model method of forecasting statistically estimates the relationship between CD72N (the dependent or endogenous variable) and a relevant set of variables (the independent or exogenous variables) including ICS. (See box for a description of the variables used in this study.) In the evaluation procedure used in this study, separate regression models are estimated utilizing the set of independent variables, excluding and including ICS. (See appendix 1 for a brief description of the regression method of forecasting and the resulting equations.)

In evaluating the influence of one variable on the forecasts of another variable, the forecast length must first be chosen.[7] Since the data used in this study are quarterly, forecast lengths are used for one quarter ahead, two quarters ahead, three quarters ahead, and four quarters ahead. The contribution of ICS to the forecasts of CD72N can thus be evaluated for up to one year ahead forecasts. Two separate regression models, one with ICS and one without, are estimated for each of the four forecast lengths. The models (with and without ICS) that best explain the variation in CD72N in each forecast length have been chosen under the condition that the independent variables would be known at the time of the forecast.[8]

The regression and the Box-Jenkins models are estimated for the first quarter of 1962 through the fourth

7. The forecast length is defined as the time span between the forecast origin and the time point in the future for which the forecast is made.

8. That is, the models with the highest R^2 were chosen, where R^2 represents the percentage of variation in the dependent variable explained by the model.

Variables Used in the Regression Models

The dependent variable is real per capita consumer expenditures on durable goods. The independent variables are as follows:

1. Real per capita disposable personal income (YD72N);
2. Real per capita financial assets of households (FA72N);
3. Lagged per capita spending on durable goods (CD72N);
4. The index of consumer sentiment (ICS);
5. The index of consumer sentiment multiplied by one over the total unemployment rate (ICSR);
6. One over the total employment rate (ORU).

The data involve quarterly observation, and all variables except ICS are seasonally adjusted. The first two variables are expected to have positive coefficients capturing the effects of income and wealth on consumption. A positive sign on lagged CD72N reflects the effect of previous consumption habits on future spending. A negative sign suggests that high spending in one period may lead to saturation and low spending in the following period. The last three variables measure the effect of consumer attitudes and expectations on consumption of durable goods. ICSR, which measures the effect of the business cycle (through the unemployment rate) on the sentiment index, is expected to have a negative coefficient. This variable can be viewed as an adjustment factor to the index itself. The higher the unemployment rate, the smaller is its impact, and the larger is the total effect of the index on consumption of durable goods.

quarter of 1975; the estimates are then used to forecast CD72N over the additional time period, including the first quarter of 1976 through the fourth quarter of 1978. The forecasts with and without ICS then are compared with the actual values of CD72N.[9] (See appendix 1 for the resulting models.)

In both the Box-Jenkins and the regression forecasting methods, it is theoretically possible to use many independent variables. In practice, however, it is very difficult to use more than one independent variable in a Box-Jenkins model. Consequently, forecasts employing this method often use only the dependent variable (univariate model) or the dependent variable and one independent variable (bivariate model). Studies have shown that the Box-Jenkins method using only the dependent variable can outperform for short forecast lengths the regression method using many independent variables.[10] Even though the Box-Jenkins forecasts of CD72N used in this study are limited to univariate and bivariate models, there is reason to believe that these models could outperform the regression model forecasts that use many independent variables, at least for short forecast lengths. (See appendix 2 for a brief discussion of the Box-Jenkins method.)

In a univariate Box-Jenkins model, the past history of a series often provides a good indication of future values of the series. Thus, a model relating current and past values of the series is developed in order to forecast future values of the series. In the bivariate model, the independent variable is used to explain the movements of the dependent variable that are not explained by its past values. The bivariate model using ICS is compared with both the univariate model using only CD72N and the bivariate model(s) using CD72N and an independent variable different from the ICS. The first comparison yields information on whether the ICS improves the forecasting of CD72N relative to using only present and past values of CD72N. This comparison measures whether the ICS adds information about the future movements of CD72N not included in CD72N itself. However, this comparison does not necessarily indicate that the ICS is a "good" variable for forecasting CD72N. Indeed, when used in a bivariate model, there may be other variables that would provide much better forecasts of CD72N. Consequently, the results of the bivariable model containing ICS also must be compared with bivariate model(s) containing other independent variables related to CD72N by economic theory. Since the Box-Jenkins procedure is fairly complex and time-consuming, it was decided to limit the comparison models to the bivariate model containing CD72N and YD72N. The variable YD72N was chosen because it appears to be most strongly related by economic theory to CD72N; if ICS performs well compared with YD72N, it should perform well compared with other independent variables.

The Box-Jenkins models also are estimated from the first quarter of 1962 through the fourth quarter of 1975. They then are used to forecast CD72N from the first quarter of 1976 through the fourth quarter of 1978, using only values of the dependent and independent variables known at the time of the forecast. (See appendix 2 for more complete discussion of this point.)

Forecasting Results

The forecasting results are evaluated using plots of the forecasts, the forecast errors, the mean forecast error (ME), the mean percent forecast error (M%E), and the root-mean-square error (RMSE).[11] The mean forecast error and the mean percent forecast error provide information on whether the forecast method yields unbiased forecasts.

9. The results of this and the Box-Jenkins forecasting are compared in Forecasting Results, pp. 19-22.

10. See Cooper and Nelson [6], Hirsch [8], Nelson [16], and Taylor, Seaks, and Wichern [18] for examples that support this result.

11. These quantities can be defined as follows:

$$ME = \frac{1}{12} \sum_{t=1}^{12} (Y_t - \hat{Y}_t),$$

where $Y_t - \hat{Y}_t$ is the forecast error for period t and t=1 for the first quarter of 1976, Y_t is the actual value, and $\hat{Y}_t$ is the forecast value of the series being investigated.

$$M\%E = \frac{1}{12} \sum_{t=1}^{12} \left(\frac{Y_t - \hat{Y}_t}{Y_t} \right)$$

$$RMSE = \sqrt{\frac{1}{12} \sum_{t=1}^{12} (Y_t - \hat{Y}_t)^2}$$

The closer these two values are to zero, the closer the method predicts the actual values, on average. These statistics, however, do not measure the variation in the forecasts; a forecasting method could have a ME and a M%E of zero and still not be a good forecasting method. The method could yield very large positive forecast errors for some quarters and very large negative forecast errors for other quarters in such a way that the errors average out to zero. The RMSE yields information on whether the forecasts are unbiased and on the variability of the forecast errors. Because the RMSE yields information on both aspects of the forecast errors, it is the most widely used method of comparing forecasts. Consequently, the RMSE is the major statistic used in this study to compare forecasts, with some emphasis on the ME and M%E. Charts 2 through 9 present plots of the forecasting results, and table 1 gives the ME, M%E, and the RMSE for all four forecast lengths and the different methods of forecasting.

Regression Results. The regression method using ICS outperforms the regression method without ICS for all four forecast lengths in terms of ME, M%E, and RMSE (see table 1). The regression method without ICS has a RMSE ranging from 46 to 127 percent larger than that using ICS, a ME ranging from $12.50 to $27.40 per capita higher, and a M%E ranging from 2.0 to 4.2 percentage points higher. The forecasts using ICS have smaller forecast errors than those not using ICS in 9, 11, 12, and 10 quarters out of the 12 quarters, which are forecast for one, two, three, and four quarters ahead, respectively (see charts 2 through 9). In the regression method of forecasting, therefore, ICS has contributed significantly to the forecasting ability from the first quarter of 1976 through the fourth quarter of 1978.

Chart 2 shows that the one quarter ahead forecast not using ICS has a fairly consistent downward bias; it usually underforecasts CD72N (10 out of 12 quarters) with an average of $19.20 per capita underforecast. The forecast using ICS follows the pattern of CD72N with more accuracy (only 7 out of 12 underforecasts) with an average of $6.70 per capita underforecast. The regression forecasts without ICS underforecast CD72N more than the forecasts with ICS (see charts 4 through 9). ICS apparently has captured some aspect of consumer spending patterns not adequately represented by the economic variables alone. Over this time period, consumer reactions to these noneconomic conditions tended to increase the level of their expenditures.

Box-Jenkins Results. Comparing the bivariate model using ICS to the univariate model (see table 1), the RMSE of the univariate model ranges from 13 to 450 percent larger than the bivariate model; the mean forecast error ranges from $6.20 to $75.20 (1972 dollars) larger per

Table 1 Summary Statistics of Forecast Errors

	One quarter ahead			Two quarters ahead			Three quarters ahead			Four quarters ahead		
	ME	M%E	RMSE	ME	M%E	RMSE	ME	M%E	RMSE	ME	M%E	RMSE
Regression with ICS	6.7	1.0	17.0	20.7	3.2	25.2	10.5	1.6	18.7	26.2	4.1	33.4
Regression without ICS	19.2	3.0	25.3	33.5	5.2	37.0	37.9	5.9	42.5	43.9	6.9	48.7
Box-Jenkins univariate CD72N only	8.8	1.3	20.2	63.3	9.7	77.9	88.6	13.7	106.4	102.1	15.8	121.6
Box-Jenkins bivariate CD72N and ICS	-.9	0.3	17.2	-7.5	-1.3	16.9	13.4	2.1	19.3	95.9	15.2	97.1
Box-Jenkins bivariate CD72N and YD72N	7.3	1.1	15.5	27.4	4.3	32.0	17.7	2.8	19.7	86.5	13.3	107.5

NOTE: ME and RMSE are expressed in terms of 1972 dollars per capita. M%E is expressed in terms of percentage points.

Chart 2
Actual and Forecasts of CD72N
Real dollars per capita

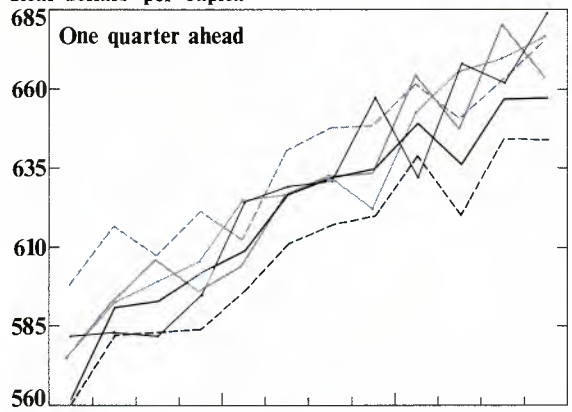


Chart 3
Forecast Errors of CD72N
Percent of actual

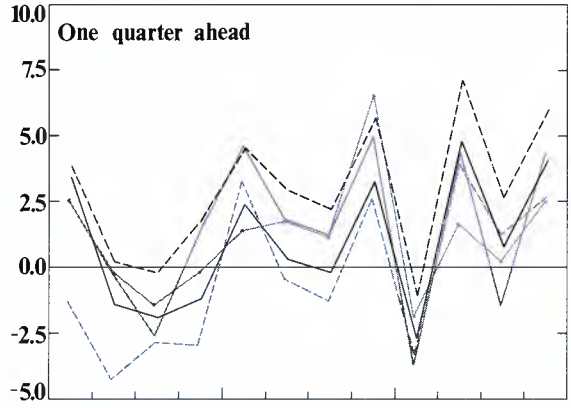


Chart 4
Actual and Forecasts of CD72N
Real dollars per capita

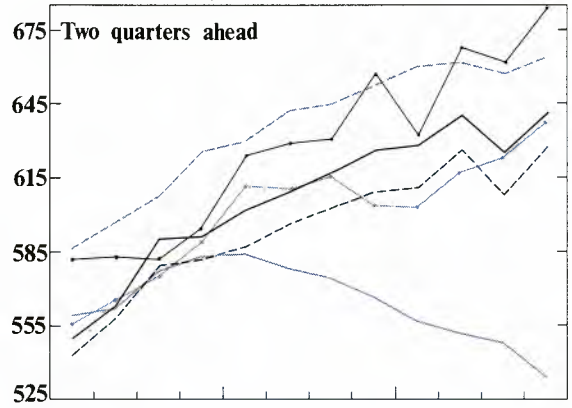


Chart 5
Forecast Errors of CD72N
Percent of actual

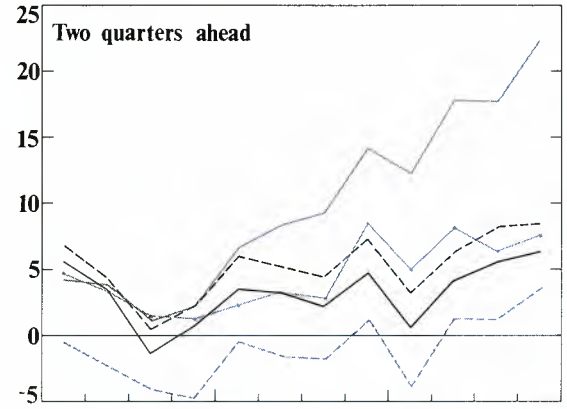
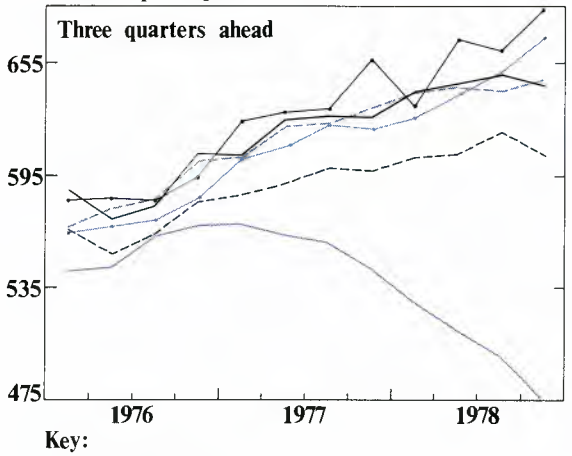
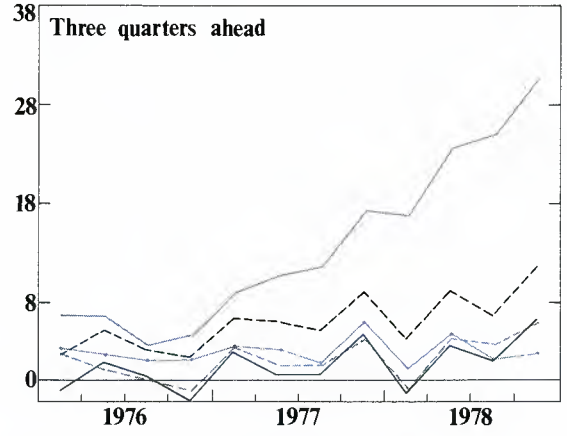


Chart 6
Actual and Forecasts of CD72N
Real dollars per capita



Key:
—+— Actual CD72N
—— Regression method with ICS
---- Regression method without ICS

Chart 7
Forecast Errors of CD72N
Percent of actual



—— Box-Jenkins univariate CD72N only
---- Box-Jenkins bivariate CD72N and ICS
—+— Box-Jenkins bivariate CD72N and YD72N

Chart 8
Actual and Forecasts of CD72N

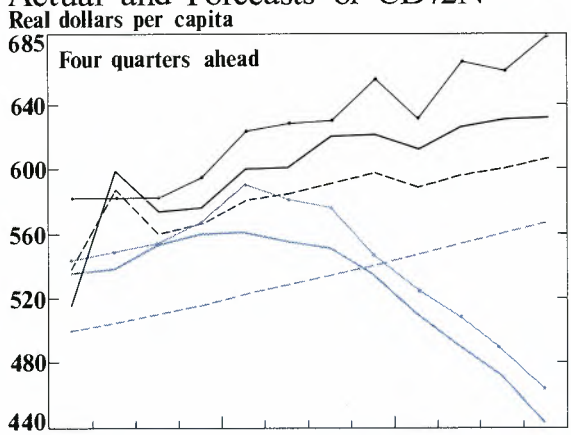
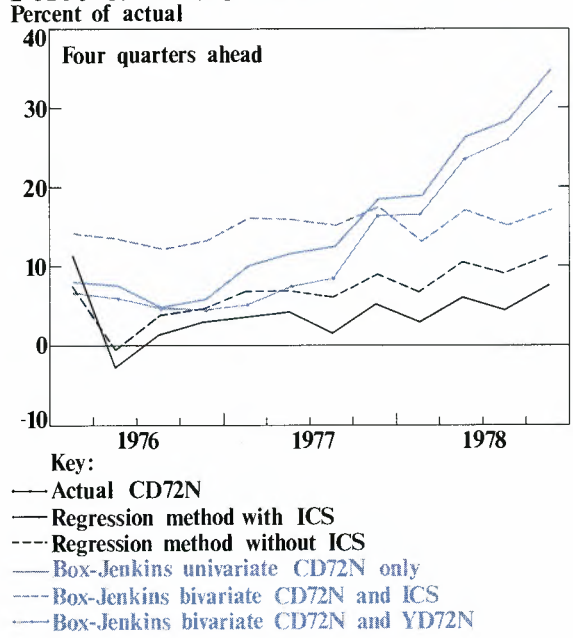


Chart 9
Forecast Errors of CD72N



capita, and the mean percent forecast error ranges from .6 to 11.5 percentage points higher. In addition, the forecast using ICS has a smaller forecast error in each quarter for the three quarters ahead forecasts; for the one, two, and four quarters ahead forecasts, it has smaller forecasts in 8, 10, and 5 quarters out of 12, respectively. Although the forecast errors of the univariate model are less than those of the bivariate model in 7 out of 12 quarters, the bivariate model has a smaller RMSE, ME, and M%E for the four quarters ahead forecasts. The forecast error in the bivariate model begins high, but it does not increase substantially over the forecast period. The forecast error in the univariate model, however, begins relatively low but increases drastically during the forecast period. In the Box-Jenkins method of forecasting, therefore, ICS has contributed significantly to improving the forecast of CD72N compared with using only CD72N in the univariate model.

In comparing the RMSEs of the two bivariate models, the model using ICS has a substantially smaller RMSE when forecasting two quarters ahead than the model using YD72N. There is not much difference for the other three forecast lengths, although the model using ICS does have a smaller RSME in two of these forecast lengths. In addition, the bivariate model using ICS has smaller forecast errors in 3, 9, 10, and 4 quarters out of the 12 for forecasting one, two, three, and four quarters ahead, respectively. For four quarters ahead, the bivariate model using YD72N has a drastic increase in its forecast error over the forecast period, while the model using ICS remains relatively level. If the forecast period were extended, the ICS model probably would compare even more favorably with the CD72N model for four quarters ahead forecasts. If a model were chosen from these results to forecast CD72N based on the RMSE, the model using ICS would be chosen for two, three, and four quarters ahead forecasts; the model using YD72N would be chosen only for one quarter ahead. The bivariate model using ICS, therefore, compares favorably with the model using YD72N and, in fact, is a slightly better predictor overall in terms of RMSE, ME, and M%E. In conclusion, ICS offers more information about future values of CD72N than does YD72N.

Overall ICS Effectiveness

To determine the overall effectiveness of ICS in forecasting CD72N, the best method must be chosen for each forecast length. As can be seen from table 1 and charts 2 through 9, the Box-Jenkins models provide better forecasts of CD72N for the shorter forecast lengths, while the regression models provide better forecasts for longer forecast lengths. Table 2 shows the ranking of these methods, with a rank of one having the smallest RMSE.

Models containing ICS provide the best forecasts for three out of four forecast lengths; in two forecast lengths (two and three quarters ahead), another model including ICS is second only to a better model containing ICS (see table 2). This result suggests that indeed ICS contains information useful in forecasting CD72N.

A Box-Jenkins model provides the best forecast, in terms of RMSE, for one and two quarters ahead, while a regression model provides the best forecast for three and four quarters ahead (see table 2). This result confirms existing theory that Box-Jenkins models generally perform well for only a few quarters ahead, while regression models have a more gradual decay in performance.

Table 2 Ranks of Forecasting Methods

	One quarter ahead	Two quarters ahead	Three quarters ahead	Four quarters ahead
Regression with ICS	2	2	1	1
Regression without ICS	5	4	4	2
Box-Jenkins univariate CD72N only	4	5	5	5
Box-Jenkins bivariate CD72N and ICS	3	1	2	3
Box-Jenkins bivariate CD72N and YD72N	1	3	3	4

Conclusion

This study is designed to determine whether surveys of consumer attitudes can improve forecasts of consumer spending on durable goods compared with forecasts that use only objective variables. The Index of Consumer Sentiment is used as a measure of consumer attitudes and expectations; disposable personal income and financial assets represent sources of spending power, and unemployment serves as a proxy for business cycles.

Regression and Box-Jenkins models are estimated, relating real per capita consumer expenditures on durable goods to objective variables and ICS. The estimated models are used to forecast CD72N, and the results from the models containing ICS and those not containing ICS are compared.

Analysis of both methods of forecasting indicates that the inclusion of ICS does indeed improve the forecasting ability of both methods. In particular, for the regression method of forecasting, ICS apparently accounts for non-economic factors that cause consumer spending to be higher than would be expected from the economic factors. It is clear, therefore, that consumer attitudes can be helpful in predicting consumer-spending patterns for durable goods.

Appendix 1 Regression Method of Forecasting

In this study two different regression models are used for each forecast length. One of these models includes ICS; the other does not. For a given forecast length, independent variables are lagged by the number of quarters necessary to ensure that the values of these variables are available at the time of the forecast. For one, two, three, and four quarters ahead forecasts, therefore, the independent variables are lagged by at least one, two, three, and four quarters, respectively. Ordinary least squares is used to estimate each model. The one quarter ahead forecast models are checked for the necessity of estimation using the Cochrane-Orcutt method of correcting for serially correlated errors.[12] Because the Durbin-Watson statistic for the one quarter ahead models is not significant for the models considered here, it is not necessary to use the Cochrane-Orcutt method. The Cochrane-Orcutt method is not used for the longer forecast length models because the resulting models would then require the lagged values of the dependent variable, which would not be available at the time the forecasts are made.[13]

The resulting forecasting functions are as follows:

One quarter ahead

1. With ICS: $\hat{CD72N}_{t+1}$

$$= .0806302\ YD72N_{t-1} + .00136659\ ICS_t - .00248406\ ICSR_t + .575325\ CD72N_t + .0000105873\ FA72N_t - .262969.$$

12. See Johnston [10].

13. The forecasts of the dependent variable could be used for these lagged values. A brief study of the possibility of using the Cochrane-Orcutt method indicated, however, that the results would probably be worse than those using least squares estimation because of the compounding of errors.

2. Without ICS: $\widehat{CD72N}_{t+1}$

$= .0541314\ YD72N_t - .208090\ ORU_{t-1}$

$+ .592829\ CD72N_t + .00001426\ FA72N_t$

$- .0988381.$

Two quarters ahead

1. With ICS: $\widehat{CD72N}_{t+2}$

$= .110768\ YD72N_t + .00150705\ ICS_t$

$- .00375331\ ICSR_t + .333011\ CD72N_t$

$+ .0000177994\ FA72N_t - .317582.$

2. Without ICS: $\widehat{CD72N}_{t+2}$

$= .0625403\ YD72N_t - .358733\ ORU_t$

$+ .433138\ CD72N_t + .0000242788\ FA72N_t$

$- .119193.$

Three quarters ahead

1. With ICS: $\widehat{CD72N}_{t+3}$

$= .205855\ YD72N_t + .0025199\ ICS_t$

$- .00481721\ ICSR_t - .0421311\ CD72N_t$

$+ .0000139278\ FA72N_t - .509799.$

2. Without ICS: $\widehat{CD72N}_{t+3}$

$= .104069\ YD72N_t - .451507\ ORU_t$

$+ .182610\ CD72N_t + .0000264406\ FA72N_t$

$- .150469.$

Four quarters ahead

1. With ICS: $\widehat{CD72N}_{t+4}$

$= .241549\ YD72N_t + .00253378\ ICS_t$

$- .00558623\ ICSR_t - .303355\ CD72N_t$

$+ .0000183806\ FA72N_t - .545761.$

2. Without ICS: $\widehat{CD72N}_{t+4}$

$= .153401\ YD72N_t - .524201\ ORU_t$

$- .110463\ CD72N_t + .0000290286\ FA72N_t$

$- .199044.$

Each of these models then is used to forecast CD72N for the same 12-quarter period, that is, the first quarter of 1976 through the fourth quarter of 1978. Only values of the independent and lagged dependent variables that would have been known in an actual forecasting situation are used. When the forecasts for the first quarter of 1976 are obtained for one, two, three, and four quarters ahead, values of the independent and lagged dependent variables are used through the fourth quarter of 1975, the third quarter of 1975, the second quarter of 1975, and the first quarter of 1975, respectively. This method of "stepping back" in time ensures that each forecast length has the same number of observations over the same period so that the different forecast lengths can readily be compared. The results of this forecasting procedure are discussed under Forecasting Results (pp. 19-22).

Appendix 2 Box-Jenkins Methods of Forecasting

The two Box-Jenkins methods of forecasting considered in this study involve (1) only values of the dependent variable being forecast (univariate models) and (2) values of the dependent variable plus an independent variable (bivariate models). Theoretically, the Box-Jenkins methods can use any number of independent variables to forecast the dependent variable; in practice, however, it is extremely difficult to use more than one independent variable. The models used in this study are restricted to include at most one independent variable–ICS or YD72N.

The univariate method develops a model relating future values of a variable to past and present values of the same variable. The first step in this development is the choice of a class of models capable of adequately describing the behavior of many time-series variables. The class of models involved in Box-Jenkins univariate forecasting is called the autoregressive integrated moving average (ARIMA). A simple example of this type of model is the first-order autoregressive model, represented by:

$$Y_t = \phi_1 Y_{t-1} + a_t$$

where Y_t is the value at time t of the dependent variable being forecast, a_t is an error term, and ϕ_1 is the autoregressive parameter that must be estimated from the data.

Once an appropriate model is chosen and estimated, it is used to obtain forecasts.[14] For the first-order autoregressive model, the forecast at time t for time t+1 (one quarter ahead forecast) is given by:

$$\hat{Y}_{t+1} = \hat{\phi}_1 Y_t$$

where $\hat{Y}_{t+1}$ is the forecast of the variable for time t+1 and $\hat{\phi}_1$ is the estimated parameter. Forecasts for more than one period ahead can also be computed using these models in a recursive manner. For this particular model, the forecasts for two, three, and four periods ahead ($\hat{Y}_{t+2}$, $\hat{Y}_{t+3}$, and $\hat{Y}_{t+4}$, respectively) are given by:

$$\hat{Y}_{t+2} = \hat{\phi}_1 \hat{Y}_{t+1} = \hat{\phi}_1^2 Y_t$$

$$\hat{Y}_{t+3} = \hat{\phi}_1 \hat{Y}_{t+2} = \hat{\phi}_1^3 Y_t$$

$$\hat{Y}_{t+4} = \hat{\phi}_1 \hat{Y}_{t+3} = \hat{\phi}_1^4 Y_t.$$

Because the forecasts for longer time lengths are functions of the shorter length forecasts, the forecast errors will tend to be larger for longer forecast lengths.

The general ARIMA model is an extension of the first-order autoregressive model and takes the format of:

$$\phi(B)\, \nabla^d Y_t = \Theta(B)\, a_t + \theta_0$$

where

$$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p$$

$$\Theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q$$

$$\nabla^d = (1 - B)^d$$

and B is the back shift operator (for example, $BY_t = Y_{t-1}$). In this model, $\phi_1, \ldots, \phi_p$, θ_0, $\theta_1, \ldots, \theta_q$, p, q, and d are all parameters estimated from the data. In general, this model is called an autoregressive integrated moving average model of order (p, d, q). The simple first-order autoregressive model is of this form with $\theta_0 = 0$, p = 1, q = 0, and d = 0. That is,

$$\phi(B) = 1 - \phi_1 B$$

$$\Theta(B) = 1$$

$$\nabla^d = (1 - B)^0 = 1.$$

Using these specifications in the general model yields,

$$(1 - \phi_1 B)\, Y_t = a_t$$

or

$$Y_t - \phi_1 B Y_t = a_t$$

or

$$Y_t - \phi_1 Y_{t-1} = a_t$$

or

$$Y_t = \phi_1 Y_{t-1} + a_t$$

which is the first-order autoregressive model as stated above.

Any ARIMA model, therefore, involves past and present values of Y_t and the error term (a_t). For any such model, the forecast of the variable Y at time t for any length of time, ℓ, into the future will be a function of the present and past values of Y_t and a_t and can be represented as

$$\hat{Y}_{t+\ell} = f_\ell(Y_t, Y_{t-1}, \ldots, a_t, a_{t-1}, \ldots)$$

where the exact form of the function and the number of Y_ts and a_ts in the function depend on the model developed and the forecast length ℓ.

In this study, the univariate method is used in two ways: (1) to forecast CD72N and (2) to forecast the independent variables used in the bivariate model (as discussed in the following description of bivariate models). Thus, univariate models are developed for CD72N, YD72N, and ICS:

$$\nabla ICS_t = a_t - .34889$$

$$\nabla YD72N_t = a_t - .51524 a_{t-1} + .024268$$

$$CD72N_t = .99278\, CD72N_{t-1} + a_t - .34646\, a_{t-7} - .21988\, a_{t-8} - .08999\, a_{t-9} + .007225.$$

The one quarter ahead forecast function for the three variables is as follows:

$$\hat{ICS}_{t+1} = ICS_t - .34889$$

$$\hat{YD72N}_{t+1} = YD72N_t - .51524\, a_t + .024268$$

$$\hat{CD72N}_{t+1} = .99278\, CD72N_t - .34646\, a_{t-6} - .21998\, a_{t-7} - .08999\, a_{t-8} + .007225.$$

The two, three, and four quarters ahead forecast functions are obtained recursively by:

14. The process of identifying and estimating Box-Jenkins models is a very sophisticated, technical process that allows the behavior of the data to determine the appropriate model. See Box and Jenkins [3] for a description of this process.

Two quarters ahead

$$\hat{ICS}_{t+2} = ICS_{t+1} - .34889$$
$$\hat{YD72N}_{t+2} = YD72N_{t+1} + .024268$$
$$\hat{CD72N}_{t+2} = .99278\ CD72N_{t+1} - .34646\ a_{t-5} - .21998\ a_{t-6} - .08999\ a_{t-7} + .007225.$$

Three quarters ahead

$$\hat{ICS}_{t+3} = ICS_{t+2} - .34889$$
$$\hat{YD72N}_{t+3} = YD72N_{t+2} + .024268$$
$$\hat{CD72N}_{t+3} = .99278\ CD72N_{t+2} - .34646\ a_{t-4} - .21988\ a_{t-5} - .08999\ a_{t-6} + .007225.$$

Four quarters ahead

$$\hat{ICS}_{t+4} = ICS_{t+3} - .34889$$
$$\hat{YD72N}_{t+4} = YD72N_{t+3} + .024268$$
$$\hat{CD72N}_{t+4} = .99278\ CD72N_{t+3} - .34646\ a_{t-3} - .21988\ a_{t-4} - .08999\ a_{t-5} + .007225.$$

In the bivariate Box-Jenkins method of forecasting, an independent variable is added to the dependent variable, and the resulting model is used to forecast the dependent variable. Transfer function models are used in bivariate Box-Jenkins forecasting; a simple example of such a model is:

$$Y_t = \delta_1 Y_{t-1} + \omega_0 X_t + a_t$$

where Y_t is the dependent variable to be forecast, X_t is the independent variable, a_t is the error term, and δ_1 and ω_0 are parameters that must be estimated from the data. The forecast for Y_{t+1} at time t, $\hat{Y}_{t+1}$, for this model is given by:

$$\hat{Y}_{t+1} = \hat{\delta}_1 Y_t + \hat{\omega}_0 \hat{X}_{t+1}$$

where $\hat{X}_{t+1}$ is a forecast of X_{t+1}, since X_{t+1} is not known at time t and $\hat{\delta}_1$ and $\hat{\omega}_0$ are estimates of the parameters. In this study, a univariate model is used to forecast the independent variable whenever a value of the independent variable is needed in the forecast function for Y_t and this value is not known.

To forecast two, three, or four quarters ahead, the following function is used recursively to obtain the forecasting functions:

$$\hat{Y}_{t+2} = \hat{\delta}_1 \hat{Y}_{t+1} + \hat{\omega}_0 \hat{X}_{t+2}$$
$$\hat{Y}_{t+3} = \hat{\delta}_1 \hat{Y}_{t+2} + \hat{\omega}_0 \hat{X}_{t+3}$$
$$\hat{Y}_{t+4} = \hat{\delta}_1 \hat{Y}_{t+3} + \hat{\omega}_0 \hat{X}_{t+4}.$$

Thus, the forecast of Y for longer time periods depends on the forecasts of Y for the shorter time periods plus the forecasts of X. This implies that the forecast error will tend to build up as the forecast length increases, since, for example, an error in $\hat{Y}_{t+1}$ will cause an error in $\hat{Y}_{t+2}$, $\hat{Y}_{t+3}$, etc.

The extension of this model leads to the general model given by:

$$\delta(B)Y_t = \omega(B)X_{t-b} + N_t$$

where

$$\delta(B) = 1 - \delta_1 B - \delta_2 B^2 - \ldots - \delta_r B^r$$
$$\omega(B) = \omega_1 - \omega_1 B - \omega_2 B^2 - \ldots - \omega_s B^s$$

B is the back shift operator (for example, $BX_t = X_{t-1}$), b is the lag length of X relative to Y (that is, the number of periods it takes for a change in X to produce a change in Y), and N_t is the noise component of the model that is assumed to follow a univariate Box-Jenkins model such as the one discussed above. For example:

$$\phi(B)\nabla^d N_t = \Theta(B)\, a_t + \theta_0.$$

This noise component represents the movement in Y that is not explained by past Y values or by current plus past X values. In this model, $\delta_1, \delta_2, \ldots, \delta_r, \omega_0, \omega_1, \ldots, \omega_s, \phi_1, \phi_2, \ldots, \phi_p, \theta_1, \theta_2, \ldots, \theta_q, \theta_0$, r, s, b, p, d, and q are all parameters that must be estimated from the data.

Once a model is identified and estimated, it is used to forecast CD72N.[15] The models developed for CD72N as a function of (1) CD72N and ICS and (2) CD72N and YD72N are:

1. $CD72N_t$
$$= CD72N_{t-1} + .001306\ ICS_{t-1} - .0007272\ ICS_{t-2} + .0009849\ ICS_{t-3} - .001563\ ICS_{t-4} + .00604 + N_{1,t}$$

15. As for the univariate model, this procedure is a sophisticated and highly technical procedure. See Box and Jenkins [3] for a discussion of this procedure.

where

$$N_{1,t} = -.34899\, N_{1,t-1} + a_{1,t}.$$

2. $CD72N_t$

$$= CD72N_{t-1} + .19976\,(YD72N_t - YD72N_{t-1}) + N_{2,t}$$

where

$$(1 + .47444B)N_{2t} = (1 - .53022B^7 - .31310B^8 - .18025B^9)\, a_{2,t}.$$

The forecasts for CD72N are thus given by:

One quarter ahead

1. $\hat{CD72N}_{t+1}$

$$= CD72N_t + .001306\, ICS_t - .0007272\, ICS_{t-1} + .0009849\, ICS_{t-2} - .001563\, ICS_{t-3} + .00604 + \hat{N}_{1,t+1}$$

where

$$\hat{N}_{1,t+1} = -.34899\, N_{1,t}.$$

2. $\hat{CD72N}_{t+1}$

$$= CD72N_t + .19976\,(YD72N_{t+1} - YD72N_t) + \hat{N}_{2,t+1}$$

where

$$\hat{N}_{2,t+1} = -.47444\, N_{2,t} - .53022\, a_{2,t-6} - .31310\, a_{2,t-7} - .18025\, a_{2,t-8}.$$

Two quarters ahead

1. $\hat{CD72N}_{t+2}$

$$= \hat{CD72N}_{t+1} + .001306\, \hat{ICS}_{t+1} - .0007272\, ICS_t + .0009849\, ICS_{t-1} - .001563\, ICS_{t-2} + .00604 + \hat{N}_{1,t+2}$$

where

$$\hat{N}_{1,t+2} = -.34889\, \hat{N}_{1,t+1}.$$

2. $\hat{CD72N}_{t+2}$

$$= \hat{CD72N}_{t+1} + .19976\,(\hat{YD72N}_{t+2} - \hat{YD72N}_{t+1}) + \hat{N}_{2,t+2}$$

where

$$\hat{N}_{2,t+2} = -.47444\, \hat{N}_{2,t+1} - .53022\, a_{2,t-5} - .31310\, a_{2,t-6} - .18025\, a_{2,t-7}.$$

Three quarters ahead

1. $\hat{CD72N}_{t+3}$

$$= \hat{CD72N}_{t+2} + .001306\, \hat{ICS}_{t+2} - .0007272\, \hat{ICS}_{t+1} + .0009849\, ICS_t - .001563\, ICS_{t-1} + .00604 + \hat{N}_{1,t+3}$$

where

$$\hat{N}_{1,t+3} = -.34899\, \hat{N}_{1,t+2}.$$

2. $\hat{CD72N}_{t+3}$

$$= \hat{CD72N}_{t+2} + .19976\,(\hat{YD72N}_{t+3} - \hat{YD72N}_{t+2}) + \hat{N}_{2,t+3}$$

where

$$\hat{N}_{2,t+3} = -.47444\, \hat{N}_{2,t+3} - .53022\, a_{2,t-4} - .31310\, a_{2,t-5} - .18025\, a_{2,t-6}.$$

Four quarters ahead

1. $\hat{CD72N}_{t+4}$

$$= \hat{CD72N}_{t+3} + .001306\, \hat{ICS}_{t+3} - .0007272\, \hat{ICS}_{t+2} + .0009849\, \hat{ICS}_{t+1} - .001563\, \hat{ICS}_t + .00604 + \hat{N}_{1,t+4}$$

where

$$\hat{N}_{1,t+4} = -.34889\hat{N}_{1,t+3}.$$

2. $\hat{CD72N}_{t+4}$

$$= \hat{CD72N}_{t+3} + .19976\,(\hat{YD72N}_{t+4} - \hat{YD72N}_{t+3}) + \hat{N}_{2,t+4}$$

where

$$\hat{N}_{2,t+4} = .47444\, \hat{N}_{2,t+3} - .53022\, a_{2,t-3} - .31310\, a_{2,t-4} - .18025\, a_{2,t-5}.$$

Whenever ICS or YD72N has to be forecast, the univariate Box-Jenkins model for the respective variables is used. The results of this forecasting method, as well as of the univariate method and the regression model, are presented on pp. 19-22.

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