

# BUSINESS

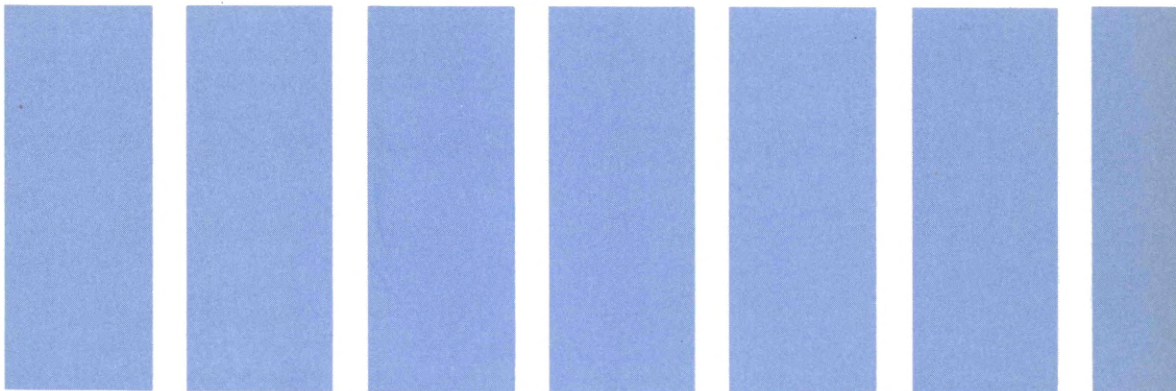
september/october 1976

# REVIEW

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A subject index of articles appearing in the *Federal Reserve Bulletin* and in the reviews published by System banks during the first half of 1976.



## FEDERAL RESERVE BANK OF PHILADELPHIA

Business Review September/October 1976

**On Our Cover:** *Lafayette and Washington Inspect Huddled Troops During the Terrible Winter at Valley Forge.* Steel engraving by Henry Bryan Hall (1808-1884) after a painting by Alonzo Chappel (1828-1887). Photograph courtesy of the New York State Historical Association, Cooperstown, New York.

Born in London, Hall came to the United States and settled in New York in 1850, where he established himself as an engraver and painter. A specialist in portraiture, Hall painted Napoleon III from life and worked on the engraving of Sir George Hayter's "Coronation of Victoria" as well as etching American heroes for collectors in New York and Philadelphia.

Chappel was born in New York and developed a considerable reputation as a painter there. His illustrations of American military scenes enjoyed wide circulation in the last century.

Lafayette, portrayed in this engraving as a serious young man, was only nineteen when he came to America in the summer of 1777 and was appointed major general by the Congress. Washington was appalled at the distribution of honorary commissions to visitors from abroad, but Lafayette learned quickly. He rode with Washington at the Brandywine in September, sustaining a wound in the leg, and accompanied him into winter quarters three months later.

Valley Forge was poverty in the midst of plenty. There were no shortages in the surrounding countryside or in nearby Philadelphia, yet neither the Congress nor the populace would support Washington's freezing, starving troops. Lafayette followed his commander's example in subsisting as many soldiers as he could out of his private fortune.

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# The Economics of Bank Security

*By Timothy H. Hannan\**

A man walked into a Hollywood bank recently with the intention of holding it up. Although temporarily successful, he was apprehended before long as a result of overlooking the little problem of a getaway: he had only one leg and he walked on crutches. In Las Vegas, another stickup man found it impossible to melt into a crowd after his crime. As a dwarf, and a burly one at that, he was easy to spot.

Many observers believe that the problem of bank crime is getting worse, and bizarre incidents such as these must make bankers and enforcement officials fear that almost everyone is getting into the act. According to the FBI, the number of bank robberies jumped from under two thousand to over four thousand and bank larcenies doubled

between 1969 and 1975. The raw figures say that bank crime has been rising, and the future appears to offer only more of the same.

Reports of bank crime trends have led to increased public concern over the adequacy of bank security measures. Calls for tighter bank security are not new to bankers. In 1968, an earlier wave of public concern led to the passage of the Bank Protection Act, which established minimum standards and imposed penalties on banks that didn't comply. To the surprise of many, however, the Act has not brought a reduction in bank crime, and questions are being raised again about the desirability of higher standards and tougher enforcement.

But before reacting to public pressure, it's useful to find out what story the figures really tell. After all, they can be read in several ways, and they may show on close inspection that the increase hasn't been as dramatic as it might seem at first glance. Further, there are matters of cost and benefit to be considered

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\*The author, who holds a Ph.D. from the University of Wisconsin, specializes in banking and urban economics. He joined the Philadelphia Fed's Department of Research in 1974.

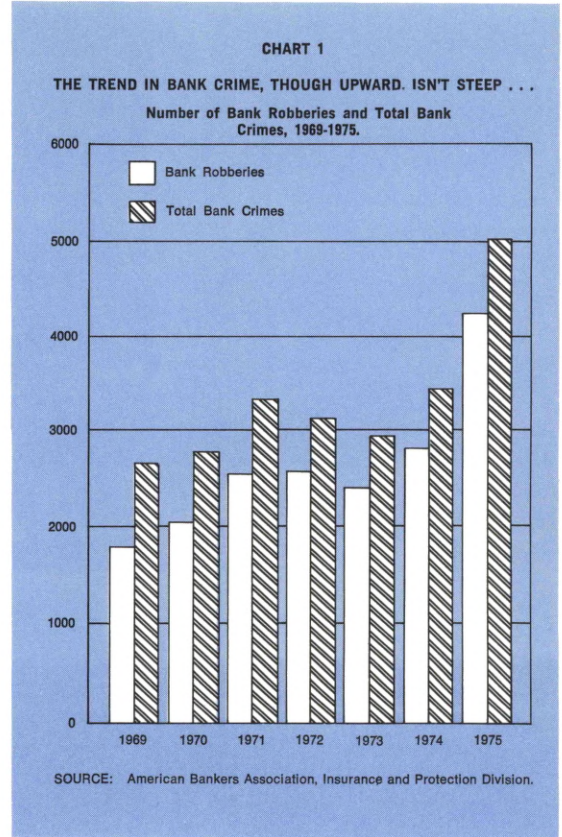
here. It may be possible to eliminate some bank crime at a reasonable cost; but the cost of reducing it drastically may be too high to justify the effort. Finally, while government standards for bank security may have some role to play, requirements that are unduly uniform may restrict bank managers' flexibility to an unreasonable extent. Unless security standards can accommodate the different circumstances of individual banks, they may impose an undue burden on bank managers and the banking public.

### BANK CRIME INCREASES: A CLOSER LOOK AT THE NUMBERS

Some people talk as if the rise in bank crime were almost vertical. But, as Chart 1 shows, the picture isn't that simple. Both robberies and the bank crime total were slightly higher in 1970 than in 1969 and higher still in 1971. Robberies were up again slightly in 1972, though the bank crime total was down that year. Both were down the next year, with the total falling almost to 1970 levels. The figures went up again in 1974, rising above 1971 levels, but not by much. The biggest rise of all came in 1975, when the bank crime total jumped up to over five thousand from the previous year's thirty-five hundred. But this was one isolated year. Thus, while bank crime has been trending upward since the beginning of the decade, the message isn't as clear as many people believe.

**Why Any Increase?** Thieves prey on banks because, as Willie Sutton said, that's where the money is. The monetary rewards from a successful bank robbery can be quite high. But that doesn't account for the present increase. Why is there more bank crime now than there used to be? And why did bank crime soar in 1975?

Some of the causes of bank crime are causes of other kinds of crime, and nearly all kinds of crime have been trending upward. The increase in robberies of chain stores, for example, has been almost twice the increase of similar crimes against financial institutions. Some criminologists believe that the rising



incidence of heroin addiction and the recessionary decline in job opportunities account for part of the crime-rate increase. The shortage of legitimate job opportunities coincided closely with increased criminal activity in 1975.

Like other criminals, bank robbers have to balance the reward of success against the risk of capture and punishment. According to a recent study (see Box), bank robbers are aware of risk and cope with it by scanning the horizon for the best possible targets and victimizing bank offices that offer the biggest take and the least prospect of being caught. Recent changes in the structure of the banking system may have altered the relation of the robber's rewards to his risks, making robbery and other kinds of bank crime less

## BOX

## AN ECONOMIC APPROACH TO BANK THEFT

Perhaps not all bank robbers act out of calculation alone, but at least one investigation has discovered a method in their madness. According to Tim Ozenne, who recently conducted a major study of the economic aspects of bank robbery, thieves have available to them a large number of targets or theft opportunities, and some of these are likely to be profitable.\* Even ill-gotten gains are not free; theft requires the expenditure of time, energy, and perhaps other scarce resources. For this reason, according to Ozenne, thieves tend to choose from their array of opportunities only those targets that offer the highest returns for the risk of being caught and punished. Thus both bank security and *efficient law enforcement* are important deterrents to attacks on banks.

This simple observation points to important economic relations in the real world of bank theft. According to Ozenne, ill-gotten return from theft, adjusted for the prospect of being caught and punished, tends toward equality across targets. If targets in one area are characterized by net returns to theft that are higher than those prevailing across the way, thieves will tend to shift their activity out of the one area and into the other. With stricter law enforcement, the average take tends to be higher. This observation is consistent with the fact that lowering the net return to robbery causes robbers to abandon the less remunerative targets, leaving the higher paying targets to be victimized. And it's reinforced by another finding: states that record the lowest number of bank robberies per banking office also tend to record the highest average take. These findings together tend to show that while making bank robbery more difficult will reduce the number of robberies by discouraging marginal crimes, it won't have as great an effect on crimes against more remunerative targets.†

\*Tim Ozenne, "The Economics of Bank Robbery," *Journal of Legal Studies* 3 (1974), pp. 19-51.

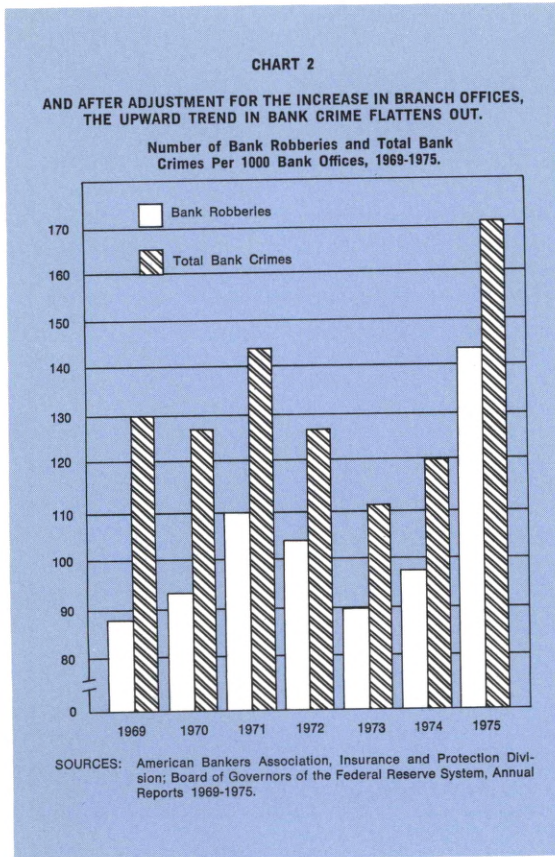
†For a more detailed discussion of the economics of criminal behavior see Timothy H. Hannan, "Criminal Behavior and the Control of Crime: An Economic Perspective," *Business Review*, Federal Reserve Bank of Philadelphia, November 1974, pp. 3-9.

risky. The most important of these changes is the growth of branch banking.

Banks have branched out at an unprecedented rate over the last decade, increasing the total number of bank offices by more than fifty percent nationwide. No longer are banks the imposing downtown fortresses they once were. They've moved a large part of their volume to suburban offices with a warmer, friendlier atmosphere for doing business. While the change of style and location has brought increased convenience to garden-variety banking customers, it also has provided more targets for tough customers that the banks would rather not be serving. Located outside high-density areas and with easy access to high-speed roads for quick getaways, suburban branch banks offer an attractive prospect to people bent on making illegal withdrawals.

The growth of branch banking has changed the shape of the industry, and failing to feed it into the analysis of bank crime statistics can give us an incomplete picture of the situation. Chart 2 graphically represents the growth in bank crime and branch banking. It shows a fall-off in the bank crime total from 1969 to 1973 broken by a high in 1971; the total then trends up in 1974 but remains below the levels from 1969 through 1972. The bank robbery figures begin to rise in 1970, fall back in 1972, and rise moderately in 1974. Both figures are up sharply in 1975. But this rise may be explained by a rapid decline in the number of openings for legitimate work during 1975.

In short, when the bank crime figures are adjusted for industry growth, the trend in bank crime appears even less alarming for the period 1969-74. And the 1975 situation, though it doesn't look good, may be just a



one-year phenomenon on which no policy deliberations should be based.

Putting the figures into perspective may dispel the air of crisis from the bank crime discussion. And it may help legislators and regulators avoid being stampeded into premature action. But it doesn't get to the basic questions—how much security banks should have and what, if anything, government should do to make sure they have it.

### HOW MUCH SECURITY?

Banks take steps to thwart criminals because successful crimes impose a cost on banks. A bank that operates in a high-crime area may suffer losses both directly, through removal of funds, and indirectly, through higher insurance premiums.

The bank manager who wants to reduce his

loss from crime has several alternatives. He may install alarms and surveillance cameras, or hire guards, or give his bank a fortified look. Ingenuity would extend the list. His choice should depend upon considerations of cost and effectiveness. But no matter which way he goes, it's sure to cost money. How much will be saved by spending a thousand dollars, or two or three thousand, for additional bank security? Perhaps not enough to make the investment worthwhile. If left to himself, the bank manager may decide to risk more frequent robberies and pay higher insurance premiums. In any case, he has to weigh the gain of reducing bank crime against the cost of prevention.

All businesses have to consider the cost and benefit of spending more on crime prevention. The cost is the expenditure made for security, and the benefit is the forestalling of losses. At least one recent study has found that businesses actually do make greater efforts to protect themselves where the prospect of loss from crime is relatively high and security measures relatively cheap.<sup>1</sup> There's reason to believe that banks do the same.

**Setting the Level.** These considerations lead to the following criterion for bank security: the level of security maintained by banks should be increased only as long as the additional savings (however defined) justify the additional cost. Savings in this case can be thought of as the reduction in damages caused by crime. Besides reducing the loss of funds and damage to bank property, increased security can reduce the number of deaths and physical injuries that result from robberies. And, to the extent that it deters bank crime, increased security can save associated police, court, and correctional costs.

The amount of bank security indicated by this criterion may not do away with successful bank robberies because the cost of security measures may be substantial. Would it really be reasonable to eliminate all bank crime if,

<sup>1</sup>See Ann P. Bartel, "An Analysis of Firm Demand for Protection against Crime," *Journal of Legal Studies* 4 (1975), pp. 443-478.

for example, it took half the gross national product to do so? Successive reductions in bank crime may require disproportionately increasing outlays for security, and eliminating all bank crime simply may not be worth the cost required to do it.

**Do Banks Pick the Appropriate Level of Security?** Neither the occurrence nor the increase of bank crime proves that banks are deficient in security. The extreme cost of prevention may justify allowing some bank crime to occur. Even an increase in bank crime need not indicate that bankers are choosing inadequate levels of security. Bank crime may increase dramatically for many reasons, and while a big increase may indicate that banks should improve security, it generally does not mean that they should improve it to the extent that no increase in crime occurs.

It has been suggested that the availability of insurance keeps bankers from investing in a high enough level of security. Banks carry insurance on their losses. The most common kind is the bankers' blanket bond, which covers losses from burglary, embezzlement, forgery, larceny, and theft, as well as providing robbery protection. Banks can buy other policies to insure losses not covered by the blanket bond. Many contend that because banks rely on such insurance, they have little financial incentive to spend money to hire guards and install needed protective devices. In other words, because of insurance, at least part of the loss from bank crime is avoided by the banks. As a result, they fail to protect themselves adequately.

This *moral hazard* issue, however, is common to many areas of insurance, and insurance companies generally deal with it by employing such devices as deductibles, minimum prevention requirements, and variable premiums. The deductible provision excludes some initial amount of loss from coverage, so that the victim bears some of the loss and hence still has an incentive to protect himself. Minimum prevention standards require the insured to take certain preventive measures, such as the installation of a burglar alarm system, in order to remain eligible for cover-

age. Finally, insurance premiums can be set at high levels for firms with heavy losses or poor security protection—an additional incentive to reduce crime loss. The use of devices such as these sharply reduces, although it may not eliminate, the tendency of insurance to foster laxity in security precautions.<sup>2</sup>

The possibility that banks may not bear certain losses from bank crime may be a more important reason for concern over the adequacy of bank security measures. If some of the costs of bank crime are not considered by bank managers because those costs are not borne by their own banks, then it's not likely that banks, left on their own, would invest enough in security.

Examples of such costs are not hard to find. If a bank fails as a result of a major bank crime, people other than the bank's stockholders and management may bear some of the loss. Nor do banks bear the full cost of death and physical injury to bank personnel and customers. And then there are the often considerable police, court, and correctional costs required to apprehend, convict, and punish perpetrators of bank crimes—crimes that might never have occurred if bank security measures had been tighter. The avoidance of such costs of doing business is regarded by many economists as an important justification for governmental action.<sup>3</sup> But if government action is necessary because bankers don't take the full cost of bank crime into account, what policy options are available to correct the situation?

<sup>2</sup>Perhaps because of such insurance devices, Ann Bartel has concluded from a recent study of firm security decisions that insurance generally is not used as a substitute for private protection. For more details, see Bartel, "An Analysis of Firm Demand for Protection against Crime."

<sup>3</sup>One might ask whether the justification for government intervention in bank security affairs doesn't apply to all other commercial establishments. If bankers don't take adequate security precautions because they don't bear all the losses from criminal attack, can't the same be said of someone who owns a department store or an all-night restaurant?

The question here is one of cost. The cost that bank crimes impose on the public may be relatively high in

## A BLUEPRINT FOR POLICY

Policy should aim for just that level of bank security at which the savings justify the cost, but all parties' savings and costs should be figured in, not just the banks'. And it's clear that the level of security that fits one bank may be inappropriate to another. It may be desirable for banks in low-crime areas located next to police stations to invest very little in bank security, for the savings from the higher security levels may not justify the cost. At the opposite extreme, it may be desirable for a large bank facing a serious crime problem to invest in the most comprehensive, up-to-date security systems.

There are two ways to achieve the desired level of bank security. The first would require individual bank decisionmakers to take the full consequences of their decisions into account. This might involve charging bankers for the losses that other members of society incur as a result of bank crime—a charge that would make it the bankers' interest to choose higher levels of security protection. Whatever its drawbacks, this approach has the distinct advantage of enabling each bank to make its own security decision after considering its own unique situation.

The more usual government approach, however, is the mandatory guideline. An example of this approach is the Bank Protection Act of 1968, which requires banks to

comparison to losses from crimes against other commercial establishments. Bank failures, which could result from successful bank crimes, long have been recognized to have extraordinarily wide-ranging effects. Further, since large sums of money usually are at stake, bank crimes usually require a larger expenditure of criminal justice resources. Indeed, it's not uncommon for the FBI to spend more money investigating a bank robbery or burglary than was taken during the offense. In the case of a recent Maryland bank crime, for example, the cost of investigation alone exceeded a quarter of a million dollars.

Though the administrative cost of government intervention in bank security decisions also can be quite high, one can argue that intervention is less costly in the case of banks because the regulatory apparatus already is in place. For all these reasons, the argument for government intervention in bank security decisions need not justify similar intervention elsewhere.

appoint security officers, formulate approved security plans, and install certain minimal devices and procedures. Establishing guidelines is a more direct approach to bank protection. It can lead to less than satisfactory results, however, if security requirements are set too high or too low or if they fail to account for the diversity of banking organizations and bank crime problems. A guideline that requires every bank to install a surveillance camera and hire an armed guard, for example, may be inadequate for banks with major crime problems but excessive and needlessly expensive for banks with only minor difficulties. Inflexibility—always a problem when centralized regulation replaces decisionmaking by managers who have a first-hand knowledge of the situation—can result in a considerable economic loss.

## HASTE MAKES WASTE

The policymaker has good grounds for approaching the subject of bank crime with caution. The raw figures on crime trends can be deceiving and generally do not serve as a sound basis for policy. Even when the story they tell is clear, they don't indicate how much or what kind of security a bank should invest in. That has to be determined in each case by an analysis of cost and benefit, and the analysis should take account of everyone who gains or loses from bank security decisions. Since security measures are not costless, requiring more security than is justified by crime reduction works out to a net loss. The mere occurrence of bank crime, or even an increase, is not a good argument for ever tighter security requirements.

Different banks have different crime problems, and guidelines won't work efficiently unless they reflect this basic fact. Strict reliance on a few rules could lead to too much security in some cases and too little in others. It's safe to expect bankers to protect themselves whether or not the government issues guidelines. And it's just possible that the wrong kind of guideline would do as much harm as no regulation at all.





# Forecasting Inflation: Does the Method Make a Difference?

*By Nariman Behravesh\**

The double-digit inflation of 1974 and 1975 caught many economists by surprise. After years of reliable service, their forecasting tools had started to lead them astray. As a result, businessmen and policymakers suddenly found themselves called upon to adjust to rapidly rising prices on very short notice. What happened? What went wrong?

Part of the forecasting failure can be attributed to the sheer intractability of events. The oil embargo, the wage-price freezes, and the agricultural shortages came out of the blue. No one could have known about them very far in advance, and no one could have known that they would hit almost all at once. But that doesn't get the forecasting tools off the hook. They're supposed to help even when we don't know exactly how the future will look.

Or rather, we rely on them precisely because we don't know how the future will look.

Runaway inflation probably wouldn't have been prevented by better economic forecasting, but its impact might have been softened. Recognizing that their inflation forecasts were off the mark, economists are taking a close look at their forecasting methods. They hope to get a better grip on price changes from now on.

## WHERE DO FORECASTS COME FROM?

When economists forecast inflation rates, they apply mathematical modeling techniques and their own powers of judgment to historical information.<sup>1</sup> A model is just a mathematical description of some state of

<sup>1</sup>For a description of economic forecasting and of how econometric forecasts differ from judgmental ones see N. Behravesh, "Forecasting the Economy with Mathematical Models: Is It Worth the Effort?" *Business Review*, Federal Reserve Bank of Philadelphia, July/August 1975, pp. 15-25.

\*The author, who joined the Philadelphia Fed's Department of Research in 1974, received his training at the University of Pennsylvania. He specializes in econometrics and macroeconomics.

affairs—in this case, the national economy. The application of mathematical techniques to the economy goes by the name ‘econometrics’. Purists at the econometric end of the forecasting spectrum rely, ultimately, on the inner workings of their computer models. Purists at the judgmental end won’t use anything more complicated than a telephone and a desk calculator. Most economic forecasters feel at home somewhere between these two extremes.

Forecasting methods differ in how they mix judgment and modeling. They differ also in how many kinds of information they take into account. And different methods typically give different results.

One method—the **consensus** or **survey** method—usually emphasizes judgment rather than modeling. The technique here is to collect a range of different estimates from economists and others and to average them out. One of the more widely known consensus forecasts is the Business Outlook Survey of the American Statistical Association and the National Bureau of Economic Research. This survey polls about fifty economists, most of whom favor judgmental methods, to predict the rate of inflation and other measures of economic activity. About half of these economists may consult an econometric forecast to check their judgment, but only a few have their own econometric models. The ASA-NBER survey arranges the contributing forecasts numerically and picks as its representative forecast the median or midpoint of the range.<sup>2</sup> Since a large part of its input consists of noneconometric and primarily judgmental predictions, the ASA-NBER survey is a representative judgmental forecast.

A second method focuses exclusively on historical data about a **single variable** whose behavior is being forecasted, leaving all others out of account. Inflation-rate forecasts generated this way reflect past changes in

price levels and nothing else. They don’t show the influence that, say, wages and productivity and aggregate demand might have on future prices.

Single-variable forecasting methods are popular with institutions that don’t have the resources for large-scale efforts and don’t require the detail of econometric forecasts. One of the more widely used is the Box-Jenkins method. The advantage of Box-Jenkins forecasts is that they’re easy to understand and easy to compute. Like trend forecasts they presuppose that the future values of a variable depend on its past values and the past errors made in predicting them. A typical forecast of this sort might postulate, for example, that the level of prices in the current quarter is related to the level of prices in the last two quarters. The exact relationship of current to past prices is estimated from historical data.<sup>3</sup>

A third kind—the **econometric model** forecast—generally provides for a number of related equations that reflect the interaction of several chains of events as revealed by the data.<sup>4</sup> The model is constructed and the data are selected according to a theory about how the economy fits together. The behavior of prices in such a model might be represented by an assertion that prices are set on the supply side of the economy by a markup over

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<sup>3</sup>The Box-Jenkins model used in this article can be found in J. P. Cooper and C. R. Nelson, “The Ex Ante Prediction Performance of the St. Louis and FRB-MIT-PENN Econometric Models and Some Results on Composite Predictors,” *Journal of Money, Credit, and Banking* 7 (1975), p. 11. The model was estimated using data through 1966.

<sup>4</sup>The pure econometric model forecasts considered here aren’t really predictions. They are retrospective or historical forecasts that try to determine what the model would have predicted if it knew the actual changes in policy instruments such as government expenditures and the supply of money. Predictions differ from historical forecasts in that they require the economist to estimate future policy changes and thus to impose some judgment on the outlook. Historical econometric forecasts, or simulations, are pure model forecasts: the internal mechanisms of the model *alone* generate the forecast.

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<sup>2</sup>The median of the contributing forecasts is chosen, rather than the mean, in order to minimize the influence of occasional extreme forecasts.

costs.<sup>5</sup> It might be assumed, for example, that prices in the U.S. economy are set so as to cover production costs and maintain profit margins. A major component of these production costs is wages, and wages are determined by the supply and demand for labor. Most of the econometric models developed in the late 1960s and early 1970s make an assumption of this kind about the influence of wages on prices.<sup>6</sup>

Most econometric forecasters, however, don't rely on a pure model forecast; they

**adjust the model forecast judgmentally** to allow for information that isn't represented explicitly, to compensate for past misses.<sup>7</sup> This kind of forecasting requires economists to help the model along with their best guesses regarding future changes in the household sector, the foreign sector, and other parts of the economy. Users also must feed in their best estimates of future changes in government expenditures and in the money stock as well as other developments that the model doesn't simulate. These are predictions based on the judgment of the forecaster, but they affect the model in ways that are consistent with its built-in assumptions about how people behave in an economic environment.

The information used by the four methods of predicting economic variables is summarized in Table 1.

<sup>5</sup>The model being used here is a modified version of the MPS (MIT-PENN-Social Science Research Council) model. The price and wage equations of this model are described in B. de Menil and J. J. Enzler, "Prices and Wages in the FRB-MIT-PENN Econometric Model," in *The Econometrics of Price Determination*, ed. Otto Eckstein (Washington: Board of Governors of the Federal Reserve System and Social Science Research Council, 1972). The price equation was estimated using data through 1968.

<sup>6</sup>W. D. Nordaus, "Recent Developments in Price Dynamics," *The Econometrics of Price Determination*.

<sup>7</sup>An example of this type of forecasting is the MIT-PENN-SSRC model modified by the judgment of three forecasters over different intervals at the Federal Reserve Bank of Philadelphia.

**TABLE 1**

Type of Information	Survey	Single-Variable†	Econometric Model Simulation‡	Judgmentally Modified Econometric Model‡
Past Values of the Variable Being Predicted	✓*	✓	✓	✓
Past Values of Other Variables	✓*		✓	✓
Actual Values of Policy and External Variables			✓	
Judgmental Information	✓			✓
Future Values of Policy and External Variables	✓*			✓

\*In survey or judgmental forecasts, it may be difficult to determine exactly how past values of variables and policy variables influence the forecast.

†In single-variable forecasts, the relation of past to future values of the variable being predicted is estimated using the historical data.

‡In econometric models, the impacts of past values of variables and policy variables on the variables being predicted are estimated using the historical data.

## HOW THE FORECASTS CAME OUT

It's easy to see how the forecasts came out for the period 1971-75 by plotting graphs of actual and predicted values. The graphs that are reproduced in Charts 1-4 on pages 14-15 show how well inflation-rate forecasts generated by the four different methods agreed with actual changes in the inflation rate. The vertical axis of each graph is the scale of forecasted inflation-rate values; the horizontal axis is the scale of actual values. If a forecasted value of, say, 2 percent were matched by an actual value of 2 percent, the dot for that forecast would be right on the diagonal; when the dot is not somewhere on the diagonal, as it usually isn't, actual values failed to coincide with projected ones. So, for example, in the first graph of Chart 1, the point labelled 74II shows that the actual rate of inflation in the second quarter of 1974 was around 9½ percent against a predicted rate of about 6½ percent.<sup>8</sup>

The charts are arranged by kind of forecast. Each of them contains four graphs that show how forecasts behave when they're used for periods, one, two, three, and four quarters beyond the base quarter. The earliest base period for all forecasts is the third quarter of 1971. The number of quarters shown diminishes from left to right across the charts as the forecast horizon extends from one to four quarters ahead.

**Comparing the Forecasts.** A glance at the graphs reveals that most of the points fall below the diagonal. This shows that all four kinds of forecasts generally underestimated inflation rates throughout the forecasting period. And the underestimates became

more severe as the forecasts looked farther ahead. The worst forecasting years were 1973 and 1974—years when international pressures tended to upset normal economic expectations.

Again, even a casual look at the graphs makes it clear that the single-variable forecasts were far and away the least accurate. The other kinds of forecasts were bunched; it's hard to tell which had the better track record simply by looking. But economists have developed several measures for ranking them more precisely. Two of these measures are mean error and mean square error; there are others as well (see Appendix).

Mean error is average error: if a forecast has a positive error of 2 in a given quarter and a negative error of 2 the next quarter, its mean error for the two-quarter period is zero. Mean error is not a very useful measure, however, because it doesn't indicate how far off the mark a forecast is. If an inflation-rate forecast, for example, were 10 percentage points too high one year and 10 too low the next, it still would average out to a zero mean error, despite its gross inaccuracy. So economists use mean square error to calculate how far off the zero line errors are, no matter how nicely they average out.

**How They Stack Up.** These measures show the relative strength of econometric methods. The pure simulation, the judgmentally modified model forecast, and the survey forecast consistently had smaller mean errors and mean square errors than the single-variable forecast, with the judgmentally modified simulation doing best for one, two, and three quarters ahead (see Table 2, page 15).

In short: While all inflation-rate forecasts have been too low in recent years, and while these forecasts have been less accurate over the longer haul, the outlook surveys and both kinds of econometric forecasts have performed far better than the forecasts based on a single variable.

## WHY DO FORECASTS MISS?

Forecasts miss in differing degrees for dif-

<sup>8</sup>The ASA-NBER and the MPS model-plus-judgment forecasts were generated using the data available at the time of the forecast. In the interim, however, the inflation data have been revised a number of times. Therefore, in order not to penalize these forecasts for the data revisions, the respective forecasting errors have been adjusted by subtracting the difference between the inflation data available at the time of the forecast and the most current data.

ferent reasons. Single-variable forecasts are likely to miss because they use little information and don't provide for judgmental corrections. Unlike the other three kinds of forecasts, single-variable forecasts don't consider the way prices are set in the economy for clues to future price changes. Because they're based entirely on past conditions and trends, they're unusually prone to missing sudden changes. The one whose performance is reflected in Chart 2, for example, assumes that the inflation trend of any two successive quarters will tell the forecaster what the inflation rates will be in the following quarter.<sup>9</sup> But it doesn't always work out that way, even in the short run.

The problem is compounded in forecasts that look more than one quarter into the future. Since single-variable forecasts depend solely on past changes, forecasts of two or more periods ahead require, as inputs, forecasts of the periods immediately preceding them. So, for example, in using the Box-Jenkins method to forecast inflation rates three quarters ahead, the economist has to feed in the predicted level of prices for one and two quarters ahead. As a result, the forecast errors for one and two quarters ahead are built into the forecast for three quarters ahead. Error accumulation is a thorn in the side of all economic forecasts of more than one period ahead. But it's especially troublesome in single-variable forecasts, since they use past inflation rates alone to calculate future rates.

Survey forecasts too set their sights on past inflation trends in estimating future trends. But the judgmental information that many contributing economists bring to bear on their forecasts reduces the weight of past trends and thus probably weakens the bias toward underestimating inflation rates. Unfortunately, the value of judgmental information appears to fall off as the forecasting

horizon moves farther ahead.

Model simulations also look backward to get a line on the future, explicitly representing the economy's behavior over a given period. Since models ordinarily allow for a range of influences on inflation rates, their forecasts usually reflect not only past changes in inflation but also past changes elsewhere in the economy.

Every retrospective forecast is subject to error when it's outrun by events. A sudden change in people's saving and spending habits, for example, can impact heavily on prices and throw the forecast off. If government unexpectedly slaps on wage and price controls, the results can baffle the forecaster. Or if another country buys heavily in the commodity markets here, even the best forecast may not provide much guidance.

Error builds up in econometric model forecasts of two or more periods ahead because past changes are used to predict future changes. Since econometric models assume that developments such as inflation are influenced not only by their own historical trends but also by wage hikes and other forces, they can accumulate error from many sources over time. Econometric models may miss also because they're approximations to the structure of the economy at a given time. They become outdated if behavioral and institutional changes that they haven't captured occur in the economy.

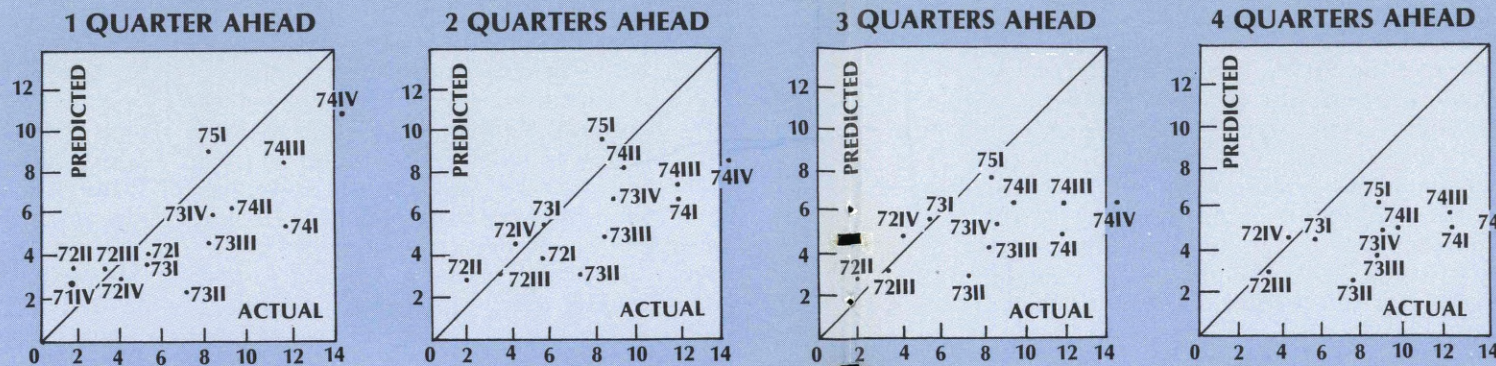
When an economist modifies a model forecast in line with his own expectations of the future, he in effect supplements the information it incorporates. This is no longer a retrospective exercise but a predictive one. Whether it makes for greater accuracy depends on how good the forecaster's judgment is and how apt he is at anticipating policy changes.

## LEARNING FROM PAST MISTAKES

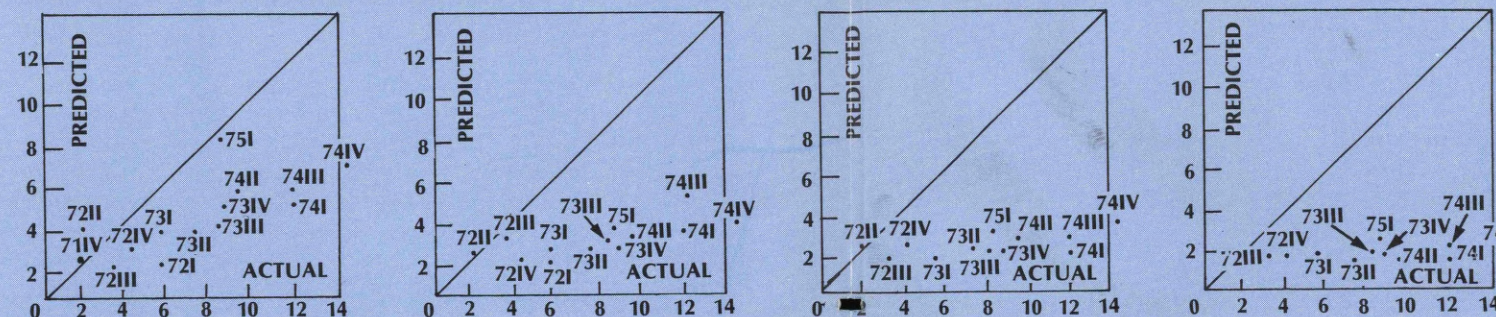
The method makes a difference in forecasting inflation. One thing economic forecasters have learned from their recent experience is that the past isn't always an accurate guide to

<sup>9</sup>The current econometric literature is considering the application of Box-Jenkins methods to a number of variables simultaneously.

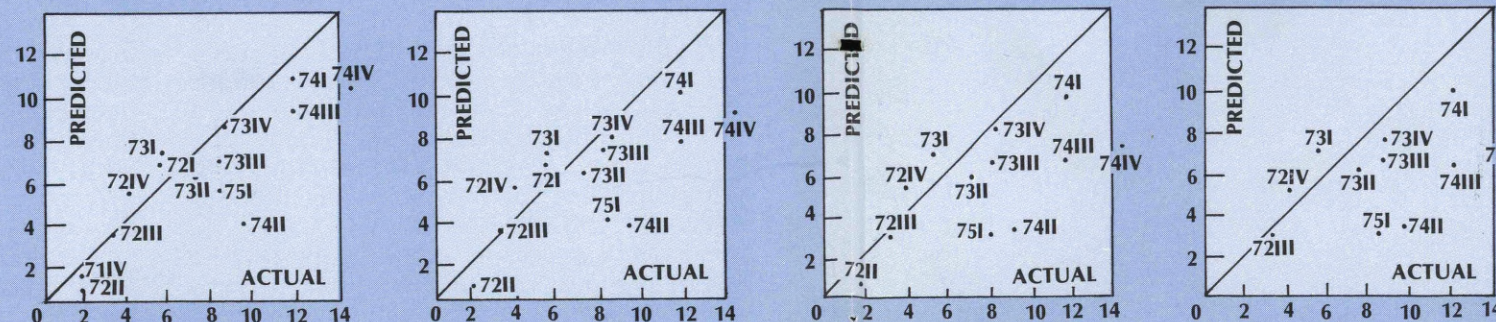
**CHART 1**  
SURVEY FORECAST:  
BUSINESS OUTLOOK SURVEY  
(ASA-NBER)



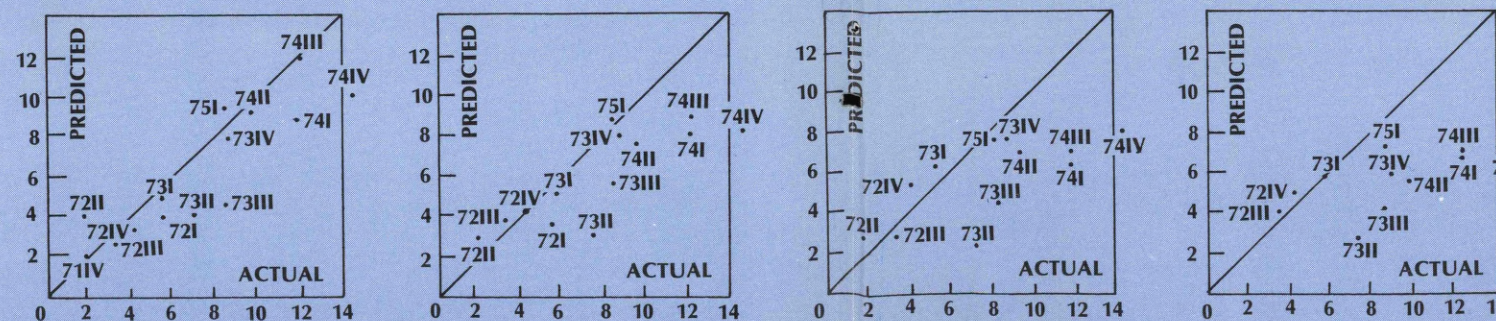
**CHART 2**  
SINGLE-VARIABLE FORECAST:  
BOX-JENKINS



**CHART 3**  
ECONOMETRIC FORECAST:  
MPS



**CHART 4**  
ECONOMETRIC FORECAST  
(MODIFIED): MPS



**DIFFERENT  
FORECASTING METHODS  
GIVE  
DIFFERENT FORECASTS**

**TABLE 2**  
MEAN ERROR OF FORECASTS

	Quarters Ahead			
	1	2	3	4
ASA-NBER	-1.82	-2.05	-2.96	-3.60
Box-Jenkins	-3.20	-4.92	-5.63	-6.56
MPS Model	-1.40	-1.87	-2.42	-2.48
MPS Model (Modified)	-1.13	-1.79	-2.14	-2.88

Mean error is average error. A positive error of any size in one quarter that's matched by a negative error of the same size in the next quarter gives a zero mean error for the two-quarter period.

**MEAN SQUARE ERROR OF FORECASTS**

	Quarters Ahead			
	1	2	3	4
ASA-NBER	8.58	9.73	17.24	19.79
Box-Jenkins	17.25	32.86	42.34	53.15
MPS Model	5.86	9.45	13.46	14.13
MPS Model (Modified)	4.60	7.61	11.57	14.79

Mean square error is computed by squaring each quarter's error and averaging out all the squares. A high mean square error is a sign that forecasting errors are relatively large.

future inflation rates. As a result, they've begun to keep a closer watch on current developments, such as commodity price movements and changes in world market conditions, for signals of higher prices ahead.

They've learned also that purism, whether of the judgmental or of the mathematical sort, imposes unnecessary restraints on the forecaster's work. Eclecticism, in the form of judgmentally modified econometric modeling, appears to offer the greatest promise for further development. It's relatively easy to reformulate some econometric models so that they capture the kind of information that would have pointed to high inflation rates in 1974 and 1975. An economist who uses one of the improved models can hope to chalk up a better track record in inflation forecasting

from now on.

The method makes a difference to policymakers, too. Because government policy is built into econometric models along with other institutional features, econometric forecasts allow policymakers to trace the influence of their decisions—for example, the influence of slower or faster monetary growth on inflation and unemployment. Single-variable and survey forecasts lack this advantage.

The unusual inflation experience of recent years provided economists with a tough test of their forecasting abilities. What they've learned is helping to reshape their forecasting tools—and, they hope, sharpen their view of the future.

## APPENDIX OTHER MEASURES OF FORECASTING ACCURACY

Mean error and mean square error are discussed in the text of this article. Mean absolute error and the Theil statistic are two other measures of forecasting accuracy. Mean absolute error is the average of the absolute values of the errors. The Theil statistic was developed by Henri Theil of the University of Chicago and is computed using the formula

$$U_n = \frac{\sum_{t=1}^m (P_{t+n} - A_{t+n})^2}{\sum_{t=1}^m (A_{t+n} - A_t)^2},$$

where the P are predicted values, the A are actual values, n is the forecasting horizon, and m is the number of forecasts in computation.

Mean absolute error, like mean square error, measures the dispersion of forecasting errors. The Theil statistic measures dispersion of the forecasting errors against the actual changes in the variable being predicted.


Here's how these two measures rank our four kinds of forecast:

### MEAN ABSOLUTE ERROR

	Quarters Ahead			
	1	2	3	4
ASA-NBER	2.43	2.39	3.19	3.71
Box-Jenkins	3.47	4.93	5.65	6.56
MPS Model	1.89	2.39	2.86	2.97
MPS Model (Modified)	1.61	2.05	2.70	3.20

**THEIL STATISTIC**

	Quarters Ahead			
	1	2	3	4
ASA-NBER	1.09	1.22	1.43	1.09
Box-Jenkins	1.55	2.24	2.25	1.79
MPS Model	0.90	1.20	1.27	0.92
MPS Model (Modified)	0.80	1.08	1.17	0.94

These results confirm the ranking of methods by mean error and mean square error. The Theil statistic seems to indicate, however, that errors associated with predicting the inflation rate don't necessarily increase over the forecast horizon. In the above example, the Theil statistics for predictions four quarters ahead are not much larger than those for predictions one quarter ahead. 



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Articles appearing in the Federal Reserve Bulletin and in the reviews of the Federal Reserve banks during the first half of 1976 are included in this compilation. A cumulation of these entries covering the years 1973 to date is available upon request. If you wish to be put on the mailing list for the cumulation, write to the Publications Department, Federal Reserve Bank of Philadelphia.

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