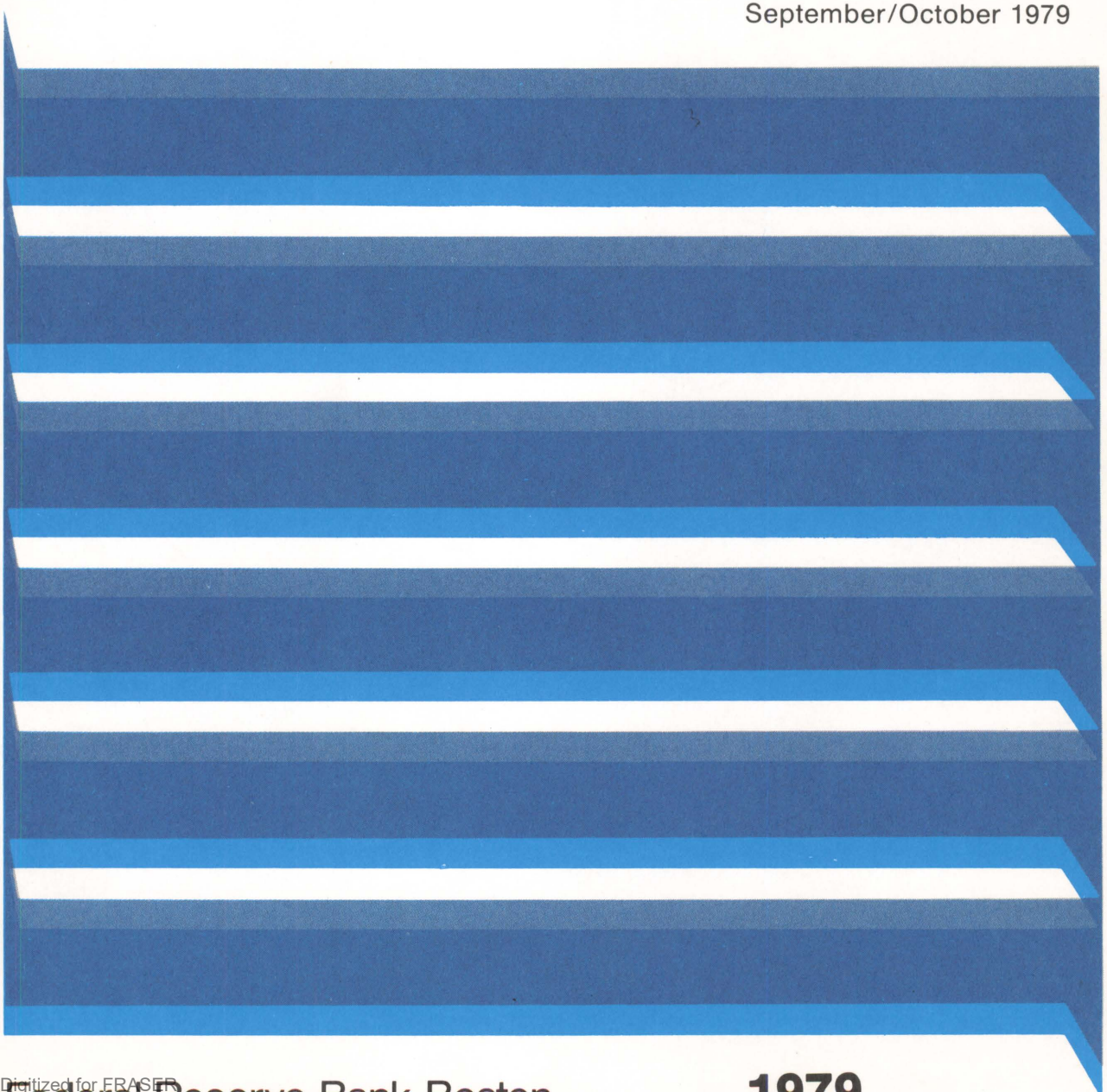
New England Economic Review

September/October 1979



Federal Reserve Bank Boston

1979

The **New England Economic Review** is produced in the Research Department, and is edited by Mrs. Ruth Norr. The views expressed are those of the individual authors, and do not necessarily reflect official positions of the Federal Reserve Bank of Boston or the Federal Reserve System. The authors will be glad to receive comments on their articles.

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In this issue . . .

Inflation and the Capital Financing of New England Commercial Banks in the 1980s

By Ralph C. Kimball and Robert L. McDonald*

Introduction

Commercial bank capital is equal to the excess of total assets over the sum of deposits and borrowed funds. Bank capital acts as a margin of safety to insure that banks will be able to pay depositors and other creditors. During most of the 1970s bank capital grew more slowly than assets, resulting in a decline in the ratio of bank capital to assets, deposits, and risk assets. Capital ratios of New England banks declined somewhat more than those of banks elsewhere. This article examines the capital adequacy of New England commercial banks with emphasis on the capital needs of those banks in the 1980s. Of particular interest is the effect of inflation on banks' capital structure and the amount of capital which may have to be raised from external sources through the sale of stock or subordinated debt.

Part I discusses the role of bank capital and analyzes the effect of inflation and changing profit margins on capital accumulation. Part II derives estimates of capital needs of New England commercial banks in the 1980s under various assumptions as to the asset growth rates and profit margins. Part III discusses some implications of Parts I and II.

Banks report almost all of their assets and liabilities at book value. During periods of inflation and changing interest rates book values may differ from real or market values. In this article the analysis is reported in terms of book values, since the available data are in that form. It is important, however, to keep in mind that book values ultimately reflect changes in real values, although changes in book values may lag changes in real values. Indeed, it is a principal theme of this article that changes in the book value of bank capital represent a delayed reaction to changes in the real value of such capital.

Part I: The Role of Bank Capital

Bank capital is defined as the sum of stockholders' equity, subordinated debt, and reserves for loan losses, or equivalently, as the excess of total assets over the sum of deposits and borrowed funds. As financial intermediaries, commercial banks pool funds from different sources and invest these funds among a large number of risky loans in the expectation that the income, net of operating expense and interest paid to

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obtain funds, will exceed the losses on those loans which default. While such expectations are usually fulfilled, a commercial bank may occasionally experience loan losses which exceed the net income generated by the successful investments. In such circumstances a bank would be insolvent, in the sense that the bank's assets would be insufficient to pay off depositors and other creditors, unless a cushion of capital existed to absorb loan losses.[1] While any decrease in bank assets arising from loan losses will reduce bank capital on a dollar for dollar basis, insolvency will not result so long as bank capital exceeds the losses charged against it. Thus, the soundness of a bank depends upon the size of the capital cushion relative to the expected potential losses. Clearly, the more capital there is relative to assets or total loans outstanding, the more loans will have to fail before the bank would deplete its capital and be unable to meet its obligated liabilities.

Because soundness is a relative concept, discussions of bank capital adequacy are usually carried on in terms of balance-sheet ratios, usually called capital ratios, with the most commonly used ratio that of capital to assets. Thus, a ratio of capital to assets of 5 percent implies that 5 percent of the bank's assets must fail before the bank becomes insolvent.

The capital-to-asset ratio is only one of a number of capital ratios, each one used for a different purpose. Not all assets embody the same risk of default, and bankers themselves may also differ in their aversion to risk. Thus, two banks with the same level of assets and capital may differ in their soundness due to differences in the composition of their portfolios. To reflect these differences in portfolio composition several different capital ratios are often used. One, for example, is the ratio of capital to risk assets, where risk assets are defined as total assets less the sum of vault cash, reserves on deposit at Federal Reserve Banks, U.S. Treasury and agency securities, trading account securities, and federal funds sold. The rationale for excluding vault cash, reserves on deposit at Federal Reserve Banks, and U.S. Treasury and agency securities is straightforward since these assets are either cash or are guaranteed by the U.S. government. Trading account securities are also very liquid, and since these securities are carried on the bank's books at market, their reported value is very close to their true value. Federal funds sold are unsecured loans to other financial institutions but since most fed funds are sold on an overnight basis, these assets are also convertible to cash on very short notice.

Another bank capital ratio which incorporates differences in the relative riskiness of bank portfolios is the capital-to-loan ratio. Since almost all losses occur on loans rather than on securities or money market instruments, the capital-to-loan ratio measures the size of the capital cushion relative to those assets most likely to fail. In some sense both the capital-to-risk assets and capital-to-loan ratio are somewhat imperfect since the capital-to-risk assets ratio ignores the riskiness attached to holding trading account securities and selling fed funds, while the capital-to-loan ratio ignores both these factors and the possibility of default on state and local securities, and neither ratio incorporates any measure of variations in the riskiness of the loan portfolio itself. However, no single ratio is likely to capture all the degrees of riskiness of a bank's portfolio, so that the capital-to-risk assets and capital-to-loan ratios represent a compromise based on a subjective judgment that the probability of default on assets other than loans or risk assets are so low that the amount of

[1] Banks differ from nonfinancial corporations in the contingencies they must be prepared to meet. To remain solvent, a nonfinancial corporation must be prepared to cover both interest on debt outstanding and principal on maturing debt. Banks must be prepared to meet these same requirements but also must be prepared to pay off almost all their liabilities. Thus banks must be concerned with their liquidity as well as cash flow.

capital necessary to shield the bank is negligible.

While capital ratios convey a great deal of information, they are not the only indicators of bank soundness. Other income and balance sheet ratios, such as that of purchased funds to total assets or liquid assets to total assets, and various measures of loan quality can also carry information as to bank soundness. Thus, for example, a slight decline in capital ratios might be more than offset by increases in loan quality and liquidity ratios.

The Sources of Bank Capital

Bank capital can be augmented in several ways. The most important source of bank capital is retained earnings. If a bank pays only part of its after-tax earnings as dividends, the remainder can be used to increase assets while on the liability side surplus or undivided profits increase by the same amount. Since undivided profits and surplus are neither deposits nor borrowed funds, the capital available to shield depositors and other creditors increases.

A second way to increase capital is by increasing loan loss reserves. A bank is allowed to deduct part of its pretax income as a provision for loan losses. The size of this provision depends upon the bank's past experience and present circumstances. If in any period actual loan losses are less than the provision for loan losses, the balance is used to increase loans or other assets, while on the liability side a reserve for loan losses is created. Since the creation of such a reserve increases assets but is neither a deposit nor borrowed funds, these loan loss reserves act as capital against which future loan losses may be charged. The principal difference between retained earnings and provisions for loan losses as a means of increasing capital is that the latter is deductible from pretax income so that the opportunity cost, in terms of dividends foregone, of an additional dollar of capital is substantially less when generated as an increase in the loan loss reserves than as retained earnings.

A third way of increasing bank capital is to sell new stock or subordinated debt to either present stockholders or to new investors, with the proceeds being used to purchase additional assets. Capital raised in this manner is often called external capital since it is obtained outside the bank, while capital raised through additions to loan loss reserves or from retained earnings is often called internal capital.

Economic theorists working in the field of corporate finance often make simplifying assumptions such as the absence of taxes, reserve requirements, and the possibility of bankruptcy as a way of easing the analysis of complex problems. In this ideal world of theoretical finance, bank stockholders and depositors would be indifferent between new deposits and additions to capital from internal or external sources as ways of financing asset growth. Of particular interest is the fact that in this world bankers could raise the capital-to-asset ratio at will simply by issuing new equity and using the proceeds to pay off deposits. Obviously, however, this idealized world is not that in which banks operate. Banks do in fact come under pressure from regulators to raise capital ratios, and yet some capital ratios remain low. The fact that capital ratios have continued to decline throughout the 1970s despite regulatory pressure and the voiced concern of bankers themselves is prima facie evidence that the simple theoretical model is unsuited to understanding the behavior of bank capital ratios.

The Importance of Profit Margins

History suggests a strong tie between commercial bank earnings and bank capital ratios. In the first half of 1978, for example, retained

earnings accounted for almost 80 percent of the $4.5 billion increase in total U.S. bank capital. If the earnings retention rate is defined as retained earnings per dollar of assets, an increase in this rate will generate additional capital per dollar of assets, resulting in higher long-run capital ratios.[2] This effect is shown in the first panel of table 1 which shows three different long-run capital ratios corresponding to three different earnings retention rates. As can be seen from table 1, if retained earnings are the only source of capital, asset growth rates are constant, and the earnings retention rate remains constant at seven-tenths of 1 percent, then in the long run the capital-to-asset ratio will converge to 7.7 percent. However, if retained earnings per dollar of assets is only five-tenths of 1 percent or three-tenths of 1 percent, then in the long run bank capital ratios will converge to 5.5 percent and 3.3 percent respectively.[3]

While there exists a unique long-run capital-to-asset ratio corresponding to different earnings retention rates, in the short run changes in capital ratios lag changes in earnings retention. If after a once-and-for-all change the earnings retention rate remains constant for a long enough period, capital will ultimately grow at the same rate as assets so that capital-to-asset ratios will be constant. But if the earnings retention rate should decrease, the amount of marginal capital generated per dollar of assets will also decline and capital will grow more slowly than assets, with a resulting decline in the capital-to-asset ratio. As shown in figure 1, the capital-to-asset ratio will continue to fall until it reaches a new long-run equilibrium level corresponding to the new earnings retention rate, at which point capital will again be growing at the same rate as assets but with a lower long-term capital-to-asset ratio.

Table 1
Effect of Profit Margins and Asset Growth Rates on Long-Run Capital-to-Asset Ratios

Panel I: The Effect of Changing Profit Margins

	Case A	Case B	Case C
Annual asset growth rate (percent)	10	10	10
Net after-tax earnings per dollar of assets (basis points)	100	80	60
Dividends per dollar of assets (basis points)	30	30	30
Retained earnings per dollar of assets (basis points)	70	50	30
Long-run capital-to-asset ratio (percent)	7.7	5.5	3.3

Panel II: The Effect of Changing Asset Growth Rates

	Case D	Case E	Case F
Annual asset growth rate (percent)	5	10	15
Net after-tax earnings per dollar of assets (basis points)	80	80	80
Dividends per dollar of assets (basis points)	30	30	30
Retained earnings per dollar of assets	50	50	50
Long-run capital-to-asset ratios (percent)	10.5	5.5	3.8

Source: See technical appendix, part I.

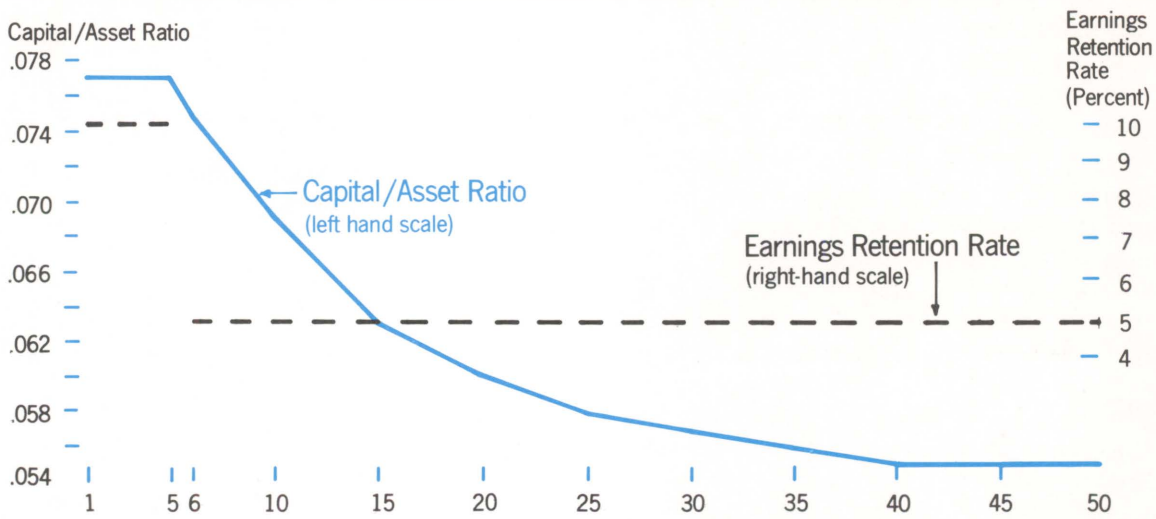
The Importance of Asset Growth

A second important determinant of long-run capital ratios is the rate of asset growth. Even if the earnings retention rate should remain constant, changes in asset growth rates will affect capital ratios. If the earnings retention rate remains constant, each additional dollar of assets will be no less profitable than the assets existing at the beginning of the period, but the existing capital must be spread over a greater number of asset dollars so that high asset growth rates result in lower capital ratios. For example,

[2] This definition of the earnings retention rate differs from that often used elsewhere. In many applications the earnings retention rate is defined as the proportion of earnings not paid out as dividends.

[3] For a derivation of these results see the technical appendix.

Chart 1
Effect of the Earnings Retention Rate on Capital/Asset Ratios



Source: See Technical Appendix

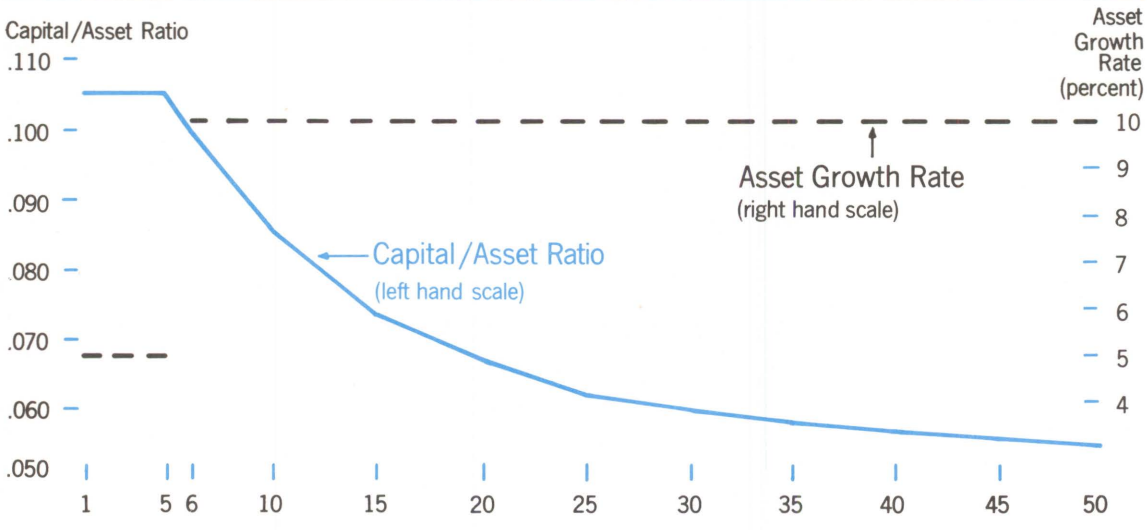
assume a bank with $100 in assets, $10 in capital, and an after-tax, after-dividends earnings rate of 1 percent on assets. If on January 1st assets should double to $200 and the retention rate remains constant, then at the end of a year capital will be equal to $12 and the capital-to-asset ratio will be 6 percent, compared with 10 percent at the end of the previous year.[4] The effect of the acceleration in the asset growth rate is to dilute the existing capital base, even if the additional assets are no less profitable than the original assets.

If asset growth should continue at the new high rate, the existing capital will continue to be spread over a steadily increasing asset base and capital ratios will continue to fall until the level of bank capital and the additions to bank capital are such that the growth rate of capital just equals the new asset growth rate. At this point capital-to-asset ratios will stabilize and assume their long-run values. Thus, just as in the case of retention rates, there are unique long-run capital-to-asset ratios corresponding to particular asset growth rates. This can be seen in the second panel of table 1, which shows long-run capital-to-asset ratios corresponding to a constant retention rate but different asset growth rates. Thus, if the earnings retention rate remains constant at 50 basis points per dollar of assets, long-run bank capital to asset ratios may converge to 10.5 percent, 5.5 percent, or 3.8 percent depending whether the long-run asset growth rate is 5, 10, or 15 percent per year. Figure 2 shows the path of adjustment of the capital to asset ratio to a once-and-for-all shift in the asset growth rate.

[4] This assumes that on January 1st assets become $200 and remain constant over the year. If assets grow over the year and really average only $150 over the entire year, then the increment to capital is less and the decline in capital ratios greater than reported above.

Chart 2

Effect of Asset Growth Rate on Capital/Asset Ratios



Source: See Technical Appendix

Because higher asset growth rates result in lower long-term capital-to-asset ratios, banks will find it difficult during periods of inflation to generate sufficient capital from internal sources to maintain steady capital ratios. An increase in the inflation rate causes accelerated growth of deposits, and also of the assets acquired with these deposits, but does not affect the capital previously accumulated. As a result capital per dollar of assets declines whenever inflation increases.

Inflation affects the profitability of firms in many different ways. Two of these ways are the effect upon the effective tax rate paid by the firm and the temporary savings on interest costs if the firm has long-term liabilities outstanding.[5] However, abstracting from these effects, inflation will affect the real balance sheets of banks and nonfinancial firms in opposite ways.[6] Because most nonfinancial firms have a greater amount of total financial liabilities than total financial assets, an increase in the price level causes a greater reduction in the real value of total financial liabilities than the real value of total financial assets. In effect the real value of the debt outstanding declines while the real value of the physical equipment financed by the debt does not. Thus increased inflation acts to strengthen

[5] Because firms are taxed on the inflation-related gains on inventories, and because firms compute depreciation deductions on the original cost of equipment, the effective real tax on earnings increases sharply during periods of inflation. As a result the return to capital declines. See Richard W. Kopcke, "The Decline in Corporate Profitability," *New England Economic Review*, May/June 1978.

Because an acceleration in the inflation rate is usually accompanied by rising interest rates, firms with outstanding long-term financial liabilities such as mortgages or bonds will experience savings on interest costs which would not occur if the liabilities had been short term. These savings are capitalized into the market price of the bond.

[6] See Richard W. Kopcke, "Current Accounting Practices and Proposals for Reform," *New England Economic Review*, September/October 1976.

Table 2
Capital Ratios at Insured Commercial Banks, 1969–77 (percent)

End of Period	Capital-to-Total Assets		Capital-to-Adj. Risk Assets		Capital-to-Loans	
	New England	Rest of U.S.	New England	Rest of U.S.	New England	Rest of U.S.
1969	9.4%	8.6%	12.9%	12.5%	16.2%	15.9%
1970	9.0	8.5	12.5	12.5	16.3	16.4
1971	8.9	8.3	12.2	12.2	16.0	16.3
1972	8.4	8.0	11.6	11.6	14.9	15.3
1973	8.3	7.9	11.2	11.1	14.0	14.3
1974	8.3	7.9	10.9	11.0	13.9	14.2
1975	8.4	8.2	11.6	11.7	15.9	15.5
1976	8.3	8.3	11.5	11.9	15.1	15.7
1977	7.8	7.9	11.1	11.7	14.5	15.1
1978:2	7.9	8.1	11.3	11.4	14.4	15.3

Definitions: Capital is defined as the sum of equity capital, subordinated debt, and reserves. Adjusted risk assets are total gross assets less cash, U.S. Treasury and agency securities, trading account securities, and Federal funds sold.
Source: Federal Deposit Insurance Corporation, *Assets and Liabilities of Commercial and Mutual Savings Banks*, various years.

the real balance sheet of most nonfinancial firms. Banks, on the other hand, have a greater amount of financial assets than financial liabilities so that an increase in the price level causes a greater reduction in the total real value of the financial assets than in the total real value of financial liabilities.[7] As a result the real balance sheet of banks weakens during inflation, and this weakening appears in book values as a decline in the ratio of book capital to assets.

The importance of asset growth in determining long-run capital ratios should be emphasized since during the 1970s bank asset growth rates accelerated. During the period 1970–78:2 asset growth at U.S. commercial banks averaged 9.8 percent per year, compared to 8.1 percent during the period 1960–69. As can be seen in table 2, bank capital ratios fell during most of the 1970s, both in New England and elsewhere.

In New England the sluggish economic activity which characterized most of the region through the early and middle 1970s resulted in slower asset growth than elsewhere. Asset growth at New England commercial banks averaged 8.4 percent during the period 1970–78:2, compared to 7.6 percent for the period 1960–69. However, substantially higher loan losses, combined with a shift in the composition of bank liabilities from noninterest bearing demand deposits to interest bearing time and savings deposits caused profit margins to decline substantially at New England banks.[8] As shown in table 3, the earnings retention rate at New England banks averaged 36 basis points during the period 1970–78:2 compared to 54 basis points for commercial banks in the rest of the country. The effect of these lower earnings retention rates more than offset the slower asset growth in the six New England states so that whereas at the end of 1969 capital ratios at New England banks exceeded those elsewhere, by the middle of 1978 capital ratios at New England

[7] See "Bank Earnings and Capital Adequacy," an address by Henry C. Wallich, Member, Board of Governors of the Federal Reserve System, before the Twelfth Annual Banking Law Institute, New York City, Thursday, May 12, 1977.
[8] See Ralph Kimball, "Commercial Bank Profitability in New England: A Comparative Study," *New England Economic Review*, November/December 1978.

Table 3
Earnings Retention Rates at Commercial Banks, 1970–78:2 (basis points)

	New England	Rest of U.S.
1970	44.8	45.7
1971	28.9	46.7
1972	35.4	52.3
1973	36.3	55.2
1974	39.7	54.1
1975	31.8	50.1
1976	25.4	52.3
1977	37.4	57.8
1978:2	48.9*	71.8*

* At annual rate.

Note: In this table the earnings retention rate includes net additions to loan loss reserves and is defined as the ratio of adjusted net income, less dividends, to assets, where adjusted net income is equal to net income after taxes and securities transactions adjusted to reflect actual net loan losses. As defined in the text and used to construct the projections in Part II the earnings retention rate does not include net additions to loan loss reserves. The ratios reported were constructed using the method developed in Peter Lloyd-Davies, *Measuring Rates of Return*, Research Papers in Banking and Financial Economics, Board of Governors of the Federal Reserve System, 1977.

Source: Federal Deposit Insurance Corporation, *Assets and Liabilities of Commercial and Mutual Savings Banks*, various years.

banks had fallen below those at banks in the rest of the United States, despite the substantial decline in capital ratios at these other banks.

Part II: Capital Needs of New England Banks

Because capital ratios lag changes in retention rates and asset growth rates, the current capital-to-asset ratio may not be the same as the implicit long-run capital-to-asset ratio. For example, a bank's current capital ratios may be satisfactory, but the current retention rates and asset growth rates may be such that capital ratios will decline in the future to unsatisfactory levels if remedial action is not taken. Thus, projections of future capital ratios are useful to both bankers and regulators, especially during periods of changing profit margins and asset growth rates.

Up to this point the discussion of the effect of retention rates and asset growth rates on bank capital ratios has assumed that retained earnings are the only source of capital. In reality, of course, banks do not have to passively accept the capital ratios implied by given profit margins and asset growth rates, but may also add external capital through the sale of additional equity or debt.[9]

This section uses assumptions concerning long-run trends in asset growth, earnings per dollar of assets, and the earnings retention rate to project additions to capital from internal sources for New England commercial banks through the 1980s. In addition, these projected capital increments generated from internal sources may be used to derive the amount of external capital needed if capital ratios are not to decline. While this method does not predict either the amount of external capital banks will actually obtain, nor the capital-to-asset ratios which will result, it does make explicit the amount of external capital needed if a future decline in capital-to-asset ratios is to be avoided.

Given data as to the existing assets and some assumed long-run value for the asset growth rates, bank assets may be extrapolated indefinitely into the future. If a long-run value is also assumed for earnings per dollar of assets, then application of this earnings rate to the projected asset values gives a series of projected annual earnings from the same period. Retained earnings may then be calculated from the series of projected earnings by assuming some payout ratio for dividends, and this series of retained earnings is equivalent to the projected annual increments to capital from internal sources.

By combining the time series of projected retained earnings with data on existing bank

[9] Capital may also be increased by additions to loan loss reserves but recent changes in the law require banks to base provisions for loan losses on their experience of actual loan losses, so that in the long run additions to loan loss reserves cannot be used to strengthen capital ratios.

Table 4
Projected Increments to Capital at New England Commercial Banks 1978–1990 ($ thousands)

	Projected Assets	Projected Additions to Capital from Internal Sources	Annual Addition to Capital from External Sources Needed to Maintain Constant Capital/Asset Ratio of 7.8 Percent
Case I			
1978	$45,836,210	$148,638	$37,892
1979	48,769,680	158,158	70,660
1980	51,890,900	168,272	75,183
1981	55,211,860	179,041	79,994
1982	58,745,360	190,499	85,113
1983	62,505,260	202,691	90,562
1984	66,505,260	215,663	96,357
1985	70,761,540	229,465	102,523
1986	75,290,210	244,151	109,085
1987	80,108,700	259,777	116,066
1988	85,235,580	276,402	123,495
1989	90,690,580	294,091	131,398
1990	96,494,690	312,913	139,808
Case II			
1978	$46,697,810	$159,193	$94,542
1979	50,620,400	172,565	133,397
1980	54,872,480	187,060	144,602
1981	59,481,740	202,773	156,750
1982	64,478,180	219,806	169,916
1983	69,894,300	238,270	184,180
1984	75,765,390	258,284	199,661
1985	82,129,650	279,980	216,432
1986	89,028,500	303,498	234,612
1987	96,506,850	328,992	254,320
1988	104,613,400	356,627	275,682
1989	113,400,800	386,583	298,840
1990	122,926,500	419,056	323,942
Case III			
1978	$47,559,380	$162,130	$158,807
1979	52,505,500	178,991	206,807
1980	57,966,020	197,606	228,314
1981	63,994,420	218,157	252,059
1982	70,649,780	240,845	278,273
1983	77,997,280	265,893	307,212
1984	86,108,930	293,545	339,164
1985	95,064,180	324,074	374,435
1986	104,950,600	357,777	413,377
1987	115,865,600	394,986	456,368
1988	127,915,500	436,064	503,828
1989	141,218,500	481,414	556,227
1990	155,905,100	531,480	614,075

Source: Author's projections.

capital, an internal-sources-only time series of bank capital may be calculated. Since this series includes no additions to capital from external sources, it can be used to predict future capital ratios in the absence of sales of equity or debt. This series can also be used to make explicit the amount of external capital needed if a future decline in capital ratios is to be avoided.

Projections for New England commercial banks of total assets, increments to capital from internal sources, and the implied increments to capital from external sources if the capital-to-asset ratio is to remain constant at 7.8 percent are shown in table 4. Case I is based on the entire postwar experience and assumes an annual asset growth rate of 6.4 percent. Case II is based on the experience of the 1970s and assumes an annual asset growth rate of 8.4 percent, while Case III assumes even higher inflation with an asset growth rate of 10.4 percent. Although the ratio of retained earnings to assets in Case I is based on an average for the entire postwar period, while that used in Cases II and III is based on an average for the 1970s only, the two rates are remarkably similar, with that of Case I equal to 32.4 basis points, while that of Cases II and III is equal to 34.1 basis points.

Table 5 condenses the information of table 4 by showing annual increments to capital, both those which actually occurred during the period 1970–77, and projected increments to capital under each of the three cases for the period 1980–1990. In each of the cases the projected average increment to capital from internal sources is substantially larger than the $120 million per year which occurred during the period 1970–77, ranging from $234 million per year in Case I to $340 million per year in Case III. While the projections appear to be very large relative to recent experience, the increased size is due mostly to the effect of compounding high asset growth rates. A bank with assets growing at an average rate of 6.4 percent will be 2.2 times as large at the end of a 13-year period as at the beginning. Similarly, a bank growing at a 10.4 percent annual rate will be 3.6 times as big. If profit margins and dividend payout ratios remain constant, retained earnings will grow proportionately.

Despite the substantial additions to capital from internal sources shown in tables 4 and 5, the relative importance of external capital increases. The second column of table 6 shows the average increments to capital from external

Table 5
Average Annual Increments to Capital at New England Commercial Banks ($ thousands)

	From Internal Sources	From External Sources	Total Capital Increments	Ratio of External to Total
1970–1977	$120,303	$44,234	$164,537	.27
1980–1990				
* Case I	233,905	110,931	344,836	.32
* Case II	289,175	223,579	512,754	.44
* Case III	340,167	393,030	733,197	.54

* Projections
Source: Table 4.

Table 6
Projections of Average Increments to Capital at New England Commercial Banks Using Extrapolation and Regression Techniques, 1980–1990 ($ thousands)

	From Internal Sources	From External Sources	Total Capital Increments	Ratio of External to Total
Case I	$233,905	$110,931	$344,836	.32
Case II	289,175	223,579	512,754	.44
Case III	340,167	393,030	733,197	.54
Regression Techniques	$222,840	225,777	448,617	.50

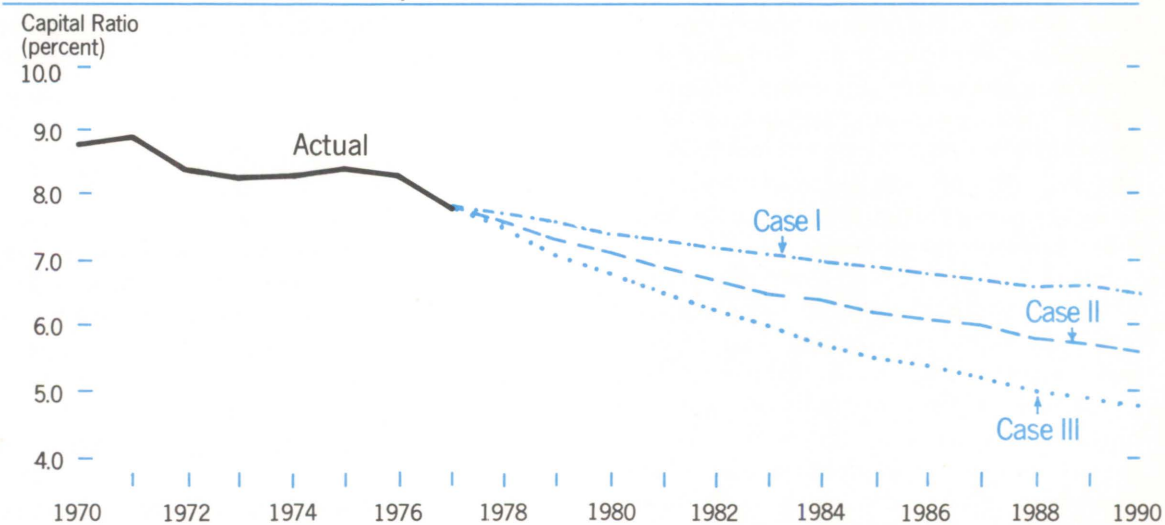
Source: Table 5 and author's estimates.

sources necessary if the capital-to-asset ratio is to remain constant at 7.8 percent, the ratio which existed in 1977. While during the period 1970–77 capital from external sources accounted for only 27 percent of total additions to capital, estimates of this ratio for the 1980s range from 32 to 54 percent, with higher asset growth rates correlated with a greater relative importance of external capital.

Another way of showing the importance of external capital in the 1980s is to calculate the capital-to-asset ratio which would occur if there were no additions to capital from external sources. As shown in figure 3, there would be a substantial decline in the capital-to-asset ratio in all three cases if additions to capital came only from internal sources. In Case I the capital-to-asset ratio would decline from 7.8 percent in 1977 to 6.5 percent in 1990, or by almost 17 percent, while in Case III the ratio would decline to 4.8 percent in 1990, or by almost 38 percent. Thus across a broad range of asset growth rates the extrapolation projections indicate an increasing reliance upon external capital if declines in capital-to-asset ratios are to be avoided.

Although the extrapolative technique used to derive the projections is appealing, both for its simplicity and intuitive qualities, it is lacking in several respects. Many of the relationships such as the asset growth rate, the earnings per dollar of assets, and the dividend payout ratio which the extrapolations assume to be constant do in fact vary, either in response to economic conditions or to actions on the part of bank management. For example, if a bank's capital-to-asset ratio is unsatisfactory, management can of course resolve the situation by issuing more equity, but in addition has the options of lowering the dividend payout ratio, slowing the asset

Chart 3 **Projected Capital Ratios at New England Commercial Banks With No External Capital Issues**



Source: Author's Projections

growth rate by bidding less aggressively for assets, or attempting to increase profit margins by lowering the rate of return offered on liabilities. In reality management may attempt to vary all of these relationships simultaneously. In addition, even if assumptions concerning asset growth rates and earnings retention rates are correct over a long period, cyclical changes in asset growth and earnings may cause the projections for any one year to be quite inaccurate.

An alternative method of projecting commercial bank capital formation is to treat crucial variables such as assets and retained earnings as dependent on general economic conditions such as the unemployment and inflation rates, the state of the New England economy relative to the United States as a whole, and interest rates. By using historical data and multiple regression techniques it is possible to derive sets of equations describing how bank behavior responded to changes in economic conditions in the past.[10] Then by using forecasts of economic conditions in the 1980s and assuming that the relationships between bank behavior and economic conditions will stay the same, it is possible to predict bank response to the economic conditions of the next decade. In particular this method of obtaining projections makes no assumptions concerning the constancy of variables such as the asset growth rate but instead assumes that bank management will adjust whatever variables are at its disposal so as to maximize profits at the level of risk considered appropriate.

Figure 4 and table 6 compare projections of additions to capital obtained using regression techniques with those obtained using extrapolation. As can be seen from the first panel of figure 4 and table 6, the projections of additions to capital from internal sources are most similar to the extrapolative projections of Case I. However, the regression techniques generate an average annual asset growth rate of 7.7 percent, considerably higher than the 6.4 percent assumed in constructing the extrapolative projections of Case I. As a result the additions to capital from external sources which will be necessary to avoid a decline in the capital-to-asset ratio are also considerably higher than in Case I. As shown in the second panel of figure 4 and in table 6, the regression techniques imply that New England commercial banks will have to obtain on average approximately $226 million per year from external sources if the capital-to-asset ratio is to remain constant at 7.8 percent, substantially above the $110 million per year projected in Case I and very close to the $223 million per year projected in Case II. As a result the proportion of capital which must be raised from external sources is projected to be substantially higher using the regression techniques. Indeed, as shown in table 6, the projected proportion of new capital to be obtained from external sources during the 1980s is 50 percent, considerably greater than the proportions projected under Cases I and II, and only slightly below that of Case III. Thus the regression techniques confirm the importance of external capital to New England commercial banks during the 1980s.

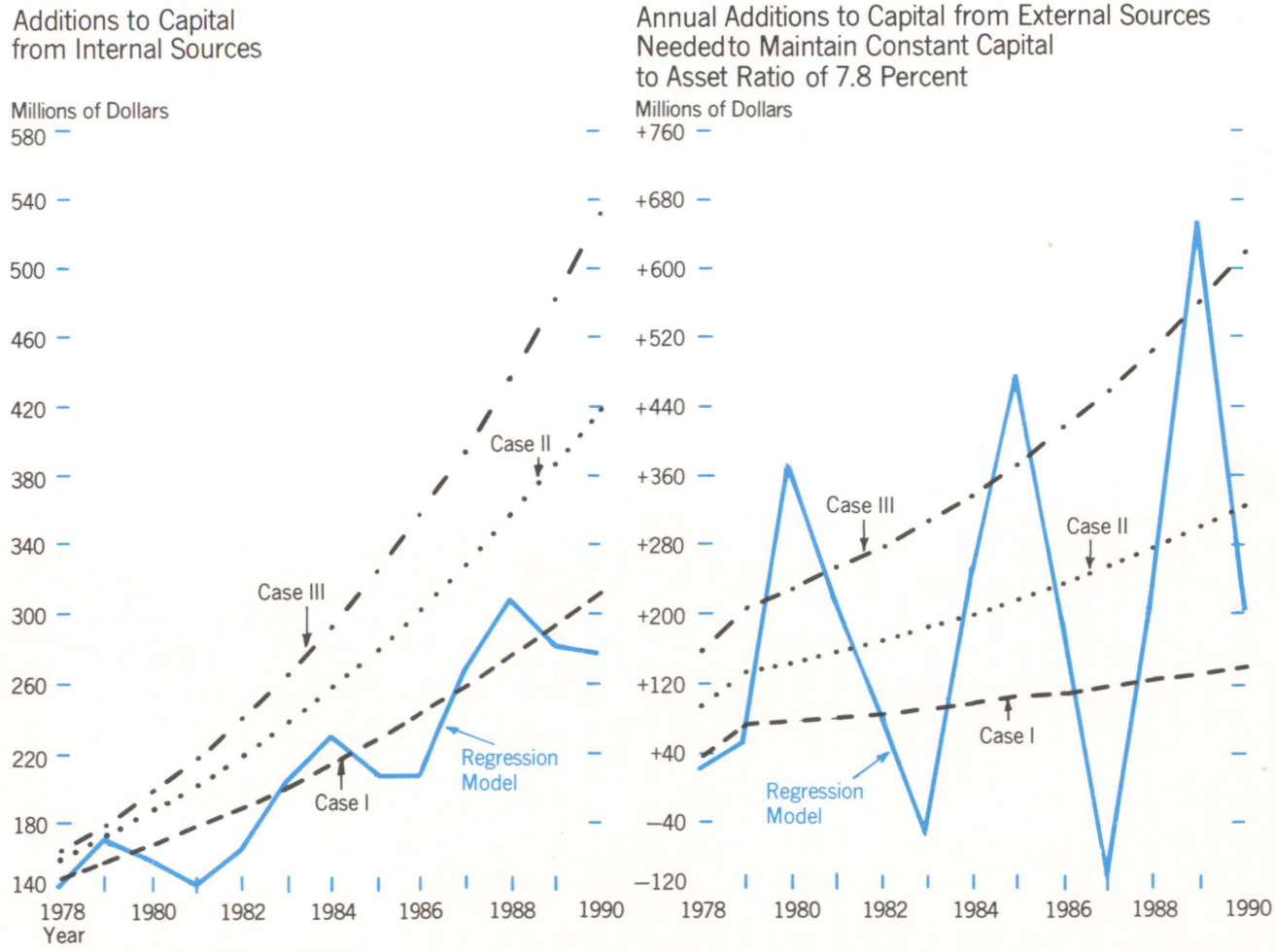
[10] The regression model is discussed in the technical appendix.

Part III: Some Implications

As shown in Part II, New England commercial banks will have to add substantial amounts of capital during the 1980s if they are to avoid a decline in capital ratios. Moreover, due to the effects of inflation, a much larger proportion of this new capital will have to be raised from external sources than was done in the past. This section discusses some of the implications of these conclusions.

To assess the impact of the substantial increase in bank capital projected for the 1980s, it is necessary to obtain some idea of the rela-

Chart 4 Estimated Additions to Capital at New England Commercial Banks, 1978 - 1990



Source: Table 4 and Author's Estimates

tive size of such capital increments. It is possible for the nominal amount of bank equity and debt outstanding to grow rapidly but be absorbed without problem if incomes and investor portfolios also grow rapidly. To obtain some conception of the relative size of New England bank capital needs in the 1980s, figure 5 compares ratios of total bank capital and new external issues relative to projected personal income in the six New England states. As shown in the first panel of figure 5, projected values of total bank capital to personal income for Cases I and II actually decline monotonically during the 1980s. The projected capital-to-personal income ratio under Case III increases slightly from its 1977 level but by 1990 it still does not exceed the level existing in 1975. Overall, the capital-to-personal income ratio during the period 1970–77 averaged 4.28 percent, while projected values for the period 1978–1990 averaged 3.03 percent for Case I, 3.44 percent for Case II, and 3.91 percent for Case III. Thus the total amount of bank capital projected during the 1980s appears reasonable when compared with levels existing in the recent past. However, as shown in the second panel of figure 5, the ratio of projected external issues to projected personal income increases sharply in Cases II and III, indicating that the relative amount of new external issues will be well above previous historical levels. For purposes of comparison, the ratio of new external capital issues to New England personal income during the period 1970–77 averaged 0.068 percent, while the ratio of projected external issues to projected personal income for the period 1978–1990 averaged 0.054 percent in Case I, 0.114 percent in Case II, and 0.195 percent in Case III. Thus the size of projected external capital issues relative to New England personal income could be as much as three times larger during the 1980s than during the 1970s. While the total amount of bank capital appears reasonable when compared to past experience, a question remains whether a shift in the composition of new capital to a substantially greater proportion of external capital represents a problem. In fact there are two related questions: whether investors will be willing to absorb the new equity and debt issues, and whether present equity holders will be willing to acquire the new capital that is needed.

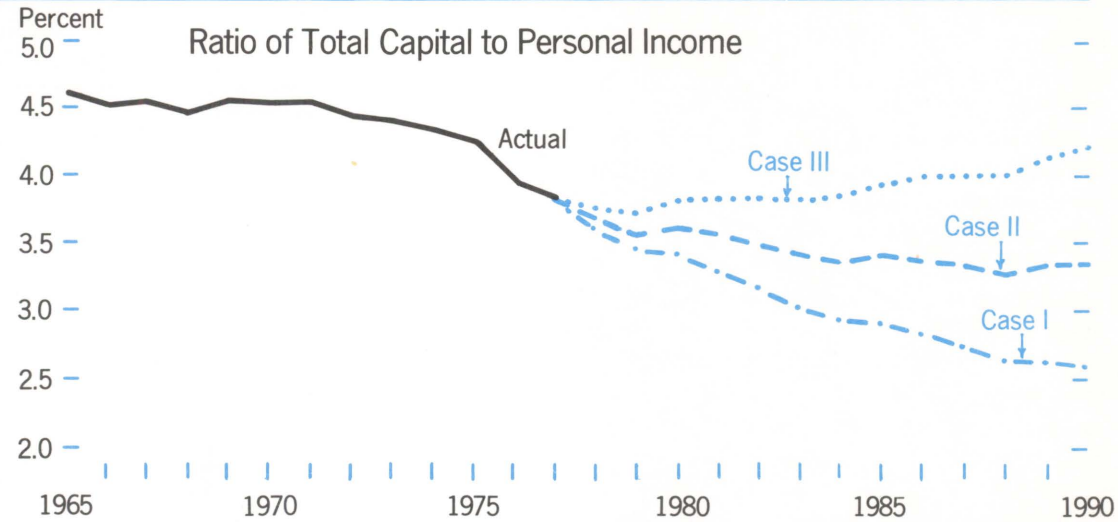
The first question is relatively simple. So long as the total amount of bank capital is not excessive during the 1980s, investors should be indifferent between new equity and old. If bank stocks are priced to offer a rate of return that is competitive with that offered by investments with comparable risks, investors should be willing to purchase whatever bank stock comes on the market, whether as a new issue or as a resale of outstanding stock. Thus the fact that a higher proportion of capital additions in the 1980s will be in the form of new stock issues should not create problems of investor acceptance so long as the new issues are priced competitively and the total amount of bank equity outstanding is not excessive.

However, while it is unlikely that there will be problems with investor acceptance, some observers have argued that present equity holders will be unwilling to seek new capital if it requires present stockholders to dilute their interest by selling stock below book value.

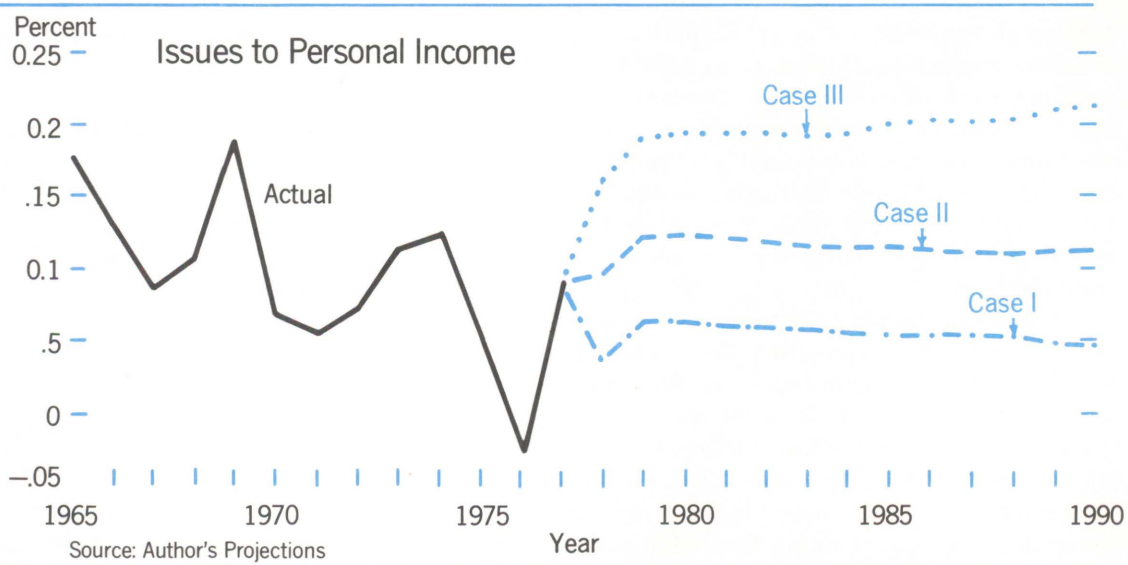
To understand the effect of inflation upon bank stock prices it is necessary to analyze the effect of an acceleration in the asset growth on the nominal rate of return to bank equity. As discussed above in Part I, an acceleration in the asset growth rate causes the capital-to-asset ratio to decline as the more rapid asset growth dilutes the existing capital. If profit margins remain constant, and the amount of assets per dollar of capital increases, earnings per dollar of capital will necessarily increase, so that the effect of an acceleration in asset growth is to increase the nominal rate of return to capital. So

Chart 5

Projected Ratio of Bank Capital to Personal Income for New England Commercial Banks



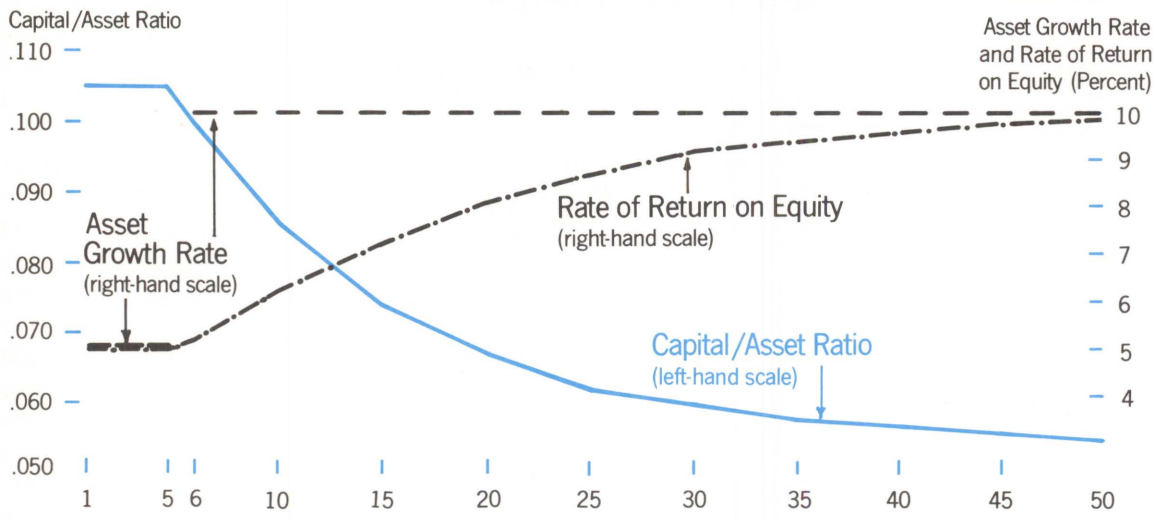
Ratio of New External Capital Issues to Personal Income at New England Commercial Banks



Source: Author's Projections

Chart 6

Effect of Asset Growth Rate on the Nominal Rate of Return to Bank Equity



Source: See Technical Appendix

long as the amount of assets levered on each dollar of capital continues to increase (that is, so long as the capital-to-asset ratio continues to fall), the nominal rate of return to capital will continue to increase. As the capital-to-asset ratio stabilizes at its new lower long-run level, the rate of return to capital will also stabilize. This process is shown in figure 6, which is similar to figure 2 and shows how the rate of return to capital varies as the capital-to-asset ratio changes.

If the acceleration in asset growth is due to an increase in the rate of inflation, the increase in the long-run nominal rate of return to capital will just be such that the real rate of return is equal to that existing before the acceleration. Thus a once-and-for-all increase in the inflation rate results in a lower capital-to-asset ratio, a higher nominal rate of return to capital, and a constant long-run real rate of return to capital.

However, despite the fact it is increasing, in the short run the nominal rate of return to bank capital valued at book may lag nominal rates of return on other investments. Just as the capital-to-asset ratio lags changes in the asset growth rate, so the nominal rate of return to book capital will also lag other nominal rates during transition. As shown in Part II, a once-and-for-all change in the asset growth rate results in an immediate change in the long-run capital-to-asset ratio, but it takes some time for this once-and-for-all change to be reflected in current book values. Likewise, a once-and-for-all increase in the asset growth rate results in an immediate change in the long-run nominal rate of return to capital, but a transition period occurs during which the nominal rate of return on book capital does not completely reflect this change.

During this transition period the nominal rate

of return to bank capital valued at book lags rates of return available on other investments which fully reflect the effect of the increased inflation rate. As a result investors will be unwilling to acquire bank stock unless it offers them a nominal rate of return equivalent to what can be earned on competing investments, and to do this bank stocks must sell below book value at a price where the ratio of earnings to share price is equivalent to comparable investments.

Another way to view this process is to assume a once-and-for-all acceleration in the rate of inflation of which everyone is aware. The increased inflation rate will adversely affect the bank to the extent that the bank holds more financial assets than financial liabilities. But the excess of bank assets over liabilities is equivalent to bank capital so that the net effect of a higher inflation rate is to reduce the real value of the existing bank capital. Of course during the current year the real value of the bank capital will be reduced only by the amount of inflation which occurs this year. But because investors are aware that the continuing high inflation rate will further reduce the real value of bank capital next year and in future years, they will be unwilling to acquire bank equity unless these future losses are reflected in the stock price. Thus during the transition period the book value of bank capital overstates the real value of this capital since it does not take into account the future losses in real values associated with a higher inflation rate.

An argument can be made that the fact that bank equity is selling below book value should not and will not affect the willingness of present stockholders to issue new stock. After all, if present stockholders are reasonable, they will realize that the current book value of their stock exceeds the real value. If stockholders accept the fact that present book value exaggerates the share's true value, they should not be adverse to acquiring new capital by selling additional shares at less than book value, so long as the new shares completely reflect the future prospects of the bank.

This argument, however, neglects the fact that many banks are closely controlled by a few stockholders who own most of the shares outstanding. These individuals benefit not only from the earnings accruing to their shares but also by their access to financing and the fact that some of them may receive employment as officers of the bank. These stockholders view the value of their shares as consisting not only of the present value of the future earnings of the bank, but also a premium reflecting the controlling position they enjoy. Sales of new equity would dilute the controlling position of these present stockholders, and to the extent it does so, also decrease the premium for control accruing to their present shares. Thus these stockholders may be reluctant to seek new capital unless a way may be found by which they may either retain control or at least realize the extra value of their shares.

One such way to realize the premium for control is to merge with a large bank or sell a controlling interest to a bank holding company. A larger organization may be willing to pay a premium to acquire control and also to have the resources to add whatever new capital is necessary to maintain satisfactory capital ratios. Moreover, since large banking organizations are able to diversify their portfolio to a greater extent, the capital needs of the combined organization may be less than the sum of the capital needs of the two organizations considered separately. Thus the need for substantial infusions of bank capital from external sources in the 1980s, combined with the reluctance of banks to sell equity at below book value, may lead to changes in the competitive structure of commercial banking in New England as small banks affiliate themselves with holding companies or merge with larger banks.

Another way for existing stockholders to preserve control is to substitute subordinated debt for new equity, and thus avoid the dilution which takes place when new equity is sold below book value. In the event of a liquidation of bank assets, depositors and other lenders take precedence over holders of subordinated debt. From the viewpoint of the FDIC, this means that subordinated debt, as well as equity, acts to shield the FDIC and other uninsured depositors, since both equity and subordinated debt would have to be depleted before the FDIC or uninsured depositors would incur any loss.

Because interest payments on subordinated debt are deductible from ordinary income for tax purposes, the after-tax cost of subordinated debt may be substantially less than that on the same amount of equity. However, while subordinated debt may be less costly than equity, the use of subordinated debt may affect the bank's cash flow in other ways. Unlike dividend payments on equity which may be suspended if need be, interest payments on subordinated debt are a legal obligation which a bank must meet or be placed in receivership. Thus while a dollar of subordinated debt is a perfect substitute for a dollar of equity in terms of shielding the FDIC and other bank creditors, it is less so in protecting the bank from failure. A similar drawback is the fact that subordinated debt, unlike equity, has a limited life and must be refunded at maturity. A bank in questionable condition might experience difficulty in replacing maturing capital notes and thus find a substantial amount of its capital being withdrawn at the exact time when that capital is most needed.

Summary

Commercial bank capital acts as a protective shield to protect depositors and other creditors. Because a bank would have to deplete its capital before being unable to meet its obligated liabilities, the more capital available relative to assets, the less likely a bank is to fail. Bank capital can be augmented from internal sources through retained earnings or additions to loan loss reserves, and from external sources through the sale of additional equity and subordinated debt.

Because retained earnings have historically accounted for almost three-quarters of increments to capital, there is a strong tie between commercial bank earnings and bank capital ratios. While there exists a unique long-run capital-to-asset ratio corresponding to different earnings retention rates, in the short run changes in capital ratios lag changes in earnings retention. Likewise changes in asset growth rates will affect capital ratios. Even if earnings retention rates remain constant, an increase in the asset growth rate caused by inflation will result in a lower capital-to-asset ratio as existing capital is spread over a greater number of asset dollars. As with the earnings retention rate, there is a unique long-run capital-to-asset ratio corresponding to each asset growth rate, but in the short run the capital-to-asset ratio will lag changes in the asset growth rate.

Because earnings retention rates at New England commercial banks are substantially lower than elsewhere, and because inflation has caused an increase in the asset growth rate, New England commercial banks will have to add substantial capital during the 1980s if a decline in capital ratios is to be avoided. Moreover, a much larger proportion of the additional capital will have to be obtained from external sources. While the additional amount of bank capital necessary to maintain constant capital ratios during the 1980s is not excessive when compared with recent experience, the proportion of such capital which must be raised from external sources may rise to an historical high.

While the new bank equity and debt are likely to be absorbed without problems by investors so

long as they are priced realistically, existing bank stockholders may be reluctant to seek additional equity if such sales result in an erosion of their controlling interest. As a result many banks may seek additional capital not through the sale of equity to the public, but through affiliation with a larger bank or bank holding company willing to compensate existing shareholders for their controlling interest. Alternatively, existing stockholders may seek to retain control while maintaining capital ratios by selling subordinated debt rather than equity.

TECHNICAL APPENDIX

I. Extrapolation and the Long-run Capital-to-Asset Ratio

Let A_j = commercial bank total assets at time j
g = the constant growth rate of assets
K_j = the amount of commercial bank capital at time j
e = the constant ratio of after-tax earnings to assets
r = the constant ratio of retained earnings to after-tax earnings
k_j = the capital-to-asset ratio at time j.

Then bank assets at time j are:

$$A_j = (1+g)^j A_o \quad (1)$$

Bank capital at time j is:

$$K_j = K_{j-1} + erA_j \quad (2)$$

Then the capital-to-asset ratio at time j is:

$$k_j = K_j/A_j = K_{j-1}/A_j + er \quad (3)$$

Since $K_{j-1}/A_j = K_{j-1}/(1+g)A_{j-1}$, then (4)

$$k_j = k_{j-1} \cdot 1/(1+g) + er \quad (5)$$

$$= K_{j-2}/A_{j-1} \cdot 1/(1+g) + er/(1+g) + er \quad (6)$$

Continuing this process:

$$k_j = er + 1/(1+g) \cdot er + 1/(1+g)^2 \cdot er + \ldots + 1/(1+g)^j \cdot er \quad (7)$$

Since $1/(1+g) < 1$, this series converges to:

$$k_j = (1+g)/g \cdot er$$

Thus, the long-run capital-to-asset ratio consistent with asset growth at rate g and retained earnings-to-asset ratio er is given by equation (7).

Regression Projections

Reduced-form equations were estimated for assets, capital, retained earnings, and net income. The estimated equations are presented in table 1.

Forecasts to 1990 of the exogenous variables, based on the Data Resources, Inc. macro-economic model, were available for all exogenous variables except New England personal income, New England total employment, and New England population. These three variables were forecast using the exogenous variable forecasts that DRI does provide. These additional equations are presented in table 2.

Variable Definitions (Means and units in parentheses following definition)

Endogenous Variables (All banking variables for insured, commercial New England banks.) Source: *FDIC Assets & Liabilities*

Total Assets: Prior to 1969, equals total assets plus valuation reserves. For 1969 to 1975 equal to total assets. For 1976 on, equal to total assets plus reserves for loan losses. These changes reflect reporting changes in the published data. Valuation reserves equalled reserves for bad debt losses on loans and other reserves on loans. With the exception of reserves on securities, which was netted out of pre-69 assets, and included in post-69 assets, the series is consistent over time ($18.6 billion).

Total Capital: Prior to 1969, equals capital account plus valuation reserves. After 1969, equal to capital account plus reserves for loan losses, plus other reserves on loans, plus reserves on securities. Before 1976, subordinated notes and debentures were included in the capital account, whereas after that date they had to be added in. Also in 1976, various capital reserves which had been separate were lumped into equity capital ($1.64 billion).

Net Income: Equal to net income after taxes less dividends on preferred stock, less interest on capital notes and debentures for the whole period. In principle, interest payments subtracted from net income and all dividends should be left in, but prior to 1969, preferred stock dividends were lumped in with interest on notes and debentures. Since preferred dividends are generally a *very* small number, the least discrepancy resulted from this treatment ($128 million).

Retained Earnings: Equal to net income after taxes less dividends on common stock less dividends on preferred stock (before 1969, less interest on capital notes and debentures, which was lumped in with preferred dividends). This treatment is completely consistent, since interest on capital notes and debentures is always removed from retained earnings ($63.6 million).

TABLE I

Range 1949–1977
Δ = % change (St. errors in parentheses)

$$\frac{\text{Assets}}{(POPNE*P)} = \underset{(10.4)}{40.8} + \underset{(241)}{258YP} - \underset{(12.0)}{17.5\Delta YP} + \underset{(.29)}{1.59UNRT}$$

$$+ \underset{(.2)}{.1TBILL} + \underset{(10.6)}{11.1(INFL)} + \underset{(21.7)}{120.5(EMPL/POPNE)}$$

$$+ \underset{(2400)}{7805GNP} - \underset{(4.4)}{27.8P} + \underset{(11.3)}{9.2GNP}$$

S.E. = .64 D.W. = 2.19 R^2 = .58
LHSMEAN = 19.45

$$\frac{\text{Capital}}{POPNE*P} = \underset{(.45)}{4.5} + \underset{(10.6)}{63YP} - \underset{(.52)}{.94\Delta YP} + \underset{(.013)}{.046UNRT}$$

$$+ \underset{(.2)}{.02TBILL} + \underset{(10.6)}{1.06(INFL)} - \underset{(21.7)}{1.12(EMPL/POPNE)}$$

$$+ \underset{(105)}{154GNP} - \underset{(.19)}{1.36P} + \underset{(.49)}{.38\,GNP}$$

S.E. = .028 D.W. = 1.63 R^2 = .99
LHSMEAN = 1.74

$$\frac{\text{Net Income}}{POPNE*P} = \underset{(.18)}{.75} + \underset{(4.1)}{20.5YP} - \underset{(.2)}{.2\Delta YP} + \underset{(.0049)}{.0082UNRT}$$

$$+ \underset{(.0035)}{.0027TBILL} + \underset{(.18)}{.01INFL}$$

$$- \underset{(.36)}{.03(EMPL/POPNE)} - \underset{(40.7)}{46.9GNP}$$

$$- \underset{(.07)}{.29P} + \underset{(.19)}{.046\,GNP}$$

S.E. = .011 D.W. = 2.49 R^2 = .95
LHSMEAN = .133

$$\frac{\text{Retained Earnings}}{POPNE*P} = \underset{(.17)}{.49} + \underset{(3.9)}{7.7YP} + \underset{(.19)}{.15\Delta YP}$$

$$+ \underset{(.0046)}{.0056UNRT} + \underset{(.0032)}{.0038TBILL}$$

$$- \underset{(.17)}{.09INFL} + \underset{(.35)}{.064(EMPL/POPNE)}$$

$$+ \underset{(38.4)}{10.7GNP} - \underset{(.06)}{.19P} - \underset{(.18)}{.22\Delta GNP}$$

S.E. = .01 D.W. = 2.74 R^2 = .88
LHSMEAN = .066

All equations estimated with a correction for first order serial correlation.

Exogenous Variables

TBILL* = Rate on 30-day Treasury bills, monthly series, averaged annually (3.70 percent).
P* = Price Level: Log of GNP deflator (1972 = 100). (4.345)
INFL* = Inflation Rate: Percentage annual change in GNP deflator (.0347).
EMPL = NE Employment: Total nonagricultural employment in New England.
Source: Employment and Training Report of the President (4.02 million)
UNRT* = Unemployment Rate: Annual
GNP* = Real (Base = 1972) GNP ($879.1 billion).
POPNE = New England resident population (10.9 million) (Data Resources, Inc.)
YP = *New England Personal Income:* Old series, 1948–1957 from DRI. Revised 1958 on, from BEA.

*Projections (for 1979 to 1990) were from DRI Winter, 1979 *U.S. Long-Term Review* for national data. The Cycle long 2003 simulation was used.

TABLE II

Range 1949–1977

$$POPNE = \underset{(1931.7)}{1531.7} + \underset{(.019)}{.045POPUS} - \underset{(.6\times10^{-7})}{.9\times10^{-7}POPUS^2}$$

$$- \underset{(12412)}{18063(4POPUS)} + \underset{(.15)}{.703POPNE_{-1}}$$

RHO = .31 S.E. = 616 R^2 = .99
D.W. = 1.61
LHSMEAN = 10,900

$$\frac{EMPL}{POPNE} = \underset{(.042)}{.24} + \underset{(5.1)}{18.9GNP/POPUS} + \underset{(.001)}{.0002TBILL}$$

$$- \underset{(.001)}{.0046UNRT} + \underset{(.05)}{.1INFL}$$

$$+ \underset{(.09)}{.18(EMPL/POPNE)_{-1}}$$

RHO = .93 S.E. = .0044 R^2 = .82
D.W. = 1.54
LHSMEAN = .368

$$\frac{YP}{POPNE*P} = \underset{(.00093)}{.00068} + \underset{(.63)}{5.36GNP} + \underset{(.00013)}{.000058TBILL}$$

$$- \underset{(.00009)}{.0001UNRT} - \underset{(.005)}{.0077INFL}$$

$$+ \underset{(.09)}{.37(YP_{-1}/POPNE_{-1}/P_{-1})}$$

RHO = .34 S.E. = .0004 R^2 = .99
D.W. = 1.98
LHSMEAN = .039

All equations estimated with a correction for first-choice serial correlation.

Personal Taxes and Interstate Competition for High Technology Industries

By Deborah S. Ecker and Richard F. Syron*

While the share of the U.S. labor force employed in manufacturing has declined substantially since World War II, one sector that has grown sharply is "high technology," in particular electronics, minicomputers, and other information processing devices. Many electronic and computer companies are located in the Northeast, particularly Massachusetts and New York, a part of the country which has seen a dramatic decline in its past industrial preeminence. The rapid growth of high technology manufacturing combined with the increased emphasis by many states on economic development has led to greatly expanded competition by states for these firms.

Interstate competition for industry is an old story. Southern states prompted by their historically lower income levels have long been active in economic promotion. However, as the northern industrialized states have experienced slower growth, they too have become increasingly involved in trying to attract industry. As a result, most states can list an impressive array of business incentives. Most economists take a dim view of the effectiveness of these incentives, partially because research has shown that very few firms actually pack up and move from one location to another. Moreover, when firms choose between locations, access to markets and the availability and cost of labor are usually more important than financing subsidies or other development incentives.

Many high technology companies say that one factor important to them in choosing location is the availability of skilled professionals. The regional growth of the electronics industry, and minicomputers in particular, has led to shortages of engineers and technicians with experience in these industries. As a result, high technology companies are interested in how these professionals evaluate different areas as a place to live. While state and local governments can

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do relatively little to alter some of the factors that influence an area's attractiveness, such as climate, one they do have some control over is the level of personal taxation.

The issues involved in altering personal taxes to attract industry are considerably different from most business incentives. The most important difference is that no subsidy is provided to industry itself; the beneficiaries are its employees. Just how great an influence state and local taxes have on professionals' location decisions is an open question. Differences in taxes certainly contribute substantially to the variation in the cost of living across locations. On the other hand, many people value adequate public services, such as schools, highways and cultural institutions and may be reluctant to live in a low tax, low service area. In spite of complaints about taxes there is no evidence that taxpayers want reduced services. However, many executives in high technology industry clearly consider high state and local taxes an important factor in attempting to recruit personnel. The issue appears to be more the difficulty of recruiting outsiders to move to high tax states than of retaining present employees.[1]

This article examines the burden of state and local taxes before and after deductions at the federal level on individuals at the $25,000 and $50,000 income levels living in representative suburban and urban locations in major industrial states. Tax burden comparisons are generally based on the total revenue from state and local taxes either per capita or as a percentage of income. However, these statewide averages are also a poor indicator of the tax burden on an individual for two reasons: first, there is significant variation in property tax by locality; second, total tax collection figures do not distinguish between taxes paid by individuals and those paid by businesses. The alternative and preferable approach to capturing total personal tax burdens is to build a comparative tax picture from the perspective of hypothetical taxpayers.[2]

This article concludes that substantial differences exist in state and local tax burdens among states, although their impact is greatly reduced by the deductibility of these payments from federal income tax liability. New York, Minnesota, Massachusetts and Wisconsin have particularly high taxes while Texas, New Hampshire and Arizona are at the low end of the scale.[3]

Methodology of the Study

The objective of this study was to examine relative tax burdens on highly paid workers living in different states. This study assumes hypothetical taxpayer families with incomes of $25,000 and $50,000 for the tax year 1977, with homes valued at twice their income, and each with two cars. Three groups of states were included: those which now have the largest concentration of the machinery industry, the industrial sector which includes much of high technology manufacturing, those which are frequently mentioned as potential centers for this

[1] High taxes also affect a state's competitive position through their impact on hourly wages. As taxes increase, so do bargaining demands to retain real purchasing power. New England's lower than average hourly wages are cited as a factor enhancing the region's competitive position. Continuing tax pressures could have a negative impact on this advantage.

[2] A detailed description of the methodology is available in a Technical Supplement available without charge from the Research Department of the Federal Reserve Bank of Boston.

[3] This study includes only taxes as a cost of government and does not take into consideration nontax fees and charges. Taxes account for the vast majority of revenues collected by state and local governments. However, to the extent that some state and local governments rely heavily on fees and charges, we understate the relative cost of government to residents of these areas. Fees, except for automobiles, and charges were not included since they vary greatly depending on the mix of services used; thus it is very difficult to say what these charges amount to for the typical taxpayer.

type of industry and which have only somewhat lower concentrations of it now, and the New England states. Because property taxes vary widely within states, objective criteria were also developed for the selection of the place of residence for tax determination. First, an analysis was made of which metropolitan areas within each state had the largest share of the state's volume of machinery shipments and the largest number of establishments in those industries. Second, for determining property tax levels, the city or town within each metropolitan area with the highest average single family residential property value was selected. All of the engineers or scientists in the high technology industry certainly would not live in the most expensive communities; however, this approach was followed in the interest of having uniform objective criteria for selecting communities and because those localities could be expected to be reasonable indicators of the general level of property taxes relative to housing values in their areas.[4]

Just as property taxes differ significantly depending on location, housing values also differ between regions. For the purposes of this study, housing values were assumed to be twice the level of income and then adjusted for interregional price differences as reported by the Federal Home Loan Bank Board. These values undoubtedly are somewhat low given the recent increase in house prices, but any underestimation of housing values should be roughly proportional across states.[5]

Widespread variations in the practices of local tax administrations are another obstacle in estimating local property taxes. Fortunately, the Bureau of the Census continues to refine its studies of assessment/sales ratios and of assessed values by property class so that its recent 1977 report presents reliable effective tax rates on many of the suburbs used in this study. In some cases tax data were obtained directly from state and county governments.

Calculations of the state personal income taxes were based principally on a study by the Advisory Commission on Intergovernmental Relations which provided average effective state income tax rates on hypothetical taxpayers at varying income levels. However, some states such as Massachusetts treat wage income differently from earnings on capital, including dividends and nonbank interest. In these cases an adjustment was made based on the proportions of earned and unearned income estimated on the basis of a Massachusetts study.

Local income and sales taxes were included where applicable as were fees and taxes on automobiles and gasoline. Taxpayers at both income levels were assumed to own two cars of the same weight and annual mileage.

Results of Study

This study indicates that substantial differences exist in state and local tax burdens for higher income workers in different parts of the

[4] As the basis for the tax figures in this study the following localities were selected:
Scottsdale, Arizona
Palo Alto, California
Denver, Colorado
W. Hartford, Connecticut
Atlanta, Georgia
Chicago, Illinois
Indianapolis, Indiana
Louisville, Kentucky
Portland, Maine
Weston, Massachusetts
Farmington Hills, Michigan
Bloomington, Minnesota
Nashua, New Hampshire
Bloomfield, New Jersey
Buffalo, New York
Winston-Salem, North Carolina
Cuyahoga County, Ohio
Lower Merion Township, Pennsylvania
Providence, Rhode Island
Dallas, Texas
Burlington, Vermont
Wauwatosa, Wisconsin

[5] Increases in housing values would normally result in lower assessment ratios so the tax impact would remain relatively constant.

Table 1
Comparison of Personal Taxes in Selected States, $25,000 Income

States	State & Local Taxes Total	State & Local Taxes As Percent of Income	State & Local Taxes Index[a]	State, Local & Federal Taxes Total	State, Local & Federal Taxes As Percent of Income	State, Local & Federal Taxes Index[a]
Arizona	$1967	7.9%	.77	$5180	20.7%	.92
California	2447	9.7	.96	5521	22.1	.98
Colorado	2164	8.7	.85	5321	21.3	.95
Connecticut	2265	9.1	.89	5394	21.6	.96
Georgia	2220	8.9	.87	5363	21.5	.96
Illinois	2141	8.6	.84	5298	21.2	.94
Indiana	2430	9.7	.95	5517	22.1	.98
Kentucky	2536	10.1	.99	5597	22.4	1.00
Maine	2570	10.3	1.01	5619	22.5	1.00
Massachusetts	3578	14.3	1.40	6377	25.5	1.14
Michigan	2483	9.9	.97	5557	22.2	.99
Minnesota	3603	14.4	1.41	6389	25.6	1.14
New Hampshire	1769	7.1	.69	5038	20.2	.90
New Jersey	3377	13.5	1.32	6226	24.9	1.11
New York	3424	13.7	1.34	6260	25.0	1.12
North Carolina	2011	8.0	.79	5210	20.8	.93
Ohio	1981	7.9	.78	5194	20.8	.93
Pennsylvania	3088	12.4	1.21	5999	24.0	1.07
Rhode Island	3133	12.5	1.23	6044	24.2	1.08
Texas	1588	6.4	.62	4899	19.6	.87
Vermont	2099	8.4	.82	5270	21.1	.94
Wisconsin	3208	12.8	1.26	6094	24.4	1.09
Average	$2549	10.2	1.00	$5608	22.4	1.00

[a] Total personal taxes relative to the average

United States. However, deduction of these taxes from the federal income tax greatly diminishes this variation since it transfers much of the high tax burden in the northern industrial states to the federal tax base.[6]

Tables 1 and 2 present data on total state and local taxes in each location by three means: absolute dollars, as a percentage of income, and relative to the average tax burden.

At the $25,000 level state and local tax burdens vary from 62 percent of the average to 141 percent. When federal taxes are included the difference is reduced to a range of 87 percent to 114 percent. At the $50,000 level federal taxes go somewhat further towards reducing the differential between the low and high tax states. In terms of state and local levies the lowest tax state is 53 percent of the average — the highest tax is 163 percent; however, when the federal income tax is included, the range is much narrower, from 90 percent of the average to 113 percent.

At the $25,000 income level the absolute spread between the states with the lowest state and local taxes and the highest is $2,015; when federal income taxes are included, it is $1,490. At the $50,000 income level the difference in state and local taxes paid between the lowest tax area and the highest is $5,778; when federal tax-

[6] Deductions for state and local taxes represent a major factor in the determination of federal tax liabilities. Almost one-third of all itemized deductions on federal returns are accounted for by state and local taxes.

Table 2
Comparison of Personal Taxes in Selected States, $50,000 Income

States	State & Local Taxes Total	State & Local Taxes As Percent of Income	State & Local Taxes Index[a]	State, Local & Federal Taxes Total	State, Local & Federal Taxes As Percent of Income	State, Local & Federal Taxes Index[a]
Arizona	$3863	7.7%	.74	$13946	27.9%	.95
California	5998	12.0	1.14	15182	30.4	1.03
Colorado	4355	8.7	.83	14231	28.5	.96
Connecticut	4257	8.5	.81	14175	28.4	.96
Georgia	4590	9.2	.88	14368	28.7	.97
Illinois	3986	8.0	.76	14017	28.0	.95
Indiana	4390	8.8	.84	14252	28.5	.97
Kentucky	4789	9.6	.91	14483	29.0	.98
Maine	5996	12.0	1.14	15180	30.4	1.03
Massachusetts	7205	14.4	1.37	15885	31.8	1.08
Michigan	4602	9.2	.88	14374	28.8	.97
Minnesota	7404	14.8	1.41	16000	32.0	1.08
New Hampshire	3496	7.0	.67	13739	27.5	.93
New Jersey	6628	13.3	1.26	15560	31.1	1.05
New York	8555	17.1	1.63	16694	33.4	1.13
North Carolina	4126	8.3	.79	14098	28.2	.96
Ohio	4086	8.1	.78	14075	28.2	.95
Pennsylvania	5875	11.8	1.12	15113	30.2	1.02
Rhode Island	6317	12.6	1.21	15375	30.8	1.04
Texas	2777	5.6	.53	13343	26.7	.90
Vermont	4989	10.0	.95	14599	29.2	.99
Wisconsin	7044	14.1	134	15787	31.6	1.07
Average	$5242	10.5	1.00	$14749	29.5	1.00

[a] Total personal taxes relative to the average

es are included, the difference is $3,351.

Total personal taxes calculated as a percentage of personal income range between 19.6 percent (Texas) and 25.6 percent (Minnesota) for taxpayers at the $25,000 income level; and, between 26.7 percent (Texas) and 33.4 percent (New York) for taxpayers at the $50,000 income level. Taxes in Texas are so low relative to the other states that the amount collected at the $50,000 income level is only slightly above the high of all states at the $25,000 income level. However, Texas has an advantage many states do not; it is able to rely extensively on extraction taxes on energy resources. The group average effective tax rate is 22.4 percent for those with $25,000 income and 29.5 percent for those with $50,000.

Tax burdens within New England vary almost as much as in the entire sample of states. By most measures New Hampshire ranks just above Texas as the lowest tax state, while Massachusetts is close to New York and Minnesota as the highest tax states.

Two states shift their relative positions between the $25,000 and $50,000 income levels. California taxes are slightly below the average for the $25,000 group and above average at the $50,000 level. New York's rank changes from

third highest at $25,000 to highest at $50,000. In both instances the shifts are the result of the graduated rate structures of the states' income taxes.

In all of the northern states examined except Pennsylvania, Wisconsin, Vermont and Ohio property taxes account for more than half of total state and local taxes. In all the southern states in the table except Texas the reverse is true. Average real estate taxes at the $25,000 level are $1,248 and at the $50,000 level $2,497. At both income levels New Jersey's real estate taxes are the highest and North Carolina's the lowest (see appendix tables 1 and 2).

Conclusions

Although deductions allowed in calculating federal tax liability greatly diminish the effective variation in state and local tax burdens, interstate differences are still sizable. At the $50,000 income level New York, Minnesota, Wisconsin, and Massachusetts had a combined federal, state and local tax burden that was $1,000 or more greater than the group average and $2,000 or more greater than the lowest tax state examined. The difference at the $25,000 level was proportional. While these numbers are not overwhelming, the difference between the high and low tax states is equivalent to about 7 percent in after-tax income, a significant amount of money.

In every state officials are faced with difficult tradeoffs in formulating tax policies. A very low level of taxes may mean unsound fiscal practices or an inability to finance necessary public services. On the other hand, high taxes may threaten to drive out industry or high-income citizens, and to discourage entrants.

It would be cynical to suggest that states should alter their tax systems to benefit generally well-off professionals at the expense of lower- and middle-income citizens. The problem for the high tax northern states is their tax levels are the result of long traditions of extensive state-sponsored service programs. Public services may be an important factor in retaining some of the state's most productive residents. However, this study suggests that the difference in personal tax burdens between the highest and lowest tax states could be a significant factor for firms attempting to recruit highly skilled professionals. Consequently, although high tax states may not be able to make immediate, drastic reductions, they clearly need to reexamine their levels of public services and recognize the need for spending restraint in order to retain their positions in an increasingly competitive world.

Appendix Table 1
Local and State Taxes by Type of Tax, Selected States, $25,000 Income

State	Income[a]	Sales[a]	Motor Vehicles[b]	Subtotal	Property[c]	Total
Arizona	$ 625	$348	$331	$1304	$ 663	$1967
California	625	295	284	1204	1243	2447
Colorado	650	410	249	1309	855	2164
Connecticut	54	305	570	929	1336	2265
Georgia	675	305	333	1313	907	2220
Illinois	525	325	218	1068	1073	2141
Indiana	450	228	394	1072	1358	2430
Kentucky	1276	266	285	1827	709	2536
Maine	525	250	308	1083	1487	2570
Massachusetts	1071	102	534	1707	1871	3578
Michigan	802	212	196	1210	1273	2483
Minnesota	1675	154	219	2048	1555	3603
New Hampshire	3	0	285	288	1481	1769
New Jersey	425	185	224	834	2543	3377
New York	1100	233	216	1549	1875	3424
North Carolina	975	261	308	1544	467	2011
Ohio	625	228	151	1004	977	1981
Pennsylvania	1452	176	206	1834	1254	3088
Rhode Island	525	239	568	1332	1801	3133
Texas	0	239	268	507	1081	1588
Vermont	775	110	186	1071	1028	2099
Wisconsin	1400	235	144	1779	1429	3208
Average	$738	$243	$294	$1264	$1285	$2549

[a] Includes local and state taxes.
[b] Assumes ownership of two cars.
[c] $50,000 house, adjusted for regional differences in property values.

Appendix Table 2
Local and State Taxes by Type of Tax, Selected States, $50,000 Income

State	Income[a]	Sales[a]	Motor Vehicles[b]	Subtotal	Property[c]	Total
Arizona	$1700	$506	$331	$2537	$1326	$3863
California	2800	429	284	3513	2485	5998
Colorado	1800	596	249	2645	1710	4355
Connecticut	571	443	570	1584	2673	4257
Georgia	2000	444	333	2777	1813	4590
Illinois	1150	472	218	1840	2146	3986
Indiana	950	331	394	1675	2715	4390
Kentucky	2700	387	285	3372	1417	4789
Maine	2350	363	308	3021	2975	5996
Massachusetts	2780	149	534	3463	3742	7205
Michigan	1550	309	196	2055	2547	4602
Minnesota	3850	224	219	4293	3111	7404
New Hampshire	248	0	285	533	2963	3496
New Jersey	1050	269	224	1543	5085	6628
New York	4250	339	216	4805	3750	8555
North Carolina	2550	333	308	3191	935	4126
Ohio	1650	330	151	2131	1955	4086
Pennsylvania	2905	256	206	3367	2508	5875
Rhode Island	1800	347	568	2715	3602	6317
Texas	0	348	268	616	2161	2777
Vermont	2650	196	186	3032	2057	5089
Wisconsin	3700	342	144	4186	2858	7044
Average	$2046	$353	$294	$2677	$2570	$5247

[a] Includes local and state taxes.
[b] Assumes ownership of two cars.
[c] $100,000 house, adjusted for regional differences in property values.

The Forecasting Record For the 1970s

By Stephen K. McNees*

ECONOMIC decisions typically depend on forecasts of the future economic environment. For individuals those forecasts are often implicit and qualitative. Business and government have come to rely increasingly on explicit, quantitative forecasts. In response to this increased demand for quantitative forecasts, around 1970 several organizations started to issue macroeconomic forecasts on a regular basis. Now, after nearly a decade of experience, the questions naturally arise: Which forecasters have been the most accurate? How has forecasting accuracy varied year by year? How good have these forecasts been? This article addresses these questions, not only to propose "answers" but also to explain the limitations of both the questions and their answers.

Description of the Forecast Data: How Forecasts Are Generated

Even though most of the prominent forecasters maintain a large macroeconometric model of the U.S. economy, the forecasts that they issue evolve from an *interaction* between the forecasters' judgment and their models.[1] This interaction reflects a variety of different motivations. For example, forecasters frequently anticipate special economic events — such as major strikes or the imposition and relaxation of wage and price controls — that are not incorporated in their models but are expected to have important impacts on the economy. At times, a forecaster may also be skeptical that his model has adequately captured qualitative forces such as "momentum," "consumer sentiment," or "animal spirits." Experience suggests that forecasts incorporating these subjective factors have generally been more accurate than those generated mechanically with a model.[2] On a more basic level, models cannot forecast. A forecast from a model requires not only the model itself — i.e., a solution procedure — but also some assumptions about the future values of certain variables *outside* — or

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[1] For a detailed description of the forecasting process, which illustrates clearly the interaction between the model and the forecaster, see R.M. Young, "Forecasting the U.S. Economy with an Econometric Model," in P. Omerod, ed., *Economic Modelling*, (Heinemann Educational Books, Inc., 1979).

[2] The evidence can be found in S. McNees, "An Evaluation of Economic Forecasts," this *Review*, November/December, 1975, pp. 25–29, especially tables 5 and 7, and A. Hirsch, B. Grimm, and G. Narasimham, "Some Multiplier and Error Characteristics of the BEA Quarterly Model," in Lawrence R. Klein and Edwin Burmeister, eds., *Econometric Model Performance*, (University of Pennsylvania Press, 1976) pp. 243–245, especially table 3.

"exogenous" to — the model. Inherently, assumptions about future values of exogenous variables come from a source outside the model.

All the forecasters in this study employ judgmental, rather than mechanical, use of their models; their forecasts reflect, in other words, the forecasters' insights (which may have been sharpened by the use of an econometric model). It would *not*, therefore, be appropriate to refer to these data as *model* forecasts to avoid a confusion between forecast and model accuracy. The two are conceptually distinct. A skilled forecaster may produce accurate forecasts with a flawed model. A good model, in the hands of an incompetent forecaster, may generate inferior forecasts. Academic economists have devoted considerable attention to the questions of how best to evaluate a model and how to compare econometric models.[3] These are extremely difficult issues that have not yet been satisfactorily resolved. To avoid confusion, therefore, it is advisable to recognize that the properties of the models as such have no *direct* bearing on the subject of this inquiry — the accuracy of the *judgmentally adjusted* forecasts which have actually been used by forecast consumers.

Revisions of Actual Data

The forecast data described in the previous section are compared below with the latest revisions of the actual data — for example, the variables which appear in the national income and product accounts (NIPAs) are taken from the current (July 1979) issue of the *Survey of Current Business*. The latest available estimates are derived from the most complete set of information and therefore are presumably more accurate than the preliminary estimates of these magnitudes. To judge and compare how accurately forecasts anticipated the subsequent course of economic events, the best possible estimate of what actually occurred is the appropriate standard of comparison. To use any other standard risks penalizing the best forecast of what actually occurred in favor of the best forecast of what was initially thought to have occurred. (The latter concept is more appropriate for other purposes, such as examining decisions made at the time the earlier more approximate data became available.)

The revisions of the data have frequently been substantial. Consequently, the actual starting point from which the forecasts were based often turns out to be very different from what the forecaster thought it to be at the time the forecast was made. Whenever the forecast base has been revised, simply to compare the predicted level with the latest revised estimate of the actual level would compound forecast errors with errors due to data revisions. In order to separate these two factors, all predicted levels are adjusted by the amount of the revision of the forecast base period. This procedure is equivalent to comparing predicted *changes* with actual changes.[4]

Although data revisions usually simply incorporate additional source data, in 1976 the NIPA data revisions contained some changes in the definitions and classifications of the data.[5] For example, purchases of mobile homes, which had

[3] See P.J. Dhrymes et al., "Criteria for Evaluation of Econometric Models," *Annals of Economic and Social Measurement*, Vol. 1 (1972), no. 3, pp. 291-324. For a new proposed method for estimating a model's accuracy see R. Fair, "Estimating the Expected Predictive Accuracy of Econometric Models," Cowles Foundation Discussion Paper No. 480R, Revised October, 1978. For a discussion of the difficulties of model comparison, a critique of comparisons with time-series equations and of Fair's method, and a proposed experiment for comparing econometric models as forecasting tools see S. McNees, "A Critique of Alternative Methods of Comparing Macroeconometric Models," in J. Ramsey and J. Kmenta, eds., *Methodology of Macroeconometric Models*, (North-Holland Publishing Co., forthcoming.)

[4] A more precise description of the methodology employed here appears in McNees, "An Evaluation," 1975, pp.6–9.

[5] For a detailed description of the 1976 benchmark revision, see "The National Income and Product Accounts of the United States: Revised Estimates, 1929–1974," *Survey of Current Business*, January 1976.

been counted as part of consumer expenditures for durable goods, were reclassified as investment in residential structures. Previous forecasts could hardly be expected to have taken these definitional and classificational changes into account. Where appropriate, these "pre-benchmark" forecasts have been adjusted to take account of the definitional and classificational changes before comparing them with the latest "post-benchmark" actual data.[6]

Forecasters, Forecast Period, and Forecasted Variables

Everyone forecasts, at least implicitly, when making economic decisions. These forecasts are often formulated in qualitative rather than quantitative terms. Some of the most highly regarded macroeconomic forecasters do not issue numerical forecasts. Qualitative, verbal forecasts can be extremely valuable either by themselves or as supplements to numerical forecasts. Such forecasts, however, are virtually impossible to evaluate. For example, a forecast that "things are going to get worse" (or "going to get better") will almost always ring true to someone who subsequently fares poorly (or well). The difficulty is that words have different quantitative implications to different persons and at different times. The word "slowdown," for example, has recently been applied to economic growth rates ranging from 5.5 to -3.5 percent.

In addition, some quantitative forecasters are, quite frankly, sloppy record-keepers. Without proper documentation of past predictions, no precise evaluation of a predictive performance can be made. Furthermore, because barriers to entry (and exit) are nonexistent, new forecasters come on the scene (and old ones give up) quite frequently. Consequently, very few forecasters have compiled quantitative forecasts for the entire decade of the 1970s.

This study deals with five macroeconomic forecasters who have issued and documented forecasts on a regular quarterly basis since 1970.[7] The forecasts examined here are those issued by Chase Econometric Associates, Inc. (Chase), Data Resources, Inc. (DRI), the MAPCAST group at the General Electric Company (GE), the Wharton Econometric Forecasting Associates, Inc. (Wharton), and the median forecast from a survey conducted by the American Statistical Association and the National Bureau of Economic Research (ASA).[8]

Although some of this group issued earlier forecasts, mid-1970 was the earliest date from which forecasts from all five participants could be found. The study ends in 1979:2, the most recent quarter for which actual data are available. Thus, there are 36 one-quarter-ahead forecasts, 35 two-quarter-ahead forecasts, etc. and 31 six-quarter-ahead forecasts in this forecast period.[9]

With the exception of the ASA (which surveys only 11 variables) all of these forecasters predict more than 100 variables (and most

[6] These adjustments are described in my memorandum "Procedure for Adjusting Pre-benchmark Forecasts," available on request from the Research Department of the Federal Reserve Bank of Boston. Adjustment factors for nominal GNP and its major components for 1970 through 1974 were provided by the Bureau of Economic Analysis of the U.S. Commerce Department. Factors estimated for 1975 through 1977 are derived from published sources and simple extrapolations of the relatively minor portions for which no published data are available.

[7] Two forecasters who have compiled long forecasting records are not covered in this study. The forecasts of the Seminar on Quantitative Economic Methods at the University of Michigan are not included because their forecasts are issued three times each year rather than quarterly. The forecasts of the Bureau of Economic Analysis of the U.S. Commerce Department are excluded because they are not available to the public at the time of their release. Both of these forecasters may appear in a future study.

[8] For more information on the ASA/NBER survey see V. Zarnowitz, "The New ASA-NBER Survey of Forecasts by Economic Statisticians," *The American Statistician*, February 1969, pp. 12–16.

[9] Complete sets of forecasts of three variables are available only for shorter periods; the forecast period begins in 1971:2 for 90-day Treasury bills, in 1971:4 for housing starts and in 1972:2 for civilian employment.

several thousand). The variables selected for this study and their abbreviations are the following:

(1) GNP Implicit Price Deflator (IPD)
(2) Real Gross National Product (Real GNP)
(3) Gross National Product (GNP)
(4) Unemployment Rate (UR)
(5) Civilian Employment — Household Survey (E)
(6) Final Sales (FS)
(7) Personal Consumption Expenditures — Nondurable Goods and Services (PCE-N&S)
Durable Goods (PCE-D)
(9) Business Fixed Investment (BFI)
(10) Investment in Residential Structures (RS)
(11) Housing Starts (HS)
(12) Change in Business Inventories (CBI)
(13) Federal Government Purchases of Goods and Services (FGP)
(14) Net Exports of Goods and Services (NX)
(15) Money Supply, Narrow Definition (M1)
(16) 90-Day Treasury Bill Rate (TBR)
(17) Commercial Paper Rate (4- to 6-month) (CPR)

Evaluation of the Forecasters: Who Was the Best?

With full knowledge of both the forecasts and the actual outcomes, the straightforward question "Who's Best?" seems to have a straightforward answer. Each forecaster's errors are simply calculated and ranked. In practice, the answer is not so simple. Each forecast includes numerous variables and covers various horizons. Furthermore, for horizons of more than one-period ahead, each forecasted value provides an estimate of two distinct concepts: (1) the cumulative change from the time of the forecast to the end of the forecast horizon (henceforth, called the level) and (2) the change from the previous quarter (henceforth, the change). For example, two forecasters might each predict that the level of GNP two quarters ahead will be $50 billion higher than its present level, but one of them may expect the entire increase to occur in the next quarter and none in the quarter after that while the other predicts a $25 billion increase in each quarter. Both forecasts will have the same two-quarter-ahead level error, but very different two-quarter-ahead change errors.

With eight sets of forecasts of 17 variables over six-quarter horizons over a nine-year period there are nearly 50,000 individual errors to be analyzed counting both level and change errors. To list the ranking of 50,000 errors is, of course, possible but not very informative. The most useful simplification is to describe each forecaster's level and change errors for each variable and horizon with a summary error statistic. There are several different summary error statistics, each with its advantages and disadvantages for specific purposes, but the most common ones frequently would produce identical rankings. The easiest to interpret is probably the mean absolute error (henceforth, MAE), i.e., the average "miss" without regard to whether it is an overestimate or underestimate. These MAEs are presented in tables 1 (using standard units of measurement) and 2 (measuring geometric annual rates of growth).

A forecast user interested in either the level or the change forecasts of a specific variable over a specific forecast horizon could use tables 1 and 2 to find which forecaster has been the most accurate. A user should bear in mind, however, that forecasts are released at different times within a quarter. Forecasts released later in a quarter tend to be more accurate than those made by the *same* forecaster earlier in the quarter because the later forecasts are based on more information. The gain in accuracy is especially important for short-horizon forecasts and for variables that are available monthly (such as employment, unemployment, and housing starts) or more frequently (such as the

Table 1
Mean Absolute Errors, Conventional Units of Measurement

Forecaster	Adjusted Level Forecasts						Change Forecasts					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Implicit GNP Price Deflator (1972=100)											
Early Quarter												
ASA	0.4	0.8	1.4	1.9	2.7	—	0.4	0.5	0.7	0.6	0.9	—
Chase	0.3	0.8	1.4	1.9	2.6	3.4	0.3	0.6	0.6	0.7	0.8	0.9
DRI	0.4	1.0	1.5	2.1	2.8	3.4	0.4	0.6	0.7	0.7	0.8	0.9
Wharton	0.3	0.8	1.3	1.7	2.3	3.0	0.3	0.5	0.7	0.7	0.8	0.8
Mid Quarter												
Wharton	0.3	0.6	1.2	1.7	2.3	3.0	0.3	0.5	0.7	0.7	0.8	0.8
Late Quarter												
Chase	0.3	0.6	1.1	1.6	2.3	3.1	0.3	0.5	0.6	0.7	0.8	0.9
DRI	0.3	0.7	1.2	1.8	2.4	3.1	0.3	0.5	0.6	0.7	0.7	0.8
GE	0.4	0.7	1.1	1.5	2.0	2.7	0.4	0.5	0.6	0.6	0.6	0.7
	Real GNP (billions of 1972 dollars)											
Early Quarter												
ASA	7.0	10.2	13.7	17.4	22.0	—	7.0	9.8	10.2	10.1	10.5	—
Chase	6.3	10.3	13.8	19.2	26.2	31.1	6.3	9.0	9.9	11.1	11.2	11.5
DRI	7.8	12.0	14.4	19.0	24.1	27.7	7.8	10.2	10.3	10.3	11.4	12.4
Wharton	7.8	11.2	13.4	17.1	22.0	25.8	7.8	9.6	10.3	10.0	11.6	11.5
Mid Quarter												
Wharton	7.0	11.0	12.7	17.2	21.0	25.6	7.0	9.9	9.0	10.3	10.7	11.4
Late Quarter												
Chase	4.8	8.3	12.7	17.7	23.4	28.6	4.8	8.0	8.5	10.1	11.6	11.6
DRI	5.8	9.4	13.2	17.9	22.2	26.1	5.8	9.0	9.5	10.6	11.7	11.9
GE	7.0	11.1	13.4	17.1	20.6	26.4	7.0	10.2	9.8	10.4	10.5	12.5
	GNP (billions of current dollars)											
Early Quarter												
ASA	8.6	13.9	19.6	22.5	23.6	—	8.6	10.7	11.7	11.7	11.4	—
Chase	8.2	14.0	21.6	26.8	32.4	39.2	8.2	11.6	12.4	13.0	13.5	15.3
DRI	8.9	13.4	19.6	23.6	25.3	25.6	8.9	10.6	11.9	11.4	12.0	12.3
Wharton	10.5	13.5	18.8	20.5	21.3	25.0	10.5	11.8	11.0	11.1	12.3	12.9
Mid Quarter												
Wharton	9.0	13.5	19.8	22.1	23.6	23.1	9.0	12.7	11.1	11.9	12.3	11.5
Late Quarter												
Chase	6.4	12.1	20.3	27.9	33.5	39.1	6.4	10.3	12.3	12.8	13.3	14.6
DRI	7.2	12.1	16.9	24.7	27.2	27.8	7.2	10.3	10.9	12.0	12.3	12.8
GE	8.5	13.0	17.0	19.8	20.6	19.2	8.5	11.8	11.8	11.1	11.4	12.7
	Unemployment Rate (percentage points)											
Early Quarter												
ASA	0.1	0.2	0.4	0.5	0.6	—	0.1	0.2	0.2	0.2	0.2	—
Chase	0.2	0.4	0.5	0.7	0.8	1.1	0.2	0.2	0.3	0.3	0.3	0.3
DRI	0.2	0.3	0.4	0.5	0.6	0.7	0.2	0.2	0.2	0.2	0.2	0.2
Wharton	0.2	0.3	0.4	0.5	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2

Table 1—(continued)

Forecaster	Adjusted Level Forecasts						Change Forecasts					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Unemployment Rate (percentage points)											
Mid Quarter												
Wharton	0.2	0.3	0.5	0.5	0.5	0.6	0.2	0.2	0.2	0.2	0.2	0.2
Late Quarter												
Chase	0.2	0.4	0.5	0.7	0.8	1.0	0.2	0.2	0.3	0.3	0.2	0.3
DRI	0.2	0.3	0.4	0.5	0.6	0.7	0.2	0.2	0.2	0.2	0.2	0.2
GE	0.2	0.3	0.4	0.5	0.6	0.7	0.2	0.2	0.2	0.2	0.3	0.2
	Employment (millions)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	0.4	0.6	0.9	1.0	1.3	1.7	0.4	0.4	0.4	0.4	0.5	0.5
DRI	0.4	0.6	0.8	0.9	1.1	1.3	0.4	0.4	0.5	0.3	0.4	0.5
Wharton	0.3	0.5	0.7	0.8	1.0	1.1	0.3	0.4	0.4	0.3	0.4	0.4
Mid Quarter												
Wharton	0.2	0.5	0.7	0.9	1.1	1.2	0.2	0.4	0.4	0.3	0.3	0.4
Late Quarter												
Chase	0.1	0.5	0.8	1.0	1.3	1.6	0.1	0.4	0.4	0.5	0.4	0.5
DRI	0.3	0.5	0.7	0.9	1.0	1.2	0.3	0.4	0.4	0.4	0.4	0.4
GE	0.2	0.5	0.8	1.0	1.3	1.5	0.2	0.4	0.4	0.4	0.4	0.4
	Final Sales (billions of current dollars)											
Early Quarter												
ASA	8.2	14.0	17.6	19.7	21.7	—	8.2	9.2	9.4	9.4	8.9	—
Chase	7.7	12.8	18.1	23.3	28.5	37.1	7.7	9.4	9.6	9.7	11.1	12.7
DRI	7.3	11.9	16.2	19.3	22.1	24.6	7.3	8.0	9.4	9.5	8.8	9.5
Wharton	8.9	12.8	14.5	17.4	18.6	22.4	8.9	8.7	8.6	8.3	8.9	9.9
Mid Quarter												
Wharton	7.8	13.1	16.3	19.4	21.9	23.3	7.8	9.0	8.8	9.2	9.1	9.2
Late Quarter												
Chase	6.4	11.4	17.1	23.2	27.9	34.6	6.4	8.6	9.5	10.3	10.8	12.1
DRI	6.0	10.7	14.9	20.2	22.7	22.6	6.0	7.8	8.7	9.7	9.2	9.8
GE	7.7	12.2	14.8	16.5	17.3	17.7	7.7	9.2	9.0	8.9	8.8	9.8
	Personal Consumption Expenditures — Nondurable Goods and Services (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	4.2	6.9	9.4	11.9	15.5	20.2	4.2	4.4	4.1	4.4	5.0	5.9
DRI	3.7	6.4	8.7	10.5	13.1	16.7	3.7	3.9	4.1	4.1	4.1	4.6
Wharton	3.6	5.5	7.4	10.5	14.0	17.7	3.6	3.6	4.1	4.5	4.6	4.6
Mid Quarter												
Wharton	3.4	6.3	8.6	10.4	13.4	17.3	3.4	4.1	3.9	4.3	4.7	4.5
Late Quarter												
Chase	3.0	5.9	8.8	11.9	15.2	19.5	3.0	4.3	4.5	4.4	4.9	5.5
DRI	3.2	5.5	7.1	9.4	12.2	15.5	3.2	3.5	3.8	4.0	4.3	4.3
GE	3.5	4.7	6.0	6.9	9.4	11.8	3.5	3.2	3.2	3.3	3.4	3.7

Table 1—(continued)

Forecaster	Adjusted Level Forecasts						Change Forecasts					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Personal Consumption Expenditures — Durable Goods (billions of current dollars)											
Early Quarter												
ASA	3.0	5.0	6.0	6.9	7.4	—	3.0	3.9	3.8	3.5	3.5	—
Chase	3.4	4.9	5.6	6.6	8.4	9.6	3.4	3.7	3.3	3.5	4.0	3.9
DRI	3.3	4.6	5.6	6.3	7.5	7.7	3.3	3.4	4.0	3.7	3.5	3.9
Wharton	3.3	4.9	6.3	7.4	7.5	8.8	3.3	3.7	3.9	3.7	4.1	4.2
Mid Quarter												
Wharton	3.0	5.3	6.7	8.0	8.2	9.0	3.0	3.8	4.0	3.8	4.0	4.1
Late Quarter												
Chase	2.1	4.4	5.5	6.7	7.7	8.9	2.1	3.4	3.4	3.7	3.9	3.8
DRI	2.3	4.1	5.3	6.5	7.2	7.7	2.3	3.1	3.5	3.8	3.7	3.8
GE	2.6	4.5	5.3	6.1	6.4	7.2	2.6	3.4	3.8	3.5	3.6	4.0
	Investment in Residential Structures (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	2.3	4.2	7.0	9.8	12.2	14.0	2.4	2.9	3.3	3.4	3.4	3.5
DRI	1.8	2.9	4.7	6.2	7.7	8.8	1.8	2.1	2.5	2.6	2.5	2.3
Wharton	1.8	2.6	4.0	5.3	6.8	8.7	1.8	2.2	2.3	2.6	2.9	3.1
Mid Quarter												
Wharton	1.5	2.4	3.9	4.5	6.2	8.1	1.5	2.0	2.5	2.5	2.7	3.2
Late Quarter												
Chase	1.5	3.1	5.4	8.3	10.9	13.2	1.5	2.3	3.4	3.4	3.2	3.4
DRI	1.2	2.5	3.7	5.6	7.3	8.7	1.2	1.8	2.4	2.5	2.4	2.5
GE	1.6	3.5	5.6	7.4	8.7	10.1	1.6	2.3	2.5	2.5	2.7	2.8
	Housing Starts (millions of units)											
Early Quarter												
ASA	0.1	0.2	0.2	0.3	0.3	—	0.1	0.1	0.1	0.1	0.1	—
Chase	0.1	0.2	0.3	0.4	0.4	0.5	0.1	0.2	0.2	0.1	0.2	0.2
DRI	0.1	0.2	0.2	0.3	0.3	0.4	0.1	0.2	0.1	0.1	0.1	0.1
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Mid Quarter												
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Late Quarter												
Chase	0.1	0.2	0.3	0.4	0.4	0.5	0.1	0.1	0.2	0.2	0.1	0.2
DRI	0.1	0.1	0.2	0.3	0.3	0.3	0.1	0.1	0.2	0.1	0.1	0.1
GE	0.1	0.1	0.2	0.3	0.4	0.4	0.1	0.1	0.2	0.2	0.2	0.1
	Business Fixed Investment (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	2.1	3.5	5.3	7.2	9.4	12.4	2.1	2.3	2.6	2.7	3.2	3.6
DRI	2.1	3.5	5.0	6.2	7.6	8.9	2.1	2.3	2.2	2.0	2.1	2.2
Wharton	2.2	3.6	4.4	5.4	6.3	8.1	2.2	2.6	2.4	2.4	2.7	2.6

Table 1—(continued)

Forecaster	Adjusted Level Forecasts						Change Forecasts					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Business Fixed Investment (billions of current dollars)											
Mid Quarter												
Wharton	2.1	3.6	4.8	5.8	6.7	8.0	2.1	2.8	2.5	2.4	2.6	2.4
Late Quarter												
Chase	2.0	3.2	4.4	6.5	8.9	11.6	2.0	2.2	2.9	3.1	3.2	3.6
DRI	1.7	2.9	4.2	5.8	7.2	8.6	1.7	2.1	2.2	2.1	2.1	2.3
GE	1.6	2.6	3.6	4.5	5.3	6.1	1.6	1.7	1.9	2.0	2.1	2.3
	Change in Business Inventories (billions of current dollars)											
Early Quarter												
ASA	5.3	5.9	6.9	7.0	8.6	—	5.3	6.0	6.6	6.7	6.8	—
Chase	5.0	6.1	7.3	8.1	8.8	10.2	5.0	6.9	7.6	7.5	7.4	7.4
DRI	5.5	6.2	8.0	7.5	8.2	9.1	5.5	6.4	6.8	6.7	7.1	7.4
Wharton	5.8	7.4	7.5	8.2	7.7	9.8	5.8	7.2	6.8	6.8	7.3	7.4
Mid Quarter												
Wharton	6.0	6.4	8.2	7.1	8.2	9.1	6.0	7.2	7.4	6.9	7.0	7.4
Late Quarter												
Chase	5.1	5.4	7.1	7.9	9.0	10.4	5.1	6.6	7.4	7.4	7.2	7.5
DRI	5.0	5.3	7.7	7.6	8.2	9.4	5.0	6.8	6.8	7.2	7.1	7.2
GE	5.9	6.1	6.8	7.7	8.8	9.5	5.0	7.0	6.7	6.6	6.7	7.3
	Federal Government Purchases of Goods and Services (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	1.7	2.6	3.4	4.0	4.4	4.6	1.7	1.6	1.5	1.6	1.6	1.8
DRI	1.5	2.2	2.6	3.1	3.6	3.7	1.5	1.5	1.6	1.7	1.9	1.8
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Mid Quarter												
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Late Quarter												
Chase	1.6	2.6	3.4	3.9	4.1	4.5	1.6	1.5	1.5	1.4	1.6	1.7
DRI	1.7	2.1	2.7	3.1	3.6	4.0	1.7	1.5	1.7	1.7	1.7	1.9
GE	1.5	2.5	3.5	4.1	4.8	5.4	1.5	1.7	1.7	1.8	2.0	1.8
	Net Exports of Goods and Services (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	4.0	5.9	6.5	7.4	8.1	8.7	4.0	4.0	4.0	4.3	4.5	4.2
DRI	3.7	6.0	8.0	9.5	10.8	11.4	3.7	3.8	3.7	4.1	4.0	4.2
Wharton	3.7	5.6	7.1	8.2	9.0	9.5	3.7	3.6	4.1	4.1	4.0	4.3
Mid Quarter												
Wharton	3.8	5.8	7.5	8.5	9.2	9.8	3.8	3.5	4.1	4.5	4.0	4.3
Late Quarter												
Chase	3.9	5.8	6.7	7.4	7.8	8.2	3.9	4.5	4.1	4.1	4.5	4.3
DRI	3.7	5.8	7.4	8.2	9.7	10.8	3.7	3.9	3.8	3.9	3.9	4.3
GE	4.1	6.7	8.2	9.7	10.8	11.6	4.1	4.1	4.3	4.3	4.5	4.0

Table 1—(continued)

Forecaster	Adjusted Level Forecasts						Change Forecasts					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Narrow Money Supply (M1) (billions of current dollars)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	1.5	2.4	2.9	3.5	4.4	4.5	1.5	1.4	1.6	1.7	1.6	1.5
DRI	1.3	2.1	3.4	4.4	5.0	5.4	1.3	1.6	1.8	1.7	1.6	1.5
Wharton	1.6	2.9	4.2	5.0	5.7	6.2	1.6	1.9	1.7	1.9	1.7	1.5
Mid Quarter												
Wharton	1.3	2.3	3.4	4.7	5.6	6.0	1.3	1.7	1.6	1.8	1.7	1.6
Late Quarter												
Chase	0.9	2.2	3.4	4.0	4.5	4.8	0.9	1.7	1.6	1.7	1.6	1.4
DRI	0.9	1.8	2.8	4.1	4.8	5.4	0.9	1.4	1.7	1.8	1.7	1.8
GE	1.3	2.4	3.5	4.6	5.5	6.5	1.3	1.7	1.9	2.0	1.8	1.7
	90-day Treasury Bill Rate (percentage points)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	0.3	0.9	1.4	1.8	2.0	2.2	0.3	0.8	0.8	0.7	0.7	0.6
DRI	0.2	0.7	1.1	1.3	1.4	1.5	0.2	0.6	0.6	0.6	0.6	0.6
Wharton	0.2	0.7	1.2	1.5	1.7	1.9	0.2	0.6	0.6	0.6	0.6	0.6
Mid Quarter												
Wharton	0.2	0.7	1.2	1.5	1.7	1.8	0.2	0.6	0.7	0.6	0.6	0.7
Late Quarter												
Chase	0.1	0.6	1.1	1.6	1.9	2.2	0.1	0.6	0.8	0.7	0.7	0.7
DRI	0.0	0.5	0.9	1.2	1.4	1.5	0.0	0.4	0.6	0.6	0.6	0.6
GE	—	—	—	—	—	—	—	—	—	—	—	—
	Commercial Paper Rate (percentage points)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	0.4	1.3	1.8	2.1	2.5	2.7	0.4	1.0	0.9	1.0	1.0	0.9
DRI	0.3	0.9	1.3	1.6	1.8	2.0	0.3	0.8	0.8	0.8	0.9	0.8
Wharton	0.3	1.0	1.5	1.8	2.0	2.2	0.3	0.9	0.8	0.9	0.8	0.8
Mid Quarter												
Wharton	0.2	0.9	1.4	1.7	1.9	2.1	0.2	0.9	0.9	0.9	0.8	0.9
Late Quarter												
Chase	0.1	0.8	1.5	1.9	2.2	2.6	0.1	0.8	1.0	0.9	1.0	1.0
DRI	0.1	0.7	1.2	1.5	1.7	1.9	0.1	0.7	0.8	0.8	0.8	0.9
GE	—	—	—	—	—	—	—	—	—	—	—	—

Table 2
Mean Absolute Errors Growth Rates

	Level Forecasts						Change Forecast					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
Forecaster	Implicit Price Deflator											
Early Quarter												
ASA	1.3	1.5	1.6	1.7	1.9	—	1.3	1.9	2.3	2.2	2.9	—
Chase	1.2	1.5	1.6	1.7	1.8	2.0	1.2	2.1	2.2	2.4	2.8	3.0
DRI	1.5	1.8	1.8	1.9	1.9	2.0	1.5	2.2	2.3	2.5	2.6	2.9
Wharton	1.1	1.4	1.5	1.5	1.6	1.8	1.1	1.9	2.3	2.4	2.7	2.8
Mid Quarter												
Wharton	1.1	1.2	1.5	1.5	1.6	1.7	1.1	1.7	2.3	2.3	2.5	2.7
Late Quarter												
Chase	1.0	1.0	1.3	1.4	1.6	1.8	1.0	1.7	2.1	2.4	2.7	3.0
DRI	1.0	1.2	1.5	1.6	1.7	1.8	1.0	1.9	2.2	2.4	2.5	2.8
GE	1.3	1.3	1.4	1.4	1.4	1.6	1.3	1.7	2.0	2.1	2.1	2.5
	Real GNP											
Early Quarter												
ASA	2.3	1.7	1.5	1.4	1.5	—	2.3	3.3	3.4	3.3	3.4	—
Chase	2.0	1.7	1.5	1.6	1.7	1.7	2.0	3.0	3.3	3.6	3.6	3.7
DRI	2.6	2.0	1.6	1.6	1.6	1.5	2.6	3.4	3.5	3.4	3.7	4.0
Wharton	2.6	1.9	1.5	1.4	1.4	1.4	2.6	3.2	3.4	3.3	3.8	3.8
Mid Quarter												
Wharton	2.3	1.8	1.4	1.4	1.4	1.4	2.3	3.3	3.0	3.4	3.5	3.7
Late Quarter												
Chase	1.6	1.4	1.4	1.4	1.5	1.5	1.6	2.6	2.8	3.3	3.8	3.7
DRI	1.9	1.6	1.4	1.5	1.5	1.4	1.9	3.0	3.1	3.5	3.9	3.9
GE	2.3	1.8	1.5	1.4	1.3	1.4	2.3	3.4	3.3	3.4	3.5	4.1
	GNP											
Early Quarter												
ASA	2.4	1.9	1.8	1.5	1.3	—	2.4	3.1	3.3	3.2	3.1	—
Chase	2.2	2.0	1.9	1.7	1.7	1.7	2.2	3.2	3.5	3.5	3.5	4.0
DRI	2.5	1.9	1.7	1.6	1.4	1.2	2.5	3.0	3.4	3.1	3.3	3.4
Wharton	3.0	1.9	1.8	1.4	1.2	1.2	3.0	3.5	3.2	3.1	3.4	3.6
Mid Quarter												
Wharton	2.6	1.9	1.8	1.5	1.3	1.1	2.6	3.7	3.2	3.3	3.4	3.2
Late Quarter												
Chase	1.8	1.6	1.8	1.8	1.7	1.7	1.8	2.9	3.4	3.4	3.5	3.7
DRI	2.1	1.7	1.6	1.7	1.5	1.3	2.1	2.9	3.0	3.3	3.4	3.5
GE	2.4	1.8	1.5	1.4	1.2	1.0	2.4	3.3	3.4	3.1	3.2	3.5
	Employment											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	1.6	1.3	1.3	1.2	1.2	1.3	1.6	1.9	2.0	1.9	2.3	2.4
DRI	1.7	1.3	1.2	1.0	1.0	1.0	1.7	2.1	2.2	1.6	1.8	2.1
Wharton	1.5	1.2	1.1	1.0	0.9	0.8	1.5	1.8	1.6	1.6	1.9	2.0

Table 2—(continued)

Forecaster	Level Forecasts						Change Forecast					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Employment											
Mid Quarter												
Wharton	1.1	1.2	1.1	1.0	1.0	0.9	1.1	1.9	1.8	1.6	1.6	1.7
Late Quarter												
Chase	0.7	1.1	1.2	1.2	1.2	1.2	0.7	1.8	2.0	2.1	2.0	2.3
DRI	1.3	1.3	1.1	1.0	0.9	1.0	1.3	1.7	1.9	1.8	1.8	1.9
GE	0.9	1.3	1.2	1.2	1.2	1.1	0.9	1.8	1.8	2.0	1.9	2.1
	Final Sales											
Early Quarter												
ASA	2.3	1.9	1.6	1.4	1.2	—	2.3	2.6	2.7	2.5	2.4	—
Chase	2.0	1.7	1.6	1.5	1.5	1.6	2.0	2.6	2.6	2.6	2.8	3.2
DRI	2.0	1.6	1.5	1.4	1.2	1.2	2.0	2.2	2.7	2.6	2.4	2.6
Wharton	2.5	1.8	1.4	1.2	1.1	1.0	2.5	2.5	2.4	2.3	2.4	2.7
Mid Quarter												
Wharton	2.2	1.8	1.5	1.3	1.2	1.1	2.2	2.6	2.6	2.5	2.5	2.5
Late Quarter												
Chase	1.7	1.5	1.5	1.5	1.5	1.5	1.7	2.4	2.6	2.7	2.8	3.1
DRI	1.7	1.5	1.4	1.4	1.3	1.1	1.7	2.2	2.3	2.6	2.5	2.6
GE	2.2	1.7	1.4	1.2	1.0	0.9	2.2	2.6	2.6	2.5	2.5	2.7
	Personal Consumption Expenditures — Nondurable Goods & Services											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	2.1	1.8	1.6	1.5	1.5	1.7	2.1	2.3	2.1	2.2	2.5	2.9
DRI	1.9	1.6	1.4	1.3	1.3	1.3	1.9	1.9	2.0	2.1	2.0	2.2
Wharton	1.8	1.4	1.2	1.3	1.3	1.4	1.8	1.8	2.1	2.2	2.2	2.2
Mid Quarter												
Wharton	1.7	1.5	1.4	1.2	1.3	1.4	1.7	2.0	2.0	2.2	2.3	2.2
Late Quarter												
Chase	1.6	1.5	1.5	1.5	1.5	1.6	1.6	2.2	2.3	2.2	2.4	2.6
DRI	1.7	1.4	1.2	1.2	1.2	1.2	1.7	1.8	2.0	2.0	2.1	2.1
GE	1.8	1.3	1.1	0.9	1.0	1.0	1.8	1.7	1.7	1.8	1.8	1.9
	Personal Consumption Expenditures — Durable Goods											
Early Quarter												
ASA	9.5	8.0	6.5	5.6	4.8	—	9.5	12.3	12.4	10.5	10.6	—
Chase	10.2	7.5	5.9	5.2	5.2	4.9	10.2	11.3	10.6	10.6	11.8	11.5
DRI	10.1	7.2	6.0	5.1	4.8	4.1	10.1	10.4	12.8	11.2	10.6	11.8
Wharton	10.2	7.9	7.0	6.1	5.0	4.8	10.2	11.5	12.7	11.3	12.5	12.6
Mid Quarter												
Wharton	9.1	8.4	7.4	6.6	5.4	4.9	9.1	11.8	12.8	11.4	12.1	12.4
Late Quarter												
Chase	6.6	6.8	5.6	5.3	4.8	4.6	6.6	10.6	10.3	11.2	11.7	11.0
DRI	7.5	6.4	5.6	5.3	4.6	4.1	7.5	9.5	10.5	11.6	11.1	11.5
GE	8.1	6.9	5.6	4.9	4.1	3.8	8.1	10.1	11.9	10.4	10.8	12.0

Table 2—(continued)

Forecaster	Level Forecasts						Change Forecast					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Investment in Residential Structures											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	16.7	14.1	15.1	16.0	15.6	14.5	16.7	19.7	21.6	21.3	20.6	21.1
DRI	12.7	10.2	11.1	11.2	10.8	9.7	12.7	15.6	18.0	17.8	15.8	14.6
Wharton	11.8	9.2	8.4	8.1	8.2	8.9	11.8	15.0	15.3	17.9	20.0	20.1
Mid Quarter												
Wharton	9.9	8.1	8.2	7.3	7.8	8.3	9.9	13.6	15.8	16.7	18.1	20.9
Late Quarter												
Chase	11.0	10.4	11.4	13.0	13.6	13.4	11.0	15.5	21.8	21.4	19.6	20.6
DRI	9.2	8.6	8.8	10.1	10.1	9.8	9.2	12.7	17.6	17.9	15.8	14.7
GE	11.2	11.4	11.7	11.6	10.9	10.5	11.2	15.3	16.1	16.6	16.4	17.8
	Business Fixed Investment											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	6.0	5.1	4.8	4.6	4.8	5.2	6.0	6.6	7.1	7.0	8.1	8.8
DRI	6.3	5.0	4.7	4.3	4.2	4.1	6.3	6.9	6.4	5.6	6.0	6.2
Wharton	6.4	5.2	4.1	3.7	3.6	3.8	6.4	7.9	6.8	6.6	7.5	7.2
Mid Quarter												
Wharton	6.4	5.3	4.6	4.1	3.8	3.8	6.4	8.2	7.3	6.8	7.2	6.4
Late Quarter												
Chase	5.4	4.9	4.7	4.8	4.9	5.2	5.4	6.6	7.9	8.2	8.2	9.2
DRI	4.9	4.1	3.9	4.0	4.0	3.9	4.9	6.1	6.4	5.8	5.8	6.3
GE	4.6	3.9	3.5	3.4	3.1	3.0	4.6	5.1	5.5	6.0	6.1	6.7
	Federal Government Purchases of Goods & Services											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	5.9	4.5	3.9	3.4	3.0	2.7	5.9	5.4	5.2	5.5	5.7	6.3
DRI	5.0	3.8	2.8	2.6	2.4	2.1	5.0	5.4	5.5	5.8	6.7	6.1
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Mid Quarter												
Wharton	—	—	—	—	—	—	—	—	—	—	—	—
Late Quarter												
Chase	5.6	4.4	3.8	3.3	2.7	2.6	5.6	5.2	5.1	4.9	5.6	5.8
DRI	6.1	3.8	3.1	2.6	2.4	2.2	6.1	5.3	5.8	6.0	6.1	6.7
GE	5.4	4.5	4.0	3.5	3.2	3.0	5.4	6.1	6.0	6.1	6.8	6.2
	Narrow Money Supply (M1)											
Early Quarter												
ASA	—	—	—	—	—	—	—	—	—	—	—	—
Chase	2.1	1.7	1.3	1.2	1.2	1.0	2.1	2.0	2.3	2.3	2.2	2.0
DRI	1.9	1.5	1.7	1.6	1.5	1.3	1.9	2.2	2.6	2.4	2.3	2.1
Wharton	2.4	2.1	2.0	1.8	1.6	1.4	2.4	2.7	2.4	2.7	2.3	2.1
Mid Quarter												
Wharton	1.9	1.7	1.6	1.6	1.6	1.4	1.9	2.3	2.2	2.6	2.4	2.2

Table 2—(continued)

Forecaster Late Quarter	Level Forecasts						Change Forecast					
	Forecast Horizon (Quarters)											
	1	2	3	4	5	6	1	2	3	4	5	6
	Narrow Money Supply (M1)											
Chase	1.4	1.5	1.6	1.4	1.2	1.1	1.4	2.3	2.3	2.4	2.2	2.0
DRI	1.4	1.3	1.3	1.4	1.4	1.3	1.4	2.0	2.4	2.5	2.4	2.4
GE	1.8	1.7	1.7	1.7	1.6	1.5	1.8	2.4	2.7	2.9	2.5	2.3

money stock and interest rates).[10] An effort was made, therefore, to group the forecasts, according to their release dates, into sets of early-quarter, mid-quarter, and late-quarter forecasts. A clear division is not always possible because some forecast sets do not follow a consistent pattern.[11]

To readers who are overwhelmed by the vast array of numbers in tables 1 and 2, a further simplification may prove useful. Each forecaster's errors for each variable can be summarized over all forecast horizons. This simplification involves not only a loss of information about differences among different horizons but requires introducing a second summary error measure. Forecast errors over different horizons are not strictly comparable. For example, a $10 billion level error for a six-quarter-ahead forecast of GNP is less serious than for a one-quarter-ahead forecast because the magnitude to be predicted is about six times as large. A summary error measure which makes allowance for such differences is the Theil coefficient — formally, the square root of the ratio of the sum of squared errors to the sum of squared actual changes. The Theil coefficient scales errors by the size of the actual changes in the predicted variable.

The results could be simplified even further by combining each forecaster's performance for all the variables. If there were a generally accepted set of weights reflecting the relative importance of each of the variables to forecast users, such an index of each forecaster's overall performance could be constructed. There is, however, no consensus on the relative importance of the variables among forecast users. In fact, users have widely varying interests, or "weights" for the different variables, and these frequently change over time. Thus, in contrast to summarizing forecasts over different horizons where the arbitrary assumption of equal weights seems plausible, assigning a set of arbitrary weights to the different variables seems most unlikely to produce an overall rating index that corresponds to forecast users' needs. The variables, therefore, are treated separately.

Accepting the Theil coefficient method of summarizing errors for different horizons and the rough grouping of forecasters by release dates, several generalizations can be gleaned from the information in tables 3 and 4:

Among the one- through four-quarter-ahead forecasts of the early-quarter forecasters, ASA was the most accurate for the unemployment rate, the change in business inventories, and

[10] See S. McNees, "An Evaluation," 1975, p. 23 as well as tables 1 and 2.

[11] See S. McNees, "An Evaluation," 1975, p. 15. A table of the forecast release dates is available from the author on request.

Table 3
Theil Coefficients One- Through Four-Quarter Ahead Forecasts

	Early-Quarter Forecasters				Mid-Quarter Forecaster	Late-Quarter Forecasters		
Forecaster / Variable	ASA	Chase	DRI	Wharton	Wharton	Chase	DRI	GE
IPD								
Level	.274	.273	.300	.243	.223	.218	.242	.224
Change	.327	.331	.349	.313	.298	.299	.310	.286
Real GNP								
Level	.462	.465	.533	.448	.456	.393	.463	.451
Change	.667	.680	.701	.670	.657	.596	.643	.689
GNP								
Level	.185	.223	.191	.182	.200	.216	.181	.171
Change	.323	.364	.321	.323	.333	.343	.303	.324
UR								
Level	.610	.854	.646	.688	.686	.814	.651	.672
Change	.762	.951	.815	.806	.828	.937	.815	.893
E								
Level	—	.545	.471	.431	.438	.474	.420	.442
Change	—	.689	.669	.594	.600	.634	.592	.602
FS								
Level	.181	.202	.170	.159	.180	.187	.157	.150
Change	.306	.327	.299	.288	.287	.308	.273	.282
PCE-N&S								
Level	—	.194	.165	.149	.165	.181	.147	.120
Change	—	.240	.219	.216	.216	.235	.205	.194
PCE-D								
Level	.508	.528	.495	.539	.589	.494	.468	.473
Change	.767	.795	.801	.788	.779	.708	.707	.740
BFI								
Level	—	.476	.421	.412	.439	.422	.364	.289
Change	—	.606	.541	.540	.560	.659	.502	.443
RS								
Level	—	.757	.502	.438	.403	.629	.425	.585
Change	—	.914	.684	.711	.683	.857	.616	.719
HS								
Level	.791	1.099	.861	—	—	.926	.697	.775
Change	.901	1.034	.968	—	—	.934	.885	.939
CBI								
Level	.712	.721	.767	.811	.785	.704	.745	.746
Change	.913	.964	.930	.958	.990	.930	.910	.973
FGP								
Level	—	.543	.454	—	—	.544	.450	.570
Change	—	.642	.611	—	—	.633	.636	.698
NX								
Level	—	.850	.977	.831	.880	.858	.889	1.004
Change	—	1.001	.983	.954	.974	1.013	.992	1.047
MI								
Level	—	.284	.304	.345	.303	.290	.268	.313
Change	—	.448	.450	.478	.432	.438	.425	.477

Table 3—(continued)

Variable	Forecaster ASA	Early-Quarter Forecasters Chase	DRI	Wharton	Mid-Quarter Forecaster Wharton	Late-Quarter Forecasters Chase	DRI	GE
TBR								
Level	—	1.027	.794	.869	.887	.860	.695	—
Change	—	1.090	.881	.960	1.006	.999	.817	—
CPR								
Level	—	.961	.743	.792	.780	.813	.648	—
Change	—	.993	.871	.904	.908	.916	.787	—

Table 4
Theil Coefficients One- Through Six-Quarter-Ahead Forecasts

Variable	Early-Quarter Forecasters Chase	DRI	Wharton	Mid-Quarter Forecaster Wharton	Late-Quarter Forecasters Chase	DRI	GE
IPD							
Level	.316	.326	.280	.261	.275	.285	.255
Change	.385	.388	.361	.344	.363	.361	.322
Real GNP							
Level	.508	.540	.461	.441	.449	.489	.459
Change	.735	.754	.728	.706	.693	.717	.734
GNP							
Level	.220	.158	.149	.161	.218	.159	.133
Change	.392	.331	.336	.333	.376	.321	.334
UR							
Level	.891	.658	.636	.611	.842	.654	.662
Change	1.033	.872	.851	.844	1.011	.864	.949
E							
Level	.549	.433	.396	.416	.498	.403	.442
Change	.733	.679	.625	.606	.678	.620	.652
FS							
Level	.201	.144	.134	.152	.190	.136	.117
Change	.355	.297	.293	.288	.338	.285	.292
PCE-N&S							
Level	.198	.163	.158	.167	.190	.152	.121
Change	.260	.224	.226	.226	.252	.216	.196
PCE-D							
Level	.487	.426	.465	.506	.461	.416	.402
Change	.818	.804	.811	.799	.753	.748	.772
BFI							
Level	.516	.404	.388	.425	.483	.376	.273
Change	.669	.535	.548	.548	.710	.514	.464
RS							
Level	.784	.491	.458	.425	.696	.448	.560
Change	.955	.695	.761	.739	.902	.655	.763

Table 4
Theil Coefficients One- Through Six-Quarter-Ahead Forecasts

	Early-Quarter Forecasters			Mid-Quarter Forecaster	Late-Quarter Forecasters		
Variable	Chase	DRI	Wharton	Wharton	Chase	DRI	GE
HS							
Level	1.036	.831	—	—	.935	.733	.790
Change	1.036	.966	—	—	.968	.907	.972
CBI							
Level	.759	.773	.813	.784	.753	.782	.763
Change	.969	.957	.981	.995	.949	.948	.969
FGP							
Level	.480	.392	—	—	.472	.400	.535
Change	.646	.631	—	—	.634	.650	.708
NX							
Level	.811	1.003	.859	.879	.797	.929	1.004
Change	1.009	.983	.970	.987	1.015	.993	1.042
M1							
Level	.247	.277	.313	.291	.262	.264	.301
Change	.453	.456	.481	.448	.446	.448	.486
TBR							
Level	1.044	.792	.878	.884	.950	.728	—
Change	1.077	.928	.976	1.015	1.052	.885	—
CPR							
Level	.978	.744	.801	.782	.877	.680	—
Change	1.013	.914	.929	.939	.986	.859	—

housing starts; Chase was the most accurate for the money stock; DRI was the most accurate for federal government purchases and short-term interest rates; and Wharton was the most accurate for the implicit GNP price deflator, employment, final sales, consumer purchases of nondurable goods and services, business fixed investment, and net exports. Among the one- through six-quarter-ahead forecasts of the mid-quarter forecaster and the late-quarter forecasters, Chase was the most accurate for the money stock; DRI for housing starts and short-term interest rates; GE for the implicit GNP price deflator, consumer purchases of nondurable goods and services, and business fixed investment; and Wharton for the unemployment rate.[12]

[12] The Wharton forecasts were made somewhat earlier and the GE forecasts generally somewhat later than the others.

Note that there are several variables where no forecaster was most accurate for both level and change forecasts. In these cases, one forecaster most accurately predicted the *pattern* of quarter-to-quarter changes while another, whose quarter-to-quarter errors were larger, had more accurate level forecasts due to error offsets (errors of the opposite algebraic sign). For example, one forecast could *under*estimate next quarter's change by $10 billion and *over*estimate the change in the following quarter by $10 billion. Even though this forecast of changes is less accurate than a forecast understating the change in each quarter by $5 billion, it is far more accurate on the level of the variable two quarters ahead. Who's best? As is true of errors for different variables, the question cannot be answered without knowing more about the needs and interests of forecast users.

The difficulty of answering the question "Who's Best?" goes far deeper. Even if attention is focused solely on the level or change forecast of one specific variable over one horizon, Tables 1 and 2 show that *the differences* in the summary error measures of the different forecasters *typically are quite small*. Particularly when only fairly short records of forecasts are available, differences in performances can stem not solely from differences in skill but also from chance or "luck." In trying to interpret the summary error measures shown above, readers should bear in mind that there is *no* test to determine rigorously whether these *differences* are significant in the statistical sense.[13] Therefore, even *if* all forecast users had identical interests (in terms of the importance assigned to the level and change errors for each variable and each horizon), there would be difficulty in determining definitively which forecaster was the best. In light of the small differences in the errors among forecasters for most variables, the conclusion that these forecasters' performances have been broadly similar is not an evasion of the question, it is simply a reflection of the facts.

[13] There is, of course, a complex structure of serial correlations among the errors of a single variable for a specific forecaster, among the variables in each forecast, and among forecasters. If these correlation patterns were stable and if sufficient data were available to estimate these patterns, this information could be used to obtain more efficient estimates of a forecast's accuracy. However, quarterly ex ante forecast data accumulate at a slow rate relative to the huge demands such an exercise makes. It is doubtful that the correlation structure would remain stable over the many years needed to accumulate the ex ante data necessary to estimate the structure. The exercise can be performed, however, with the stochastic simulations from econometric models but only under the strong assumption that certain variances are constant across time. See Ray Fair, "Estimating the Expected Accuracy," footnote 14, p. 21. All such exercises are motivated by the natural desire to infer future accuracy from past performances. They hinge ultimately on some assumptions about continuity — that the future will be in some sense like the past. The realism of this assumption for economic forecasts is discussed briefly in S. McNees, "The Predictive Accuracy of Econometric Forecasts," this *Review*, September/October 1973, p. 6.

Variations in Accuracy over Time

The error measures used to evaluate the forecasters in the previous section *summarize* their performances over a nine-year period. Thus, they do not convey how their accuracy varied *within* those years, i.e., when the errors were "large" and when they were "small." This section examines how the accuracy of these forecasts varied during the 1970s. The measures of accuracy, shown in Table 5, are the errors of the *median* (among five) *one-year-ahead* forecasts of four important economic variables: the rate of growth of real GNP, the inflation rate (as measured by the implicit GNP price deflator), the rate of growth of nominal GNP, and the change in the unemployment rate.[14]

Note first that the variation in these errors has been substantial — for example, real growth rate errors *ranged* from 7.0 percentage points to zero compared with an *average* error (MAE) of 1.4 percentage points. The *maximum* errors for the inflation and unemployment rates are 5.4 percentage points and 2.2 percent, respectively, but each of the variables was predicted one-year-ahead with perfect accuracy on one or more occasions.

Notice also that the "large" and "small" errors tend to cluster together (in contiguous time periods).[15] To illustrate this all errors greater than the MAE for the entire period could be defined as "large" or "failures" (and printed in blue) and the others called "small" or "successes" (and printed in black). The clustering of "failures" is most evident for the real GNP forecasts. With a single, minor exception (the four-quarter period ending in 1978:1), *all* of

[14] The median was selected from the early-quarter forecasts by ASA, Chase, DRI, Wharton, and the Bureau of Economic Analysis of the U.S. Commerce Department.

[15] The clustering reflects, in part, that these are overlapping four-quarter periods. Unusual errors for one particular quarter will tend to show up in four consecutive errors.

Table 5
Errors of Median One-Year-Ahead Forecasts 1971:I–1979:II (Based on five forecasters)

Four Quarters Ending In	Percent Change in GNP	Real GNP	Deflator	Change in Unemployment Rate
71:1	-1.0	0.5	-1.3	-0.9
71:2	-1.3	0.3	-1.6	-0.9
71:3	-1.1	0.5	-1.6	-0.5
71:4	-1.2	.0.0	-1.1	-0.4
72:1	-0.5	0.6	-0.8	-0.1
72:2	-0.7	-0.8	0.1	0.2
72:3	-0.6	0.1	-0.7	-0.1
72:4	-1.7	-1.2	-0.4	0.2
73:1	-2.3	-1.3	-0.7	0.4
73:2	-1.7	0.0	-1.7	0.1
73:3	-2.2	0.7	-2.8	0.3
73:4	-2.3	1.4	-3.7	0.1
74:1	-0.2	3.8	-4.1	-0.3
74:2	-0.7	3.3	-4.0	0.0
74:3	-1.1	3.8	-5.4	-0.3
74:4	0.3	4.1	-4.5	-0.5
75:1	4.1	7.0	-4.6	-1.9
75:2	2.5	4.6	-2.4	-2.2
75:3	0.3	-0.7	0.2	-0.9
75:4	-0.7	-1.9	0.8	0.5
76:1	-2.2	-3.0	0.1	0.1
76:2	1.3	0.6	0.5	-0.1
76:3	2.6	0.9	1.4	-0.7
76:4	1.8	0.5	1.1	-1.1
77:1	1.7	1.0	0.5	-0.5
77:2	0.0	0.4	-0.3	-0.4
77:3	-1.5	-0.7	-0.6	0.0
77:4	-0.6	0.0	-0.6	0.0
78:1	1.8	1.7	0.0	0.5
78:2	-1.0	0.0	-1.0	0.5
78:3	-1.5	0.3	-1.7	0.6
78:4	-3.0	-0.8	-2.1	0.6
79:1	-2.3	0.1	-2.2	0.4
79:2	-1.2	0.8	-1.9	0.7
Mean Absolute Error	1.4	1.4	1.7	0.5

the "failures" or "large" errors occurred in forecasts of the periods ending between 1974:1 and 1976:1. Similarly, with one insignificant exception, *all* of the forecasts of this period were "failures" in the sense that their errors were substantially greater than the average error over the entire period.[16]

An alternative way of describing the clustering of real growth errors is to note that the 1.4 percentage point MAE for the entire period can be divided into two portions — the 3.6 percentage point MAE during the large error period and the 0.6 percentage point MAE in the other 25 quarters. It could be argued *either* that the difficult 1974:1–1976:1 period was an extraordinarily unusual one (due perhaps to the aftereffects of the relaxation of wage and price controls or the sharp rise in the price of imported oil) *or* that forecasters have learned from their mistakes on that occasion. In their extreme form, either of these lines of reasoning suggests that that episode can be regarded as an aberration, unlikely to recur, implying that the standard for future errors of one-year-ahead real growth forecasts may be closer to the 0.6 percentage points in the "normal" periods than to the 1.4 percentage points for the entire period. Only time will tell whether this optimistic speculation is warranted.

Clustering is also clearly present for the inflation rate forecasts. The errors of *all* the inflation rate forecasts of the period from 1973:3 through 1975:2 were substantially above the 1.7 percentage point MAE for the whole period. The *only* other period of above average inflation errors is the most recent one, 1978:3 through 1979:2. However, the *largest* error in this most recent period is less than the *smallest* error in the previous "large" error period from mid-1973 to mid-1975. It would probably be overly generous

[16] The exception is deemed insignificant because it reflects the offsetting of greater-than-usual short-term overestimates by greater-than-normal longer term underestimates.

to regard the recent larger-than-average inflation errors as an aberration: the errors in the last four years were no larger than those in the early 1970s and the lessons-learned-from-past-mistakes argument loses much of its force when used repeatedly. In any event, the 1.7 percentage point MAE for the entire period can be thought of as the combination of a 3.9 percentage point MAE from mid-1973 to mid-1975 and a 1.0 percentage point error in the periods before and since.

There is some tendency for "failures" and "successes" for different variables to occur at the same time. For example, mid-1974 to mid-1975 was a period of extreme failures for forecasts of real growth, inflation, and unemployment rates. However, several exceptions are notable. For example, inflation forecasts of late 1973, late 1978, and early 1979 were overly optimistic while forecasts of real growth were of average or better accuracy. Following a period of large errors, inflation forecasts from mid-1975 through mid-1978 (i.e., one-year-ahead forecasts made from mid-1974 through mid-1977) were extremely accurate. Thus, the high level of unemployment that prevailed in those years cannot be explained by contemporaneous "surprises" in the inflation rate. (This explanation is, however, consistent with the 1974–75 experience.)

Typically, one would expect overestimates of the strength of real growth to be associated with underestimates of unemployment. This is, of course, the major explanation for the extraordinarily large underestimates of unemployment in early 1975. As might be expected, in nearly two-thirds of the periods examined overestimates of output were associated with underestimates of unemployment and vice versa. Virtually all of the occasions when this inverse relation did not hold occurred in 1973 and in the last five quarters, periods of extraordinarily weak productivity. Moreover, there had been several occasions (most notable early 1971) when "small" to average overestimates of real growth occurred along with "large underestimates of the unemployment rate or (as in early 1974) when "large" overestimates of real growth were associated with "small" unemployment rate "errors."

The constellations of errors for different variables that have occurred in important episodes from 1971 through 1977 have been analysed in some detail elsewhere.[17] The highlights of the experience since 1977 have already been noted: "large" underestimates of the inflation rate (though far less serious than in the 1973-75 debacle) and overestimates of the unemployment rate of "average" size coupled with relatively accurate real growth forecasts, reflecting overly optimistic productivity predictions.

The record, in sum, is mixed. Examination of variations in forecast accuracy over time reveals instances of outstanding success along with some dismal failures. It is difficult to find a better description in any more sweeping generalization. One can only speculate on the important questions: Can one realistically expect forecasts to ever be significantly more accurate than those of 1972, and mid-1976 through mid-1978? Must we fear a repetition of the 1974 to mid-1975 experience when the forecasts indicated little about the future course of the economy?

Conclusion: How Good Were These Forecasts?

One way to evaluate a forecast is to select some absolute standard (such as the average error over an extended period) to judge whether a specific error was "large" or "small" and a

[17] See S. McNees, "Lessons from the Track Record of Macroeconomic Forecasts in the 1970s," in S.Wheelwright and S. Makridakis, eds., *Forecasting*, (North-Holland/TIMS Studies in the Management Sciences, vol. 12, 1979.)

forecast was "good" or "bad." Using an absolute standard, the preceding section illustrates that forecasts of the 1970s have ranged widely from "very good" to "horrid."

An alternative, more sophisticated approach recognizes that the inherent uncertainty or randomness associated with different forecast periods seems to vary widely over time. On some occasions, such as 1974-75, even a fairly sizable deviation between a forecast and the actual outcome would represent a comparatively brilliant forecast. On others, such as 1972 and 1976-77, even the least gifted forecasters anticipated the future course of the economy almost perfectly. Accordingly, it is nonsensical to label a forecast "good" or "bad" on the basis of the absolute magnitude of its error. Forecast evaluation must be *relative* rather than *absolute* because no reasonable absolute standard exists.[18] The only sensible answer to the question "How Good Were These Forecasts?" is the answer to the question "Were Other Forecasts Better or Worse?" If another forecaster could document a systematically superior record, these forecasts were obviously not the most accurate available. If no other set of forecasts was systematically more accurate, these performances, while not ideal — no forecaster was gifted with perfect foresight — would represent the *minimum, feasible* errors for forecasts of the 1970s. In that event, the opinion that these forecasts were "poor" would only express a wish that the future had been less uncertain or that we had known more than we in fact did.

The traditional standards of comparison for evaluating economic forecasts have been simple, noneconomic rules of thumb such as a "no-change" rule (next period will be equal to last period) for "untrended" variables and a "same-change" rule (next period's change will be equal to the last period's change or the average change over several past periods) for variables with trends. While economic forecasts have usually been more accurate than these simple rules for most variables, there are several exceptions and many close calls. For example, the no-change rule offers fairly stiff competition to the forecasts of "untrended" variables such as short-term interest rates, the personal savings rate, the change in business inventory investment, housing starts, and the federal deficit or surplus.[19] Forecasts of these variables have often been less accurate or only slightly more accurate than the simple no-change. Instances of the superiority of such simple rules suggest that there are areas where these forecasts could realistically have been improved.

In recent years, the simple rules have been replaced as standards of comparison by more mathematically complex, noneconomic formulae, usually called time series "models" or equations. Although these equations have been studied extensively, little solid evidence is available on how the accuracy of time series predictions of the major macroeconomic variables compares with that of actual forecasts of the type studied here.[20] Three recent studies have

[18] The most natural absolute standard, the ideal of a zero error, is unrealistically naive. Whenever there is some inherent uncertainty or randomness, the absolute minimum of a zero error is not feasible.

[19] Since the Theil measure is based on the ratio of the (squared) forecast error to (squared) actual outcome, the Theil value for a no-change forecast is exactly equal to one. The Theil coefficients of the forecasts of these variables have often exceeded one. This conclusion is evident from inspecting the Theil coefficients presented in tables 3 and 4 above and in table 1 in S. McNees, "An Evaluation of Economic Forecasts: Extension and Update," this *Review*, September/October, 1976.

[20] Most of the vast literature on this subject is not relevant here for one or more of the following reasons: (a) Ex post model predictions rather than actual before the fact forecasts are used. (b) The analysis is confined to one-period-ahead predictions. (c) Extremely short or ancient forecast periods are studied. (d) Disaggregated, microeconomic variables rather than the conventional macroeconomic variables are examined. (e) The time-series equations were fit after the fact using the latest revised data and therefore contain information which was not available at the time an actual forecast would have been made.

contrasted time series predictions with actual, ex ante forecasts.[21] Even though they adopt different approaches, all three reach broadly similar conclusions: (1) For a majority of variables, time series equations are less accurate than actual forecasts. (2) The margin of superiority typically increases significantly as the forecast horizon extends further into the future. (3) Therefore, in the minority of cases where time series equations were more accurate than the forecasts over short horizons, the superiority disappears in longer horizons. The limited success of time series equations in forecasting macroeconomic variables suggests that economic forecasters have not been rendered superfluous by statistical formulae.[22] However, the dominance of the time series equations or even "naive" rules for some variables over some horizons illustrates that better forecasts could have been made if the forecasters had paid greater attention to the statistical properties of the economic variables to be forecast.

The forecasts examined above must be considered "good" until other forecasters document that it was possible to have produced systematically more accurate predictions. Because these forecasts are fairly widely publicized, other forecasters could well have matched these performances simply by repeating the views in a publicized forecast. At the same time, the large errors for some variables in some time periods — large not only absolutely but also relative to purely statistical formulae which could have been employed at the time — indicate ample room for improvement. These performances surely do not uniformly represent the *minimum, feasible* errors. Whether and how rapidly forecasting accuracy can improve in the future depends in part on what can be learned from studying the track record of the economic forecasts in the 1970s.

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[21] See Hirsch et al., "Some Multiplier and Error Characteristics," table 3; S. McNees, "The Accuracy of Macroeconometric Models and Forecasts of the U.S. Economy," in P. Omerod, ed., *Economic Modelling*, table 2; and O. Eckstein, "Econometric Models for Forecasting and Policy Analysis: The Present State-of-the-Art," a lecture presented to the American Statistical Association, Washington, D.C. August 15, 1979, table 5. These studies are only relatively, not totally, immune to the limitations noted above.

[22] Arnold Zellner's work illustrates that it is more reasonable to consider time series equations and structural econometric models in complementary rather than competitive roles. See, for example, A. Zellner and F. Palm, "Time Series Analysis and Simultaneous Equation Econometric Models," *Journal of Econometrics*, Vol. 2, No. 1, (April 1974), pp. 17–54. The same spirit of complementarity applies to economic forecasts and time series equations. A time series representation or a "random walk" can be the most instructive technique for forecasting some variables. When data for important explanatory variables are not available, the time series approach is the only feasible one.

Mortgage Finance and the Housing Cycle

By Neil G. Berkman*

ALTHOUGH the goal of a decent home for every American family did not receive formal Congressional endorsement until the passage of the Housing Act in 1949, reducing the cyclical instability of residential construction has been an objective of national economic policy since the Great Depression.[1] Policies to achieve this goal have taken various forms over the years, ranging from direct government purchases and subsidies to mortgage insurance to alterations in the characteristics of the mortgage contract to the creation of new financial institutions, but the stabilization goal has proven difficult to attain. Economic theories offered to explain the continuing intransigence of the housing sector share an emphasis on the particularly credit sensitive nature of housing demand and residential mortgage finance. This unanimity on the importance of financial conditions in the housing market does not imply general agreement on the precise nature of the mechanism linking interest rates and credit flows to home construction, however. Recent empirical studies have challenged the widely accepted "credit availability" view of the housing cycle, arguing that the movement of interest rates alone is sufficient to account for observed changes in residential investment.[2] If this is true, then the efficacy of existing policies that supplement the flow of funds into housing during periods of credit restraint must be called into question. Indeed, it may be that the proliferation of these so-called "secondary" mortgage market programs has created additional demand for funds in already tight money markets, and thus exacerbated the housing cycle rather than smoothed it. This paper assesses alternative theories of the housing cycle, analyzes their competing policy implications, and presents evidence on the impact of government support programs on the volatility of the housing sector.

I. A Bit of Background: The Importance of Housing in the Economy

Residential fixed investment averages only about 5 percent of real GNP, and employment in home building is an even smaller fraction of

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[1] For a brief history of legislation involving the housing industry, see Miles L. Colean, *The Impact of Government on Real Estate Finance in the United States* (National Bureau of Economic Research, 1950) and Oliver Jones and Leo Grebler, *The Secondary Mortgage Market* (University of California Press, 1961) ch. 7.

[2] See, for example, Francisco Arcelus and Allan Meltzer, "The Markets for Housing and Housing Services," *Journal of Money, Credit, and Banking*, vol. V (February 1973), pp. 78–99 and Paul DeRosa, "Mortgage Rationing and Residential Investment: Some Results from a Brainard-Tobin Model," *Journal of Money, Credit, and Banking*, vol. X (February 1978), pp. 75–87.

total civilian employment. Why is public policy concerned with instability in such a relatively small sector of the economy? The answer is that despite its rather modest direct contribution to aggregate output, the housing sector accounts for a disproportionate share of total credit flows, indebtedness and wealth, generates employment and income in a myriad of ancillary industries such as furniture and appliances, and contributes heavily to the magnitude of cyclical fluctuations in output generally.

It is well known that the housing industry has a history of extreme volatility. A glance at the upper half of chart 1, which chronicles the behavior of private nonfarm housing starts and real residential fixed investment for the period 1950–1977, illustrates this fact. While there is no trend in the housing starts series — starts have fluctuated quite faithfully about an annual average of approximately 1.5 million units since 1950 — the swings around the average level are quite severe: over the six complete housing cycles that have occurred in the postwar period, starts have declined an average of 37 percent and risen an average of more than 50 percent; the average downturn lasts about eight quarters, although the longest — 1954–58 — lasted 13 quarters, while the average cyclical expansion lasts about 11 quarters. This instability is also reflected in the behavior of real residential fixed investment, as the data in table 1 confirm. The table shows that residential investment is the most volatile component of real final sales, as measured by the average percentage deviation of each component around its long-run trend growth rate, surpassing both consumer durables expenditure and federal government purchases of goods and services for that honor. As a result, cycles in housing construction are a primary source of cycles in real GNP. For example, the figures in table 2 reveal that the decline in residential investment accounted for at least 24 percent of the decline in aggregate real output in the three most recent recessions. The total effect of declines in housing on the economy is even larger than these figures indicate because construction normally turns down before the peak in other sectors of the economy and since housing

Table 1
Comparisons of Sectoral Volatility 1950–1977

Sector	Annual Trend Rate of Growth[a]	Average Annual Percentage Deviation from Trend Rate of Growth[b]
GNP	4.7%	4.4%
Consumption	3.2	3.8
Durables	2.8	17.8
Nondurables	2.7	3.6
Services	4.1	2.1
Business Fixed Investment	5.6	11.5
Residential Fixed Investment	1.8	21.3
Federal Goverment Purchases of Goods and Services	9.8	16.5
State & Local Government Purchases of Goods and Services	5.6	4.2

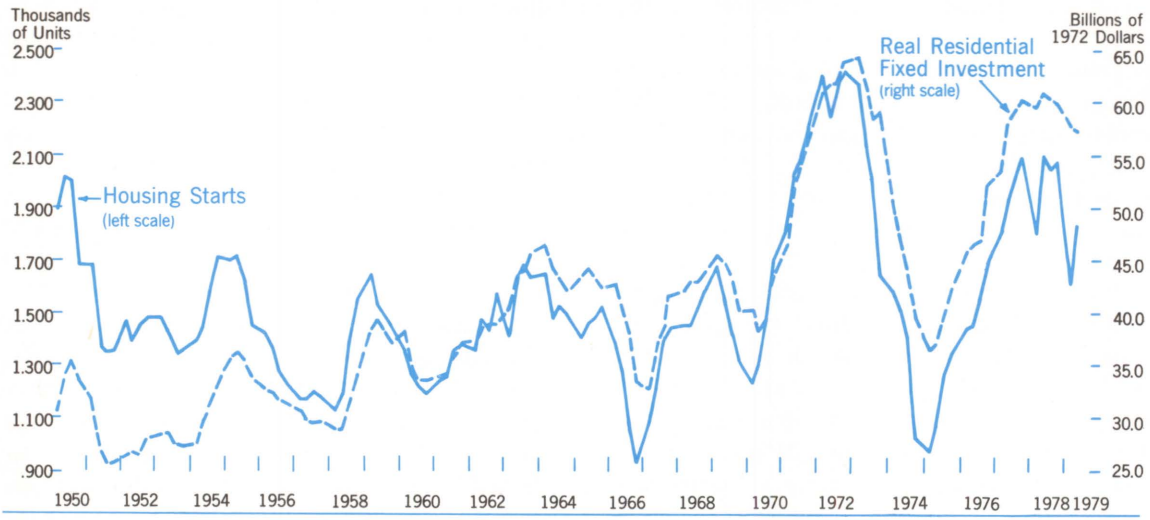
[a] Derived from ordinary least squares regression:

$$\ln x - \ln x_{-1} = \alpha + \beta \text{TIME} + \epsilon$$

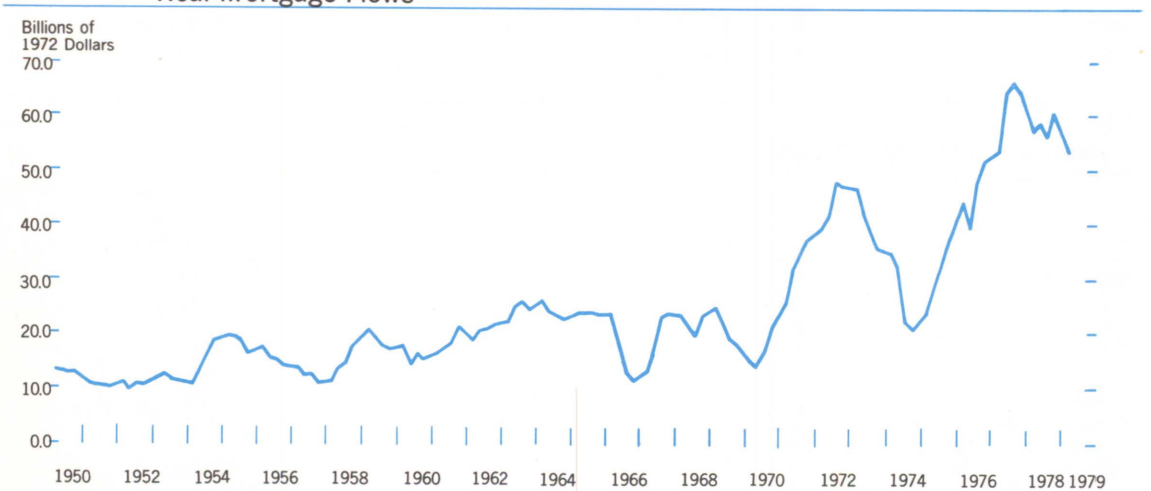
on quarterly, seasonally adjusted Commerce Department data expressed in 1972 dollars.

[b] Set equal to the standard error of the above regression.

Chart 1 Housing Starts and Real Residential Fixed Investment



Real Mortgage Flows



Source: U. S. Department of Commerce, *Survey of Current Business.* Board of Governors, Flow of Funds Accounts.

Table 2
Residential Construction and the Business Cycle

(1) Date of NBER Reference Cycle	(2) Change in Real GNP (Billions, 1972$)	(3) Change in Real Residential Fixed Investment (Billions, 1972$)	(4) Column (3) ÷ Column (2) (%)	(5) Change in Real Residential Fixed Investment, Peak to Trough in Corresponding Housing Cycle (Billions, 1972$)	(6) Column (5) ÷ Column (2) (%)
1953:3-1954:2	-16.8	+1.9	—	- 8.0	48
1957:3-1959:1	-22.2	- 0.6	3	- 7.3	33
1960:1-1960:4	- 8.8	- 4.8	55	- 5.8	66
1969:3-1970:4	-12.0	- 3.3	28	- 6.9	58
1973:4-1975:1	-72.8	-17.7	24	-28.1	39
MEMO: 1965:4-1966:4	+40.8	- 9.0	—	- 9.0	—

Source: U.S. Department of Commerce. *Business Conditions Digest.*

has declined, for instance in 1966, when there was no "official" recession at all.[3] Thus, despite its relatively small average contribution to total output, cyclical fluctuations in the housing industry have significant repercussions on the pace of activity in the economy as a whole.

The financial counterpart of home construction is mortgage creation. This is the reason that the real value of mortgage flows (displayed in the lower half of chart 1) follows a pattern similar to that of housing starts and real residential fixed investment. Mortgages are normally required for the purchase of existing as well as new homes, however, and mortgage borrowing often serves to finance the acquisition of assets other than houses.[4] It is therefore not surprising that mortgage flows were slightly less volatile than housing starts, at least until the 1970s, or that the housing sector accounts for a larger proportion of total credit flows than of total real GNP. Table 3 quantifies the role of housing in the capital markets for selected years in the postwar period. As of the end of 1978, home mortgages represented 62 percent of total household liabilities and nearly 20 percent of all debt outstanding in the economy. Surprisingly, the stock of mortgage debt is almost as large as the debt of the U.S. government and is more than 50 percent larger than outstanding corporate debt. The flow of new mortgages is an equally impressive portion of the yearly flow of money market activity. Mortgage borrowing made up almost 65 percent of all household borrowing in 1978, and 22 percent of the funds borrowed by all creditors that year was based on a home mortgage. The table also shows that although three traditionally important mortgage lenders — commercial banks, life insurance companies, and to a lesser extent savings and loan associations — have reduced the proportion of new funds devoted to mortgage acquisition, mortgages have grown in importance as a source of funds for households, increasing from 51 to over 60 percent of total borrowing since 1950.

Reflecting the diversity of financing requirements masked by the generic term "house-

[3] A comparison of the timing of downswings in starts to that of "official" recessions as designated by the National Bureau of Economic Research (the shaded areas in chart 1) shows that housing has turned down in advance of each of the five business cycle peaks, although the lead time has grown shorter over the years, and rebounded prior to the trough in general economic activity in all but the most recent episode.

[4] For an analysis relating to the fungibility of mortgage borrowing, see Allan H. Meltzer, "Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Markets," *The Journal of Finance*, vol. XXIX (June 1974), pp. 763-778.

Table 3
The Role of Housing Finance in the Capital Markets

Stock Concepts

Year	Household Liabilities	Savings & Loan Assets	Commercial Bank Assets	Life Insurance Company Assets	Total Debt Outstanding	U.S. Government Debt Outstanding	Corporate Debt Outstanding
			Home Mortgages as a Percent of:				
1950	55%	78%	6%	14%	11%	21%	115%
1955	58	80	8	20	15	38	145
1960	61	77	9	21	18	58	158
1965	60	73	9	19	20	80	179
1970	58	71	9	13	19	87	148
1975	61	66	9	6	19	88	155
1978	62	68	11	4	20	92	181

Flow Concepts

Year	Total Increase in Household Liabilities	Total Increase in Savings & Loan Assets	Total Increase in Commercial Bank Assets	Total Increase in Life Insurance Company Assets	Total Debt Funds Raised	Funds Raised by U.S. Government	Funds Raised by Corporate Debt
			Increase in Home Mortgages as a Percent of:				
1950	51%	88%	19%	58%	28%	**	335%
1955	58	83	34	47	30	***	352
1960	62	74	Neg.	23	27	**	205
1965	54	69	11	12	21	439	212
1970	60	48	2	*	14	69	64
1975	74	55	7	*	20	44	118
1978	63	71	15	*	22	111	335

* Indicates net sale of mortgages during year.
** Indicates net reduction of U. S. government debt.
*** Federal government borrowing in 1955 totaled only $.2 billion, while home mortage borrowing totaled $12.6 billion.
Neg. = negligible (less than 1 percent)
Source: Board of Governors of the Federal Reserve System, Flow of Funds Accounts.

holds," the supply side of the mortgage market is made up of many different types of financial institutions. The data in table 4 show how the supply of mortgage funds has been distributed during the postwar years. The savings and loan industry has always been the dominant lender, increasing its holdings from 29 to 46 percent of the outstanding stock and its yearly net acquisitions from 26 to 55 percent of the total flow between 1950 and 1975. Commercial banks and life insurance companies, on the other hand, have moved away from the home mortgage market, both increasing their relative position in commercial mortgage and corporate and government bond finance at the expense of home loans. Indeed, life insurance companies have let their holdings of home mortgages run off in recent years, while commercial banks contributed only 6 percent of the total mortgage flow in 1975.[5] In their place have emerged the so-called "secondary" mortgage market participants — the Federal National Mortgage Association (largest of the federally sponsored mortgage credit agencies) as well as the Federal Home Loan Mortgage Corporation (issuers and guar-

[5] Commercial banks have traditionally been volatile participants in the residential mortgage market, however. In 1977, their purchases accounted for 18 percent of total new home mortgage originations.

Table 4
Major Sources of Mortgage Finance

	1950		1955		1960		1965		1970		1975	
	% of Stock	% of Flow	% of Stock	% of Flow	% of Stock	% of Flow	% of Stock	% of Flow	% of Stock	% of Flow	% of Stock	% of Flow
Savings & Loan Associations	29	26	34	40	39	53	43	41	42	45	46	55
Mutual Savings Banks	10	13	13	19	14	15	15	18	14	7	10	2
Commercial Banks	21	20	17	14	14	Neg.	14	19	14	6	16	6
Mortgage Pools	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Neg.	1	1	8	6	23
Sponsored Credit Agencies	n.a.	n.a.	Neg.	1	2	8	1	3	5	31	6	6
Households	17	3	10	1	7	7	7	7	8	*	8	7
Federal Government	3	4	3	1	3	Neg.	2	*	2	*	1	4
State and Local Government	Neg.	1	1	Neg.	1	1	1	Neg.	1	Neg.	1	2
Life Insurance Companies	19	32	20	20	18	12	13	6	9	*	4	*
Other	1	1	2	4	2	4	4	5	4	3	2	*

Mortgage Pools: Government National Mortgage Association, Federal Home Loan Mortgage Corporation and Farmers' Home Administration guaranteed securities.
Sponsored Credit Agencies: Federal National Mortgage Association, Federal Home Loan Mortgage Corporation and Federal Land Banks.
* = Net seller during year.
Neg. = negligible (less than 1 percent).
n.a. = not applicable (no holdings).
Source: Board of Governors of the Federal Reserve System, Flow of Funds Accounts.

antors of mortgage pool securities) and the Government National Mortgage Association (guarantors of mortgage-backed securities), all to be discussed below, who in the brief ten-year period 1965–1975 grew from an insignificant market share to supplying nearly one-third of the funds for new home loans.

Considered from either the real or the financial side, the role of housing in the economy is far greater than its direct contribution to GNP would indicate. Public housing policy, expressed in such ways as the growth of the secondary market just mentioned, must therefore be judged not only in terms of its success at achieving a long-range quantity or quality goal, but also in terms of its ability to moderate the short-term housing cycle. Casual analysis of recent experience might suggest that existing policy has failed to achieve the latter objective. This conclusion is premature. A firmer conclusion must await the results of an analysis of the housing policies themselves, the theoretical foundations on which they are based, and the quantitative estimates of their impact.

II. Credit Cost Versus Credit Availability: Theoretical Aspects of the Housing Cycle

Because most home purchases are financed with borrowed money, theoretical models of the housing market have traditionally emphasized the link between housing starts and the supply of mortgage funds. In turn, the supply of mortgage funds, composed mainly of deposits at banks and other financial institutions, has been related either to the interest rate that can be earned on these deposits or to the difference between this rate and the rate on alternative (i.e., nondeposit) investments. The high positive correlation between housing starts and new money flows into commercial banks and thrift institu-

tions on the one hand, and the high negative correlation between these variables and interest rates on the other, quite evident by inspection of the series displayed in chart 2, must be accounted for in any acceptable theory of the housing cycle. Although similar in some ways, the theories capable of doing this differ in the relative importance assigned credit availability and credit cost as key causal factors in explaining fluctuations in home construction.

The *credit availability* view of the housing cycle is closely associated with a process called "disintermediation." As open market interest rates rise in the late stages of a business expansion, due to an increase in the demand for funds by government and business relative to the supply of funds generated internally or by actions of the Federal Reserve, the maximum rates paid on deposits at commercial banks and thrift institutions under Regulation Q grow ever less attractive when compared to market rates on such alternative short-term investments as Treasury bills and commercial paper. This interest rate differential or "spread" induces deposit holders to disintermediate, that is, to withdraw their money from the custody of primary mortgage lenders and to purchase government and corporate debt directly. The outflow of funds from financial intermediaries naturally reduces their ability to finance new mortgage loans, with the result that housing construction declines once the existing stock of mortgage commitments has been worked off.[6] The logic of this model implies that only when the interest rate gap is finally closed, presumably during the ensuing business cycle downturn, will savings flows to primary mortgage lenders revive and housing starts recover.

Several properties of the credit availability model should be noted. Although it accounts for the observed correlation between housing starts, savings flows, and interest rates mentioned previously, the explanation focuses exclusively on the supply side of the mortgage market. In this model an increase in the quantity of mortgage funds supplied leads to an increase in housing starts; a decrease in the quantity of mortgage funds supplied leads to a decrease in starts. Apparently neither the demand for nor the cost of mortgage loans has an independent role in explaining the housing cycle. In other words, the model implicitly assumes that the demand for mortgage funds is relatively insensitive to the changes in mortgage rates and terms that may accompany shifts in the quantity of mortgage funds supplied, so that home construction only declines when deposit outflows force primary lenders to "ration" the available mortgage supply.[7] Housing starts could be stabilized in such a world either by offsetting household deposit outflows with funds raised from other sources or by preventing the outflows to begin with by allowing deposit rates to vary with market rates generally. The secondary mortgage market institutions to be discussed below provide an example of the first strategy; the creation in mid-1978 of six-month money market certificates that pay an interest rate tied to the rate on six-month Treasury bills (and thus exempt from Regulation Q ceilings) is an example of the second.

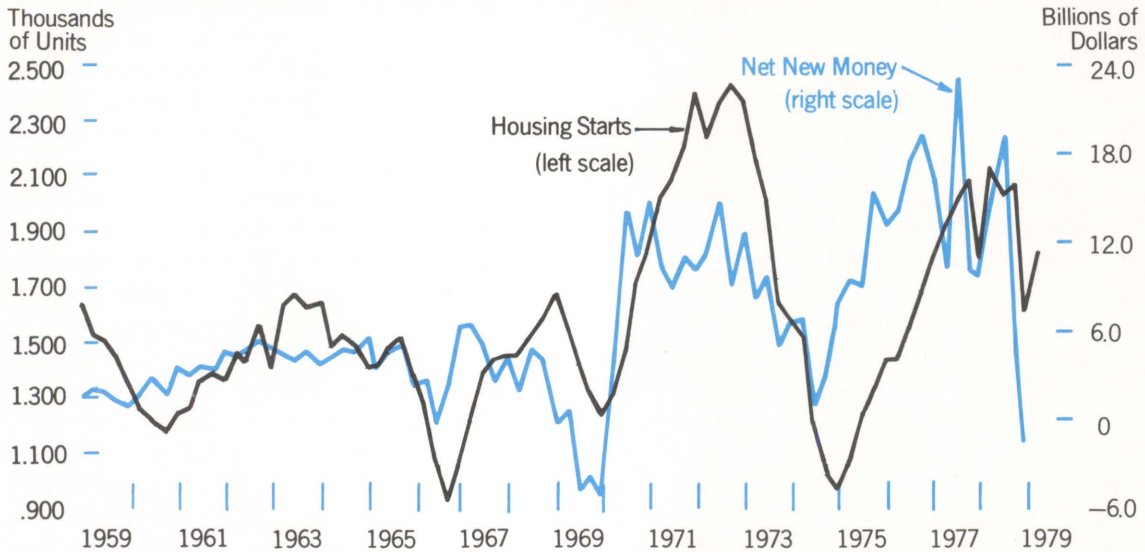
An alternative (but not mutually exclusive) *credit cost* theory of the housing cycle stresses the demand side of the mortgage market, recognizing that the decision to purchase a house is based on the same factors as the decision to purchase any other long-lived asset.[8] In this view the

[6] This explains the slight lag of housing starts behind net new money shown in chart 2.

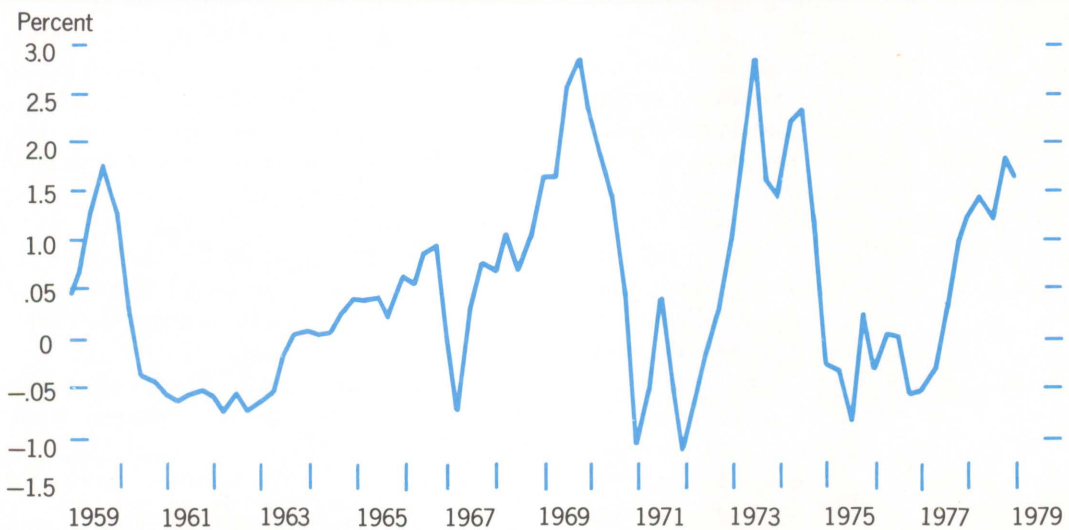
[7] Rationing can take many forms, e.g., increasing required downpayments, shortening the term of the mortgage, extending loans only to "established" customers. The credit availability view of the housing cycle is usually attributed to Jack Guttentag, "The Short Cycle in Residential Construction, 1946–1959," *American Economic Review*, vol. LI (June, 1961), pp. 275–298.

[8] The origins of this theory are difficult to identify. The present value formulation was eloquently stated by J.M. Keynes, *The General Theory of Employment, Interest, and Money* (London: MacMillan, 1936); the model was applied to the housing market by Arcelus and Meltzer, "The Markets for Housing."

Chart 2 Housing Starts and Net New Money



Interest Rate Differential:
6mo. Treasury Bill Minus Time Deposit Rate



Source: See Technical Appendix

demand for houses, whether newly built or used, depends on the present value of the stream of services a house is expected to provide over time, where the mortgage rate, representing the cost of financing the acquisition of the service stream, serves as the appropriate discount rate. The distribution of this demand between new and used homes will vary with the relative price of new and used homes (a price itself determined in part by the outstanding stock of homes); the "quality" of the homes demanded will depend both on prices and on household wealth. Given house prices, wealth and the existing housing stock, the increase in open market interest rates (including mortgage rates) that accompanies a business expansion will produce a decline in the demand for homes, since the present value of the expected stream of housing services varies inversely with the discount rate. Further, to the extent that the rise in interest rates reduces the market value of the outstanding stock of household financial assets, the demand for houses will also fall due to the decline in wealth. The shift in the demand for houses will be translated into a decline in mortgage demand and housing starts, of course, so the implications of this model are consistent with the observed negative correlation between housing starts and interest rates cited above. The negative correlation between interest rates and deposit flows arises for the same reason in this as in the previous model, the increasingly attractive interest rate spread, but the decline in the supply of mortgage funds is no longer taken to be "the" causally significant factor in explaining the housing cycle. Although disintermediation can play a role in the credit cost model, in the sense that deposit outflows may force mortgage lenders to seek loanable funds from higher cost alternative sources and thus to raise mortgage rates, the credit cost view emphasizes the "postponement" effect of higher rates on the demand for homes rather than the rationing effect of deposit outflows on the supply of mortgages emphasized in the credit availability view.

The credit cost model suggests that a policy designed to prevent, or at least to moderate, cycles in mortgage interest rates would stabilize home construction. But because interest rates on all debt instruments tend to move together, reducing the amplitude of fluctuations in mortgage rates would in general require that other interest rates be stabilized as well.[9] While the Federal Reserve could in principle reduce the variability of interest rates through the judicious use of open market operations (if only for a brief period), the advisability of such a strategy is clearly open to question. Interest rate movements are important in the conduct of monetary policy, not to mention their role in directing alterations in the pattern of real resource allocation made necessary by changes in the economic environment. Since the short-term benefits of a slightly smoother housing starts series are unlikely to outweigh the long-term costs of a policy that sacrificed a key tool of monetary control and prevented the operation of a crucial economic signaling mechanism, other perhaps less powerful policies would be preferable to this clumsy approach. One alternative is simply to subsidize mortgage interest costs to borrowers, a policy already in use to some extent through the device of allowing mortgage payments to be deducted from income for tax purposes. A second alternative is to subsidize the interest cost of funds to primary mortgage lenders, a policy also currently in use for savings deposits through the device of Regulation Q.

As a glance at chart 2 will confirm, housing starts have never jumped precipitously from a

[9] For example, the simple correlation between the rate on FHA mortgages and the BAA corporate bond rate is .96; between the mortgage rate and the rate on 3–5 year Treasury bonds is .96; between the mortgage rate and the rate on commercial paper is .74. Note that an interest rate stabilization policy would be appropriate in the credit availability world as well, so long as rates were held below the level required to induce substantial disintermediation.

high to a low rate in a single quarter; the downturns and upturns have always occurred gradually over time. From the point of view of empirical relevance, one particularly attractive implication of the credit cost model is that housing starts will begin to fall when interest rates turn upward, as more and more potential buyers drop out of the market, and continue to decline as long as interest rates rise — just the pattern that has been observed.[10] On the other hand, the credit availability model implies that starts will decline *sharply* once new deposit flows are sufficiently low to induce rationing, but not decline dramatically until then. Historical evidence does not conform particularly closely to this implication, although some form of mortgage rationing undoubtedly takes place during periods of credit restraint.[11] Thus, a mixed model that incorporates both cost and availability effects would provide the most accurate theoretical description of the housing cycles observed over the postwar period. In such a model, credit availability would be considered a constraint variable that comes into play only occasionally, for example during "credit crunches" when mortgage rationing may occur because of usury ceilings or lender reluctance to raise mortgage rates enough to clear the market, but is swamped in importance by cost effects the rest of the time.[12]

[10] Strictly speaking, the model argues that the demand for new homes will decline when mortgage rates increase faster than the value of the stream of services expected to accrue to the homeowner. In this view, the "surprising" strength of housing starts in the last half of 1978 despite rapid mortgage rate increases is simply due to an even more rapid increase in the perceived nominal returns from owning a house.

[11] Anecdotal evidence of the existence of mortgage rationing is abundant. Consider, for example, this excerpt from an article in *The Wall Street Journal*, July 6, 1978, p. 32: "Tight money is making it tougher to get a home mortgage in some parts of the country these days. . . . Some (banks) make (mortgage) loans only to established customers. . . . A savings bank in Rochester, N.Y. has stopped making mortgage loans altogether."

[12] This is essentially the same disequilibrium argument used to justify the presence of income as a constraint variable in the consumption function. See Robert W. Clower, "The Keynesian Counter-Revolution: A Theoretical Appraisal," in F. H. Hahn and F. Brechling, eds., *The Theory of Interest Rates*, (London: Macmillan Co., 1965) ch. 5, pp. 103–125.

The discussion to this point has completely neglected the supply side of the new home market. In principle, home builders should also be affected by the kinds of financial pressures that influence the demand for new homes, although their response to these pressures may be different from those of home buyers. The decision to build new homes is based on the builder's assessment of the potential profitability of the construction project. A project will be undertaken if the expected sales price of completed homes exceeds their construction costs — land, labor, materials, financing — by an amount sufficient to provide a rate of return comparable to that offered by other investments with a similar degree of risk. Because construction projects are typically financed with borrowed funds, rising interest rates will tend to reduce housing starts by increasing the costs and reducing the returns expected from production of new homes. Although this credit cost effect can be expected to dominate credit availability effects in most stages of the housing cycle, it is possible that builders, like buyers, must occasionally limit starts because disintermediation forces lenders to ration construction loans. Indeed, since most homes are originally built for inventory rather than to order, the availability effect may operate more powerfully on builders than on buyers.[13] A mixed cost-availability model seems for these reasons to be as appropriate on the supply as on the demand side of the market for new homes.

Because the policy implications of the credit cost and credit availability models differ sharply, the resolution of the disagreement between these two points of view is of more than purely theoretical interest. For example, if credit availability proves empirically to be the primary causal factor in the housing cycle, then the usefulness of policies that contribute to the instability of deposit flows — policies such as Regu-

[13] According to the Bureau of the Census, only 35 to 40 percent of single-family homes are custom built.

lation Q deposit rate ceilings — would be called into question; if credit cost dominates, then the usefulness of policies that produce upward pressure on mortgage rates — policies such as exempting six-month money market certificates from Regulation Q ceilings — would be called into question. If both cost and availability effects are important, perhaps during different phases of the housing cycle, then it is still an open question whether the existing policy mix is the one most likely to achieve the stabilization goal. An empirical analysis of these issues will be presented later in the paper, but since understanding the tests of the various housing cycle models requires some familiarity with the structure of government housing policy, the institutional characteristics of housing finance must be considered in more detail before the data are subjected to empirical scrutiny.

III. Alphabet Soup: The Government Housing Program

Public housing policy has for many years been designed to increase the supply of mortgage funds relative to the supply that would be forthcoming in the absence of the programs. Although the methods used in pursuit of this goal vary from program to program, the common underlying idea is to tap sources of mortgage money other than the notoriously unreliable savings deposit. Housing policy may thus be loosely but accurately characterized as intended to offset the mortgage supply constraints that play such an important role in the credit availability model of the housing cycle.

Primary mortgage lenders, institutions such as commercial banks and savings and loan associations that originate loans directly for the ultimate home buyer, use deposit inflows to accumulate a portfolio of mortgage loans. This traditional home financing mechanism suffers from four well-known and interrelated weaknesses. First, of course, is its susceptibility to interruption by sudden deposit outflows, the problem of disintermediation already discussed. This susceptibility in turn produces a second weakness, the constant risk of bankruptcy created by borrowing short in the form of deposits and lending long in the form of mortgages. Contributing to this risk is a third weakness, the absence of a ready resale (or "secondary") mortgage market, which makes it difficult to convert outstanding mortgages quickly into cash to meet deposit drains or to issue new mortgages. The failure of a secondary market similar to that of the highly organized resale markets for corporate stock or government bonds to develop for home mortgages may be traced to a fourth weakness in the home financing mechanism, the nature of the mortgage contract itself. Because each mortgage is unique in terms of buyer and collateral, the credit worthiness of neither well known outside a small local area, as an asset it lacks the standardization necessary to generate high-volume trading on centralized exchanges. These four weaknesses — deposit volatility, asset and liability incompatibility, portfolio illiquidity, and lack of homogeneity — are at the heart of the availability problem, and so form the basis for government policy towards the housing market.

FHLB

The earliest and probably the most direct approach to solving the availability problem was embodied in the Federal Home Loan Bank Act of 1932. Among other things, this piece of legislation granted the newly created Federal Home Loan Bank Board, overseer of the 12 district Federal Home Loan Bank System, the power to issue debt in its name and to use the proceeds to provide advances to its member institutions, principally savings and loan associations. The FHLB thus serves the savings and loan industry

in much the same way that the Federal Reserve System serves the commercial banks, both standing ready under certain circumstances to advance cash to needy member institutions. There are many important differences between these two agencies, however, and one in particular must be noted in this context. Unlike the Fed, the FHLB cannot "create" cash at no cost to itself to lend to member banks, nor is it free to set the interest rate (the "discount rate") to be applied to such loans. On the contrary, since the FHLB must borrow from the public on the open market to raise funds for its members, the cost of its borrowing, and therefore the interest rate it must charge on advances, fluctuates with market rates generally. Despite its status as an "agency" borrower, this means that FHLB advances tend to be a relatively expensive source of funds for member savings and loan associations during periods of monetary restraint when deposit outflows have reduced the supply of funds subject to rate ceilings. Due to the increasing cost of financing home loans through FHLB advances during these periods, mortgage interest rates are likely to rise. Whether this method of providing mortgage funds will insulate home construction from a round of tight credit will then depend on the relative strength of the cost and the availability effects on housing starts.

The importance of FHLB advances as a source of funds to the savings and loan industry is illustrated in chart 3. As a percentage of total fund inflows, advances have fluctuated widely over the postwar period, although in general they represent less than 15 percent of the total quarterly increase in savings and loan liabilities. The fact that the ratio is often negative indicates that these loans are rapidly repaid whenever credit conditions warrant. On the other hand, FHLB advances have sometimes accounted for more than 50 percent of total inflows. It is of course not surprising that these periods — 1966, 1969, 1973 and '74 — are often cited as examples of "credit crunch" episodes

Chart 3 Ratio of the Change in Federal Home Loan Bank Advances to the Change in Savings and Loan Liabilities

Source: Flow of Funds Accounts, Board of Governors of the Federal Reserve System.

when short-term interest rates and deposit disintermediation reached high levels.

FHA, VA

The low downpayment, long-term, fully amortized mortgage contract so familiar to most homeowners traces its origins back to the Great Depression. Prior to that time the purchase of a home was normally financed through the acquisition of several small, short-term, unamortized loans that had to be renegotiated every four or five years. Lenders were reluctant to provide long-term financing because of the riskiness and illiquidity of such loans, arising both from their rarity and their lack of standardization, forcing borrowers to accept this precarious financing arrangement. The system proved adequate through the early years of this century when periodic refinancing could be fairly easily obtained, but during the Depression widespread foreclosures occurred. One goal of the National Housing Act of 1934 — legislative birthplace of the Federal Housing Administration (FHA) insured mortgage, and later the Servicemen's Readjustment Act of 1944, legal basis of the Veterans Administration (VA) guaranteed mortgage — was to correct some of the deficiencies of the existing mortgage contract in order to reduce its riskiness, improve its marketability, and place the housing industry on a sounder financial footing.

The FHA is authorized to insure, and the VA to guarantee, the payment of part or all of principal and interest on certain types of residential mortgages originated by private lenders. Specifically, FHA or VA backing can be arranged on long-term, fully amortized mortgage loans, subject to downpayment and interest rate restrictions that vary from time to time as market conditions warrant.[14] The insurance feature is designed to appeal to a broad group of potential lenders who might not otherwise be interested in acquiring mortgages as an investment or who have left the mortgage market because of its history of high risk. A deepening of the lender base is further encouraged by the standardized contract required for FHA or VA approval, which creates the opportunity for primary lenders to "mass market" bundles of mortgage loans to large institutional investors. Mortgage bankers have made the greatest use of this feature, originating blocks of mortgages for resale to insurance companies or more recently to the Federal National Mortgage Association or to the public through the auspices of the Government National Mortgage Association (to be discussed below). Taken together, these two features also work to increase the liquidity of mortgage loans, since the obstacles to reselling a small loan made to a relatively unknown borrower are to a large extent removed by the standardized, insured FHA or VA contract.

Table 5 shows the importance of FHA and VA mortgages in overall mortgage flows for selected dates in the postwar period. The government-backed share of the mortgage market has gradually declined over the years, although it still represents a significant percentage of total mortgage originations. Not so easily measured, however, is the contribution these programs have made to improving the mechanics of mortgage finance in the conventional sector of the market. The long-term, fully amortized mortgage contract now offered by virtually all lenders was pioneered by the FHA and the VA, and the burgeoning private mortgage insurance industry owes much to the precedent set by these two government insurance programs.

FNMA

To stimulate the development of a secondary market in FHA mortgage loans, the National

[14] As of 1978:3, the FHA rules allow a maximum loan of $60,000 at a maximum rate of 9.5 percent over a 30-year mortgage term, with 3 percent downpayment on the first $25,000 and 5 percent downpayment on any additional amount.

Table 5
Importance of FHA/VA Loans in Total Mortgage Flow

	FHA/VA Mortgages (billions)	Total Mortgages (billions)	Share of FHA/VA in Total (percent)
1950	$3.9	$10.1	39
1955	6.8	16.1	42
1960	3.1	16.0	19
1965	4.0	25.7	16
1970	9.0	26.4	34
1975	6.7	59.0	11

Source: Board of Governors of the Federal Reserve System, Flow of Funds Accounts.

Housing Act included provisions authorizing the establishment of privately financed and administered national mortgage associations. These associations were to operate in the same manner as any other pure financial intermediary, issuing liabilities (debt securities) to one group of investors in order to acquire assets (in this case FHA-insured mortgages) from another group. Probably because of the depressed economic conditions in the 1930s, no such private associations were ever founded. As a result, the Federal Housing Administration created a public agency, the Federal National Mortgage Association (FNMA) — often referred to simply as Fannie Mae — to operate a resale market in FHA (and subsequently VA and conventional) mortgage loans.

Just as corporate bond dealers trade on both sides of their market, Fannie Mae was originally conceived as both a buyer and a seller of existing mortgage contracts. This was expected to benefit homebuilding not only by providing a new source of mortgage funds and increasing the liquidity of home loans, but also by correcting the regional imbalances in mortgage availability that occasionally develop and reducing the volatility of mortgage interest rates over the course of the business cycle. Fannie Mae has never operated as a market maker in this traditional sense, however. For one thing, Fannie Mae rarely sells mortgages from its portfolio, relying instead almost exclusively on new bond issues to raise funds for mortgage acquisitions, so the smoothing effect on mortgage rates that is presumed to result from a purchase and sale program has not been provided.[15] Nor does Fannie Mae operate a "spot market" in existing mortgage contracts. Unlike a corporate bond dealer, Fannie Mae does not normally stand ready to buy whatever outstanding mortgages are offered to it, but purchases only those mortgages for which a purchase commitment has been previously arranged.

Purchase commitments, auctioned periodically to participating primary lenders, permit the mortgage originator to deliver a specified dollar amount of mortgages to Fannie Mae at a price determined at the auction at any time before a fixed expiration date, usually no more than one year from the date of issue of the commitment. With a purchase commitment in hand, the originator is assured of a market for a bundle of mortgage loans; this assurance in turn facilitates the construction and sale of the new homes upon which the mortgages will ultimately be written. While this system technically constitutes a mortgage resale market, it does so only in the narrow sense that the originator need not hold newly issued mortgages until maturity, but can place them immediately with Fannie Mae as the permanent investor. It does not constitute a resale market in the broader sense that any mortgage, however old, and with or without a purchase commitment, can be quickly sold by its current owner. Thus, since it rarely sells mortgages from its portfolio, and since virtually all of the mortgages it buys are newly issued and pur-

[15] For example, in 1977 FNMA bought mortgages worth $4.8 billion and sold mortgages worth only $67 million. Given the high elasticity of substitution between debt instruments of similar maturity, the time arbitrage function for mortgages is probably already being performed in the corporate bond market.

chased on the basis of prior commitments, Fannie Mae should perhaps be regarded more as a "buyer of last resort" than as a true secondary market facility.

GNMA

A major restructuring of the secondary mortgage market occurred in 1968 with the passage of the Housing and Urban Development Act. This act rechartered Fannie Mae as a private corporation, bringing to partial fruition the original goal of creating a private mortgage resale industry, and established a new agency within the Department of Housing and Urban Development, the Government National Mortgage Association (GNMA), otherwise known as Ginnie Mae, to provide certain services thought to require continued government support. As the agency through which direct government intervention in the housing market was to be channeled, Ginnie Mae inherited the operation of some of the programs previously run by Fannie Mae, for example the subsidized low income housing programs.[16] In addition, Ginnie Mae was authorized to operate a program involving the creation of a new type of financial instrument — the guaranteed mortgage-backed security — aimed at increasing institutional participation in housing finance.

The basic idea behind the mortgage-backed security program is simply to convert a mortgage, for reasons mentioned earlier an asset with limited appeal to many potential investors, into an instrument with widespread appeal and ready marketability. Ginnie Mae accomplishes this feat by guaranteeing the payment of principal and interest on securities issued by primary mortgage lenders, predominantly mortgage bankers, where a pool of FHA and VA mortgages serves as the collateral behind the issue. Securities guaranteed by Ginnie Mae are of the "pass-through" type, which means that the normal monthly principal and interest payments made on the underlying mortgages, as well as any early principal repayments, are passed through by the originator directly to the Ginnie Mae security holder.[17] These securities differ from a corporate or government bond in that payments are made monthly rather than semiannually and that each payment represents both interest and amortized principal rather than just interest alone. Ginnie Mae issues have proved to be more attractive to many investors than the underlying mortgages themselves because all of the servicing involved is performed by the originator, because the certificates bear the widely recognized GNMA name and seal, and because the risk of default is eliminated by the guaranty; pass-through securities are able to compete with bonds in the portfolio of potential investors because of the attractive interest return they normally provide. Taken together, these features ensure a ready resale market for Ginnie Mae issues and explain why more than $50 billion of the securities have been marketed since 1970 to a broad range of traditional and nontraditional mortgage lenders (see table 6).[18] Unlike Fannie Mae, Ginnie Mae thus appears to have established a true secondary market in government-backed mortgage loans.

FHLMC

The Emergency Home Finance Act of 1970 created the Federal Home Loan Mortgage Corporation (FHLMC) — Freddie Mac — under the direction of the FHLB to operate a secon-

[16] The direct subsidy programs are often run in conjunction with FNMA and GNMA through the so-called Tandem Plans. See Government National Mortgage Association *Annual Report*, 1977.

[17] Note that the originator never intends to add these mortgages to his portfolio but uses the GNMA program as a source of permanent financing.

[18] The resale market in Ginnie Mae pass-throughs is quite active, with quotes published daily in the financial press. A futures market in GNMA securities has also recently been developed.

Table 6
Distribution of Ownership of Ginnie Mae Securities 1977 Year End

Individuals, private investment trusts, private pension trusts (IRA, Keogh, etc.)	33%
Mortgage Bankers	19
Savings and Loan Associations	16
Savings Banks	12
Retirement pension funds	11
Commercial banks and credit unions	9

Source: Government National Mortgage Association, *Annual Report*, 1977

dary market in conventional mortgage loans.[19] Like Ginnie Mae, Freddie Mac raises funds to acquire mortgages by selling participations in mortgage pools, in this case collections of conventional mortgages originated mainly by savings and loan associations. Also like Ginnie Mae, Freddie Mac guarantees the payment of principal and interest on the securities it issues. These securities are of two types: participation certificates, which are essentially equivalent to Ginnie Mae pass-throughs, and guaranteed mortgage certificates, which are one step closer to a conventional bond with semi-annual interest and annual principal reduction payments.[20] Approximately $10 billion of Freddie Mac securities have been issued since 1971, about 65 percent of them purchased by conventional mortgage lenders, savings and loan associations and commercial banks with excess loanable funds, and the remainder purchased by such nontraditional lenders as bank trust departments and pension funds. Although not yet as large as Ginnie Mae, Freddie Mac has apparently also been successful both in broadening the mortgage lender base and in helping to eliminate regional imbalances in the flow of mortgage funds.

[19] In addition, this act authorized Fannie Mae to purchase conventional mortgages. In 1972 Fannie Mae first exercised this authority.

[20] Pass-through securities represent more than 90 percent of total Freddie Mac issues.

The mortgages underlying FHLMC securities do not carry an FHA or VA guaranty. To avoid the marketing problems that could arise with securities backed by uninsured loans, Freddie Mac deals only with conventional mortgages that carry an original loan-to-value ratio of not more than 80 percent, or in the case of lower downpayment loans, with mortgages that carry private insurance up to the equivalent minimum equity ratio. The FHA and VA programs encouraged widespread acceptance of the modern mortgage contract by providing a government guaranty; FNMA and GNMA proved that suitably repackaged versions of these instruments could be made acceptable to a broad spectrum of primary and secondary investors. Freddie Mac extended the techniques developed by the government-backed sector into the potentially much larger conventional market and demonstrated that private insurance is an acceptable form of security for mortgage-backed issues. This achievement is especially significant because of its implications for the future development of the secondary mortgage market. Since conventional mortgages account for more than 75 percent of total originations, a viable private resale industry is essential if past successes in this field are to be maintained. Fortunately, recent experience indicates that the momentum generated by the government-sponsored secondary market programs has begun to spill over into the private sector. Encouraged by the success of Ginnie Mae and Freddie Mac, since 1975 a small number of savings and loans have marketed several billion dollars worth of mortgage-backed bonds with semi-annual interest and lump-sum principal payments, five-year maturity, and collateral provided by a pool of existing conventional mortgages held in portfolio; more recently, several large commercial banks and private mortgage insurers have offered pass-through securities through private underwriters on conventional fixed and variable rate mortgages, securities marketed under the

name of the originating institution and carrying no government sponsorship whatsoever. The growing acceptability of these new financial instruments indicates that after 40 years, government intervention has finally produced the intended result — the development of a private secondary market in home mortgage loans.

While the value of the government's contribution to improving the mechanics of mortgage finance cannot be doubted, disagreement persists over the effect of direct intervention in the mortgage market on the volatility of residential construction. No amount of a priori reasoning will settle the credit cost versus credit availability controversy, of course, nor will individual pieces of empirical evidence ever be taken as conclusive proof of the veracity of either theoretical position. Still, statistical analysis of the mixed cost-availability model suggested by economic theory can be used to determine which position is consistent with the data, and so which position should in the absence of contradictory evidence be accepted as true.

IV. Credit Cost versus Credit Availability: An Empirical Analysis

The mixed credit cost–credit availability model implies that the number of new homes demanded at any point in time depends on the stock of existing homes, on the price of new homes, on the pace of household formation, on the level of real disposable income, on the cost of financing the purchase, and through its effect on the mortgage rate, on the availability of mortgage funds. Similarly, the model suggests that the number of new homes supplied at any point in time depends on the price of new homes, on the price of alternative forms of shelter, on the cost of materials and labor, on the cost of financing construction, and on the availability of construction loans. The model also recognizes that the magnitude of the cost and the availability effects on both the demand and the supply side of the market may be different when the economy is experiencing a "credit crunch" than when credit conditions are less severe. Historical data can be used to estimate a model that incorporates these demand and supply factors. With the estimates in hand, it is then a straightforward matter to appraise the relative importance of credit cost and credit availability in explaining the housing cycle.

The housing sector of the Federal Reserve Board (FRB) econometric model of the U.S. economy is well adapted to examine empirically the credit cost–credit availability controversy. This model of the housing market uses two relationships to explain the real value of single-family housing starts as a percentage of total personal consumption expenditures during the 1958:3–1977:4 period.[21] The first relationship is operative only when no credit crunch is in progress. In this case, housing starts depend on the mortgage rate, house prices, household formation, and the other fundamental factors considered above, but do not depend directly on credit availability. In other words, except to the extent that the availability of credit affects the mortgage rate, this relationship provides no mechanism for credit flows to influence housing starts — the pure credit cost case.[22] The second

[21] The Board's model has separate equations for single- and multi-family housing starts. Only the equations for single-family starts are considered here; the results for multi-family starts are quantitatively similar. The general form of the single- and the multi-family equations is the same. The estimated equations are reproduced in the Technical Appendix. For a complete description, see Flint Brayton, "The Housing Sector," Board of Governors of the Federal Reserve System, April 1979, processed.

[22] The relationship between the mortgage rate and credit availability does not appear to be either particularly strong or especially stable. For example, a regression of the mortgage rate on a constant, the corporate bond rate, the lagged mortgage rate, and a measure of credit availability (the sum of net deposit flows into commercial banks and savings institutions, FHLB advances, and Fannie Mae purchases) over the 1958:3–1968:4 period yields an estimated coefficient of −.007 on the availability variable, with an estimated t-statistic of 1.02; over the 1965:1–1979:1 period, the estimate of the availability coefficient is .008, with a t-statistic of 2.22.

relationship is operative only when a credit crunch is in progress. In this case, housing starts depend solely on the availability of credit; fundamental economic factors are allowed no role in influencing homebuilding during these periods — the pure credit availability case. For the purposes of this model, a credit crunch is assumed to begin when the rate of growth of the flow of funds into the mortgage market falls at least 2 percentage points below the average rate of growth of this flow during the previous year and to end when the growth of the supply of mortgage funds again reaches this previous peak level. The supply of mortgage funds is defined as the weighted sum of the deposits of primary mortgage lenders (commercial banks, savings and loan associations, and mutual savings banks), the policy reserves of life insurance companies, FHLB advances, and Ginnie Mae, Fannie Mae, and Freddie Mac mortgage purchases, the weights reflecting the importance of mortgages in the portfolio of each of these lenders. Credit crunches so defined occurred in 1960:1–3, 1966:3–1967:1, 1969:2–1970:1, and 1973:3–1975:1.[23] The model is presented in detail in the technical appendix.

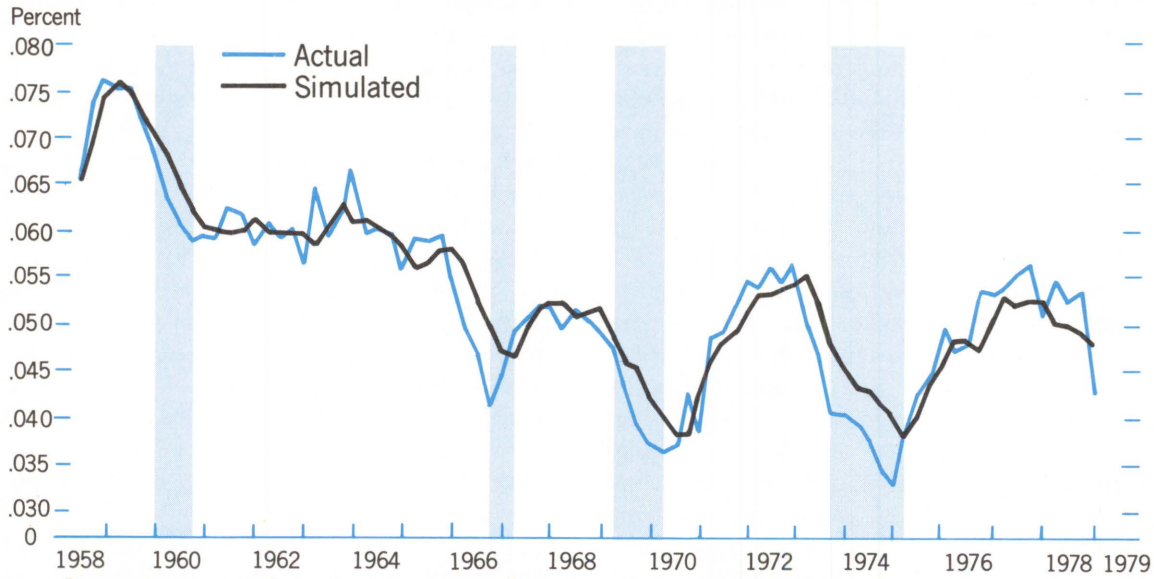
The credit availability hypothesis implies that the influence of mortgage rationing on the pace of home construction overrides the influence of underlying demand and supply factors whenever a credit crunch is in progress. If fundamental economic factors — including the mortgage rate — in fact become irrelevant during such episodes, then that part of the FRB housing sector model which embodies them should provide significantly less accurate predictions of actual housing activity when mortgage rationing is assumed to have taken place than the relationship that captures the pure credit availability view. To determine if this is the case, the first equation in the FRB model — the equation which allows housing starts to depend on credit cost, house prices, and other fundamental factors — was used to simulate two housing starts series over the entire 1958:3–1979:1 period, *including* those quarters in which a credit crunch is judged to have occurred. The first simulation incorporates the effects on home construction of demographic, price, and other variables as well as the effect of the mortgage rate. The housing starts series predicted by this simulation is displayed along with the actual series in chart 4.[24] The second simulation holds all fundamental variables except the mortgage rate constant at the values observed at the peak of each housing cycle; thus, with only the mortgage rate allowed to vary along its historical path, this second simulation permits an analysis of the effect of credit cost on the decline in housing starts in isolation from the effects of all other factors. The decline in the real value of single-family housing starts as a percentage of total personal consumption expenditures implied by these two simulations was then compared to the decline in starts predicted by the second equation in the FRB model — the credit availability equation designed to be operative only during periods of mortgage rationing — as well as to the declines that actually occurred in each of the last four housing cycles. The results of this experiment are summarized in table 7, where the actual declines and the declines predicted by the various simulations — as measured both from the peak to the trough of each cycle as well as from the beginning to the end of each associated credit crunch — are presented.

As a glance at chart 4 and table 7 will confirm,

[23] See Brayton, "Housing Sector," pp. 11–13. The average duration of these credit crunch periods is about a year. Since the associated housing cycles last an average of about two years, this is *prima facie* evidence that credit availability cannot be solely responsible for fluctuations in home construction.

[24] This simulation is static in the sense that actual rather than predicted values of the lagged dependent variable — as well as the actual value of last period's error — were used in its construction. See technical appendix.

Chart 4 Actual and Simulated Housing Starts Series *



* Real value of single family housing starts as a percentage of personal consumption expenditures.
Source: See text.

most of the decline in single-family starts observed in each of the four housing cycles occurred while a credit crunch was in progress. For example, starts as a percentage of total personal consumption expenditures fell nearly 30 percent from the peak reached in 1967:4 to the ensuing trough in 1970:2, but 24 percentage points of this decline — slightly over 80 percent of the total — took place during the credit crunch that lasted from 1969:2 to 1970:1. The credit availability equation in the FRB model does a creditable job tracking the decline that actually occurred during this (and every other) period of mortgage rationing — it predicted that starts would fall by 28.1 percent as a result of the 1969–70 crunch — but so does the other equation in the FRB model as long as all of the fundamental factors that influence starts are allowed to operate. This equation is far less accurate when the credit cost effect is considered in isolation, however: on average, the increase in the mortgage rate alone is responsible for about 16 percent of the decline in housing starts observed from the peak to the trough of the four housing cycles (although it accounted for over 26 percent in the 1967–70 cycle) and about 12 percent of the decline in starts observed during the credit crunches (although it accounted for over 21 percent in the 1973–75 crunch).[25] Thus, while the mortgage rate has served as a depressing influence on homebuilding in the initial phase of a housing cycle, making it an important determinant of the *timing* of the peak in housing

[25] The lagged value of housing starts is the single most important explanatory variable in the FRB model. This variable presumably reflects an effect operating through the supply side of the new home market. Since it would be prohibitively expensive to adjust the pace of residential construction to accommodate immediately every change in the demand for new homes, due for instance to the costs involved in rapidly hiring or firing labor, the adjustment of the housing stock to a shift in demand will be spread out over more than a single quarter; thus, the level of housing starts this quarter will be closely related to the level of starts last quarter.

Table 7
The Role of Credit Cost and Credit Availability in Four Recent Housing Cycles

Date, Peak to Trough	Actual Percentage Decline in Housing Starts[a]		Percentage Decline in Housing Starts Predicted by FRB Model, Mortgage Rate Plus Other Factors Operating[b]		Percentage Decline in Housing Starts Predicted by FRB Model, Mortgage Rate Effect Only[c]		Percentage Decline in Housing Starts Predicted by FRB Model, Credit Availability Effect Only[d]
	Peak to Trough	During Credit Crunch Phase Only[e]	Peak to Trough	During Credit Crunch Phase Only	Peak to Trough	During Credit Crunch Phase Only	During Credit Crunch Phase Only
1959:1-1960:4	-22.8	-16.0	-21.6	-10.8	-2.2	+0.3	-15.3
1965:4-1966:4	-30.7	-16.6	-19.3	-17.0	-2.9	-1.6	-19.7
1967:4-1970:2	-29.7	-24.0	-26.5	-18.5	-7.8	-4.0	-28.1
1973:1-1975:1	-41.6	-34.0	-29.8	-26.4	-7.2	-7.2	-26.5

Notes:
[a] The percentage decline in the real value (1972 dollars) of single-family housing starts as a percentage of total real personal consumption expenditures.
[b] Derived from a static simulation of equation I.1 in the technical appendix. See footnote 24.
[c] Derived from the mortgage rate elasticity of housing starts implied by equation I.1 in the technical appendix.
[d] Derived from a static simulation of equation I.2 in the technical appendix.
[e] Maximum percentage declines that occurred during the credit crunch periods 1960:1-3, 1966:3-1967:1, 1969:2-1970:1, and 1973:3-1975:1, respectively.

starts, its role has evidently not been as large as the role of other factors — including credit availability as well as underlying demand and supply variables — in determining the eventual *severity* of a housing decline.

The results in table 7 provide support for the hypothesis that the effect of credit availability plays a relatively more important causal role in the housing cycle than the effect of credit cost. These estimates of the magnitude of the cost and the availability effects must be interpreted with caution, however, because the model from which they were derived was estimated in such a way as to maximize the apparent influence of credit availability on housing starts and to minimize the effect of credit cost. This is so because the model was estimated in two parts: the credit cost equation was fit only to data observed when no credit crunch was in progress; the credit availability equation was fit only to data observed during (arbitrarily defined) credit crunches. Because some of the largest increases in mortgage rates observed since 1958 occurred during those periods when the credit cost effect was not allowed to operate, the estimated impact of the mortgage rate on housing starts in the FRB model — far from trivial as it stands — may be smaller than the true effect. Similarly, because the measure of credit availability employed in the FRB model is defined in such a way that it always declines significantly whenever housing starts decline significantly (and only then), the estimated impact of credit availability may be greater than the true effect. For these reasons, it is probably correct to say that credit cost is somewhat more important and credit availability somewhat less important than the figures in table 7 indicate.

Despite this disclaimer, it may still be argued that the empirical results imply that future hous-

ing cycles can be expected to be less severe than those experienced in the past because the existence of the secondary mortgage market and such disintermediation-preventing innovations as the six-month money market certificate will render credit crunches and the associated phenomenon of mortgage rationing obsolete. While this conclusion follows from the evidence presented here, countervailing forces that tend to blunt the salutary effect on the housing cycle of the improved reliability of the supply of mortgage funds are also at work and their influence must be recognized. In particular, it must be borne in mind that although the evidence indicates that the cost of credit historically has not been the dominant cause of housing cycles, the data also show quite clearly that mortgage rates do affect the pace of residential construction to a significant extent. The traditional source of mortgage money — the savings deposit — is unreliable, but due to Regulation Q it is nevertheless the least costly source of loanable funds. Money market certificates, mortgage-backed bonds, FHLB advances and the rest of the new components of the mortgage-financing apparatus can serve to offset savings deposit outflows and thus to prevent the availability effect from operating, but only at a significantly higher cost. As the "cost push" created by the increasing reliance on secondary sources of mortgage funds is reflected in mortgage rates, rationing by price (the credit cost effect) may replace rationing by queue as the principal constraint on homebuilding during future tight money episodes. For this reason, housing cycles may continue to occur even in the absence of availability problems associated with dramatic credit crunches. Current developments in the housing industry provide support for this assertion: although no evidence of a traditional credit crunch has emerged in recent months, housing starts through July 1979 have declined nearly 15 percent from their November 1978 peak of 2.1 million units, a decline accompanied by a sharp increase in mortgage rates.[26] Thus, the extent to which the innovations in mortgage finance described in this paper will in fact ameliorate the housing cycle may ultimately depend as much on their impact on the variability of the mortgage rate as on their direct availability effect on home construction.

V. Conclusion

Over the years since the Great Depression, no sector of the American economy has received more attention from public policy makers than the housing industry. Based on the belief that the pace of home construction is directly related to the quantity of mortgage funds available, a belief reinforced by the repeatedly observed association between outflows of funds from primary mortgage lenders and downturns in housing starts, numerous government programs have been designed to stabilize and possibly to increase the flow of funds into the mortgage market. The various institutions created for this purpose have achieved remarkable success in improving the mechanics of housing finance — by standardizing the mortgage contract, by broadening the lender base, by encouraging the growth of a mortgage resale industry — and thus in establishing a reliable (though relatively costly) supply of funds for mortgage loans. Since the evidence presented in this paper suggests that the availability of credit has been the single most important determinant of the severity of past declines in homebuilding, these achievements may be expected to lessen the severity of housing cycles in the future. On the other hand, the

[26] The FHLB series on conventional mortgage rates for new homes rose from 9.87 percent in November 1978 to 10.75 percent in July 1979. International evidence also supports the assertion in the text. Canada, for example, has experienced housing cycles as severe as those experienced in the United States even though no deposit ceilings are imposed there.

empirical results also reveal that the cost of credit has had a significant independent impact on the pace of residential construction. Should the price of a more reliable supply of mortgage funds be an increase in the variability of the mortgage rate, at least part of the stabilizing influence of the secondary mortgage market and the other mortgage financing innovations described in this study will be lost. It is therefore premature to conclude that the traditional housing cycle is a thing of the past. Perhaps the behavior of the housing industry during the current period of relatively "high cost" money will help to resolve this issue.

Technical Appendix

I. The FRB Housing Sector (single-family starts)

1. No credit rationing

$$QHS1 = \underset{(1.7)}{-.938} + \underset{(21.8)}{.835}\ QHS1_{-1}$$

$$\underset{(2.2)}{-.595} \ln\left(\frac{KH1}{\frac{1}{8}\sum_{i=0}^{7} CON_{-i}}\right)$$

$$\underset{(0.8)}{-.172} \ln(POP) + \underset{(2.7)}{1.050} \ln(NHH)$$

$$\underset{(2.9)}{+.615(1/12)} \sum_{i=0}^{11} (\ln(RCH2_{-i}) - \ln(RCH1)_{-i}))$$

$$\underset{(3.2)}{-.553} \ln(RCH1) - .4\ \epsilon^{i}$$

where

$$QHS1 = \ln\left(\frac{HS1 + EHAA + EHM - ZHS1}{.01 * PEH * \frac{1}{8}\sum_{i=0}^{7} CON_{-i}}\right)$$

$$POP = \frac{.5N20 + .5N65}{.5N20 + N25 + N45 + .5N65}$$

$$RCH1 = \frac{PEHL}{PCON} * \left((1-T) * (RM + 100 * UTP) + 2.5 - P1_g^e\right)$$

$$RCH2 = \frac{PEH}{PCON} * \left(RM + 100 * UTP + 2.5 - \frac{P2_g^e}{(1-T)}\right)$$

HS1 = value of single-family housing starts
EHAA = expenditures on additions and alterations
EHM = expenditures on mobile homes
ZHS1 = value of subsidized single-family starts
PEH = implicit price deflator for expenditures on residential construction
CON = real personal consumption expenditures (1972$)
KH1 = real stock of single-family houses (1972$)
N20 = population aged 20–24
N65 = population aged 65 and over
N25 = population aged 25 to 44
N45 = population aged 45 to 64
NHH = average number of persons per household
RCH1 = cost of capital for single-family houses
RCH2 = cost of capital for multi-family houses
PEHL = asset price index for single-family housing
PCON = price deflator for CON
T = average personal income tax rate for federal and state and local taxes
RM = mortgage rate
UTP = property tax rate
$P1_g^e$, $P2_g^e$ = expected inflation (capital gain) terms, a weighted average of past PEH inflation rates

sample period: 1958:3–1959:4,
1960:4–1966:2,
1967:2–1969:1,
1970:2–1973:2,
1975:2–1977:4

2. Credit rationing

defined J by $DCR = \ldots = DCR_{-J} = 1, DCR_{-J-1} = 0$

$$1 - \left(\frac{\exp(QHS1)}{.5(\exp QHS1)_{-J-1} + \exp(QHS1)_{-J-2}} \right)$$

$$= \sum_{i=0}^{5} a_i \left(1 - \frac{Z1_{-i}}{Z2_{-J}} \right) * DCR_{-i}$$

where $Z1 = \left(\left(\frac{X}{X_{-2}} \right)^2 - 1 \right) * 100$

$$Z2 = \left(\left(\frac{X_{-2}}{X_{-6}} \right)^2 - 1 \right) * 100$$

$X = .94\,(MSL + ZAFH) + .72 * MMS + .42 * MIS + .15 * (M1 + MT) + ZVMOR$

$a_0 = .270\,(12.3)$ $a_3 = .218\,(11.1)$
$a_1 = .233\,(17.8)$ $a_4 = .181\,(9.0)$
$a_2 = .222\,(13.6)$ $a_5 = .084\,(3.3)$

DCR = credit rationing dummy
MSL = savings and loan association deposits
MMS = mutual savings bank deposits
MIS = life insurance reserves less policy loans
M1 = basic money stock
MT = time deposits at all commercial banks
ZAFH = FHLBB advances
ZVMOR = mortgages held by U.S. government sponsored credit agencies and mortgage pools

sample period: 1960:1–1960:3
1966:3–1967:7
1969:2–1970:1
1973:3–1975:1

NOTE: t-statistics for all estimated coefficients appear in parentheses.

SOURCE: Flint Brayton, "The Housing Sector," Board of Governors of the Federal Reserve System, April 1979, processed.

II. Derivation of Chart 2

The quarterly housing starts series (private, nonfarm) was taken from various issues of *Business Conditions Digest*, U.S. Department of Commerce.

The quarterly interest rate differential series was derived by subtracting the weighted average interest rate on passbook and time deposits (ATD) from the rate on six-month Treasury bills. Using deposit rate and volume data for commercial banks (CB), savings and loan associations (SL), and mutual savings banks (MSB) taken from the FMP data tape, ATD was constructed as follows:

1) Compute weighted average interest rate paid on deposits at each type of institution, e.g.,

$$CBR_t = \left(\frac{\text{CB passbook deposits}}{\text{total CB deposits}} \right)_t * (\text{CB passbook rate})_t + \left(\frac{\text{CB time deposits}}{\text{total CB deposits}} \right)_t * (\text{CB time deposit rate})_t$$

where CBR = weighted average rate on commercial bank deposits.

2) Compute $ATD_t = W_t^1 * MSBR + W_t^2 * SLR + W_t^3 * CBR$

where

$$W_t^1 = \left(\frac{\text{total MSB deposits}}{\text{total deposits at MSB, SL, CB}} \right)_{t-1}$$

and similarly for W_t^2, W_t^3.

The net new money series was constructed from data in the Flow of Funds Accounts, Board of Governors of the Federal Reserve System. Net new money in any quarter was set equal to the difference between the net increase in household, personal trust, and nonprofit organizations time and savings accounts at commercial banks and savings institutions and the interest credited to these accounts during the quarter. The amount of interest paid during a quarter was estimated by applying the current weighted average deposit rate to the stock of deposits outstanding as of the end of the previous quarter.

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In this issue . . .