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On our cover: Of the historical houses in Philadelphia's Fairmount Park that are opened to the public, Strawberry Mansion is the largest. It was once the home of U. S. District Court Judge William Lewis, a friend of George Washington. In 1798 Judge Lewis built the center section, naming the house Summerville. The wings were added in the mid-1820s by a subsequent owner. The present name stems from the early 1840s when a resident sold strawberries and cream to visitors. The furnishings of the mansion are Federal, Regency, and Empire.

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The Battle for Energy Independence: How Much of a Good Thing?*

By Timothy H. Hannan

Abundant low-cost energy has been fundamental to the American way of life for a long time. It's hard indeed to imagine Americans without their climate-controlled houses, aluminum cans, and large gasoline-burning automobiles. Yet, as anyone who cooled his heels in a gasoline line last year can testify, a stable source of abundant low-cost energy can no longer be taken for granted. Domestic demand for energy has increased rapidly in recent years; domestic supply has not. To help fill this widening gap, Uncle Sam has relied increasingly on imports from the Middle East, where a volatile mixture of oil and politics has already resulted in one serious embargo and poses an ever-present threat of future embargoes.

As the recent gasoline lines and closed factories so dramatically demonstrated, a sudden curtailment of foreign oil can cause considerable economic disruption in a nation grown accustomed to relative energy abundance. To reduce the threat of similar economic disruptions in the future, the nation has embarked on a policy of energy self-sufficiency. Government funds are being allocated to stimulate research and development of alternative sources of energy, voluntary conservation efforts are being promoted, and—just to help voluntary conservation along—tariffs are being imposed on imported oil.

All of this brings up the question of the desirability of these efforts and the degree to which they should be pursued to bring about energy self-sufficiency. As economists never tire of proclaiming, resources are not limitless. The economy cannot at the same time satisfy all desires for more goods and services, higher quality environment, and greater reliance on domestic production of energy. In the area of energy policy, this means that hard choices must be made not only among the various methods of reducing

*This article deals primarily with the economic issues involved in seeking energy independence. Political or diplomatic considerations also may be important in determining the degree of energy self-sufficiency appropriate for the United States.

energy dependence but also among the various levels to which energy dependence should ideally be reduced. Because resources are scarce, complete energy self-sufficiency in the near future may come at a very high price indeed.

ENERGY DEPENDENCE: HOW CAN IT BE REDUCED?

Uncle Sam's arsenal contains many weapons to combat the energy problem. Most are designed to cut U. S. consumption of energy, boost domestic production of energy, or perhaps achieve some combination of the two. But as the current debate over energy policy serves to emphasize, the various methods of reducing energy dependence are not identical, and much controversy remains concerning the appropriate path to follow. Consider a few of the more important alternatives available.

Research and Development. Government-funded research designed to accelerate development of alternative sources of energy can play an important role in enhancing the nation's domestic production of energy, particularly in the long run.[1] The future availability of low-cost energy from nuclear, solar, and geothermal sources, or from synthetic fuels and oil shale deposits, may require substantial investments in research and development. Although the return to such investments may prove quite significant, so too may be the time required for these investments to pay off in the form of abundant low-cost energy. Thus, research and development of new technologies is generally viewed as having only long-run significance.

Voluntary Conservation. In addition to efforts designed to increase domestic energy production, a reduction in dependence on foreign sources of energy can also be achieved by policies designed to reduce domestic demand. Voluntary conservation is a currently practiced example of such a policy, and it has met with at least limited success. However, often self-interest and the goals of voluntary conservation don't jibe. An individual who believes his neighbors will adequately conserve energy may find it in his self-interest not to do so. Because of this "free-rider problem," as economists often call it, conservation on a voluntary basis is generally recognized as having significant limitations. For this reason, policymakers have increasingly called for mandatory, and perhaps less palatable, means of reducing energy dependence.

Rationing. Mandatory conservation through rationing is one such policy and has in fact been proposed by a number of national leaders. The problems involved in developing an equitable rationing system, however, are simply enormous. Decisions would have to be made on how to allocate gasoline, fuel oils, jet fuel, diesel fuel, and many other refinery products to the thousands of categories of consumers—a function which, according to Treasury Secretary William E. Simon, would require 15,000 to 20,000 full-time employees, incur $2 billion in Federal costs, and require 3000 state and local boards to handle the exceptions.[2] Perhaps more important, rationing does not provide the needed incentives for suppliers

[1]Although the private sector must be counted on to undertake most of the energy research and development, Government-funded research may prove to be quite important. Development of new energy technologies often involves expanding basic knowledge of fundamental processes. In such cases, research and development may provide a large gain to the economy as a whole, but there may be little opportunity for any one firm to derive a large enough part of this gain to warrant undertaking the research. Hence, Government participation in such efforts is needed.

[2]Statement of the Hon. William E. Simon, Secretary of the Treasury, before the Ways and Means Committee of the U.S. House of Representatives, January 22, 1974, *Department of Treasury News*, pp. 9–10.

of domestic energy to increase domestic production. Without new energy production, rationing would continue to be needed many years into the future.

The Tariff. Imposing a tariff on imported oil is another tool available to policymakers. A tariff is simply a tax placed on each unit or the value of each unit of an imported good, and its imposition on oil is designed to increase the price paid for imported oil. Of major significance is the tariff's effect on the price of domestic oil. With the imposition of a tariff, domestic oil becomes relatively more attractive to consumers of energy. As long as the price of foreign oil exceeds that of domestic oil, users will try to buy from domestic producers. When this happens (and as long as at least some domestic oil is not subject to Government price controls), the average price of domestic oil will be bid up to a higher level.[3]

Because of the dual role of prices in discouraging consumption and promoting production, this whole process results in less dependence on foreign energy sources. First, the rise in the price of oil, both foreign and domestic, will cause domestic purchasers of energy to review their expenditures and cut down on the more easily avoided uses of energy. In the industrial sector, for example, firms that did not consider energy conservation measures worthwhile when energy prices were low will now find it profitable to eliminate heat leaks, switch to less energy-intensive technologies, or improve waste-heat recovery systems. Consumers who once drove large automobiles 30 miles to work and failed to insulate their homes will now find public transportation, small cars, and six-inch insulation remarkably "good buys."

Second, unlike a policy of voluntary conservation or mandatory conservation through rationing, the impact of the tariff in reducing energy dependence is not limited to that of simply discouraging consumption. This is because a price rise brought on by the tariff will also increase the incentives of domestic producers to bring more energy to the market. Economic rewards are important. Faced with a rise in the price of energy, producers of coal, oil, and other sources of energy can be expected to search for and develop additional sources. Energy deposits identified by geologists but previously too costly to work—such as the vast oil shale deposits in Colorado and Wyoming—may now be tapped simply because higher prices make doing so profitable. And efforts to develop new technologies in the production of energy may be stimulated for the same reason.

Thus, by raising the prices we must pay for energy, a tariff on imported oil both reduces domestic consumption of energy and increases domestic production—making the nation less dependent on foreign sources of energy.

The Quota. Unlike the tariff, the quota restricts imports in terms of quantities, rather than in terms of a tax on each unit or on the value of each unit. Its impact, however, is quite similar. Like the tariff, the quota (by directly reducing the supply of imported oil, rather than by directly increasing its price) causes an increase in demand for domestic energy. Since a significant portion of domestic energy production is not subject to price controls, this means that the average price of domestic energy will rise, performing the dual function of discouraging domestic consumption and encouraging long-run domestic production. Thus, the quota, like the tariff, provides policymakers with a double-barreled weapon that can be used to make the nation more self-sufficient in energy.

[3]Government price controls are currently in effect on only a portion of domestically produced crude oil. In applying price controls, a distinction has been made between "old oil" and "new oil." New oil is defined as all oil produced on a property in excess of output in the same month of 1972. New oil and oil from wells producing less than ten barrels per day are not subject to price controls. Domestic "old oil," however, is currently held at a price of $5.25 per barrel.

The tariff and the quota can differ in terms of the revenue that they generate for the Government or in terms of the predictability of their economic impact (see Box 1). In general, however, the similarities are more striking than the differences. Both provide an incentive for domestic production, both discourage domestic consumption, and, to bring about these results, both require that we pay higher prices for energy.

BOX 1

TARIFFS AND QUOTAS: THE SIMILARITIES AND THE DIFFERENCES

The economic impact of tariffs and quotas can be quite similar. In fact, for any given tariff, there is a theoretically equivalent quota. If supply and demand responses to price changes are known with certainty, it is possible to predict the level of imports that will result under a certain tariff and simply impose that quota to achieve the same result.

There are, however, some potential differences between the two means of restricting imports. One potential difference is the revenue that they generate for Uncle Sam's coffers. Since a tariff is a tax, it provides revenue for the Treasury as long as it doesn't discourage all imports. But a quota is not a tax. It simply sets the level of imports allowed into the country and therefore does not generally provide revenue to the Government. Both means of restricting oil imports cause the domestic price to rise above the world price, but the difference goes to the Government in the case of the tariff and usually to the oil importers in the case of the quota. However, even this distinction can be eliminated if, under a quota, the Government chooses to auction off import licenses. By pursuing such a scheme, the Government could obtain roughly the same funds from selling import licenses under a quota as could be collected under a tariff. With the right conditions, both approaches can generate the same revenue.

A potentially more important difference between a tariff and a quota stems from the fact that it is often not possible to predict future changes in supply and demand conditions. Under these circumstances, tariffs and quotas thought to be the same can have divergent results. For example, if world oil prices decline unexpectedly, a tariff will result in an unexpected increase in the percentage of the domestic market supplied by foreign oil, while a quota will not. Also, the failure of domestic supply to expand as expected will lead under a tariff to an increase in imports, but under a quota it will cause an unanticipated increase in the price of domestic oil. Because of uncertainty, the tariff and quota can lead to unexpected and different results.

Oil Storage. Policies such as Government-funded research and development, voluntary conservation, rationing, and quota or tariff arrangements are designed to reduce imports by either reducing domestic consumption of energy, increasing domestic production, or achieving some combination of the two. But as some economists have been pointing out, there are also ways to soften those periodic blows from the Middle East without significantly reducing overall imports of oil, and a policy of oil storage is perhaps the most frequently mentioned example.

Storage performs the function of being an alternate source of supply when the going gets rough. By stockpiling oil bought from foreign sources or by storing domestic oil in the ground in the form of reserve capacity, sudden shortages of imported oil can be partially or totally filled by dipping into a stockpile accumulated for just such a rainy day. Oil storage, then, is another of the many potentially useful steps that can be taken to ensure a steady supply of energy.

REDUCING ENERGY DEPENDENCE: THE GAINS AND THE COSTS

Clearly, there is a potential gain to all such efforts designed to reduce the nation's vulnerability to oil embargoes.[4] When the spigots are turned off temporarily in the Middle East the resulting economic disruptions can cause considerable hardships. This is because domestic supply patterns and domestic consumption patterns cannot be changed readily at a moment's notice. It takes time to expand domestic energy production and introduce expensive production technologies which are not required when Middle East oil is flowing freely. And on the consumption side, it takes time to change over to more energy-efficient applicances, smaller automobiles, better-insulated buildings, and less energy-intensive technologies in commerce and industry. Because of this short-run inability to adjust to less energy, sudden embargoes can mean production bottlenecks, factory layoffs, cold homes, and other hardships. Therefore, the advantage of policies designed to avoid or reduce their impact can be large. This can be true even of policies such as a tariff or a quota, which are designed to replace temporary curtailments in imported oil with a permanent one. Because periodic sharp reductions in imported oil can be so severe in the short run, there may be a positive gain from policies designed to discourage imports gradually in the long run. These long-run policies can cause the economy to make adjustments without the major disruptions associated with sudden embargoes.

By cutting consumption, increasing production, or stockpiling reserves, the country can help protect itself from future embargoes. Of particular importance, the nation's foreign and domestic policies do not have to be unduly influenced by foreign producers of oil.

But while there's something to be gained from such policies, there are also significant costs. Because resources are indeed scarce, reducing the nation's vulnerability to foreign oil embargoes requires sacrifice. If it is to be achieved through increased domestic production, large expenditures may be required for further exploration and for research and development of alternate sources of energy. If it is to be achieved by reducing domestic consumption, money will have to be spent on better insulation, more efficient engines, and improved heat-recovery systems. Moreover, we will have to get along on less energy consumption even when embargoes are not underway. Tariffs and quotas also impose these kinds of costs since they are simply tools designed to increase production and decrease consumption. And because they do so by raising the price of energy, they also bring about higher gas prices, higher heating fuel costs, and higher prices of goods whose production requires large amounts of energy. Even an oil storage policy, which is not designed specifically to reduce consumption or increase production, may require considerable sacrifice in the form of large expenditures on oil storage facilities.

THE QUESTION OF POLICY

As is the case with so many economic problems, hard choices must be made among competing ends. To protect the nation from

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[4]In addition to avoiding or reducing the impact of embargoes, policies designed to make the nation more self-sufficient in energy can also help the balance of payments problem. However, since fluctuating exchange rates tend to correct imbalances in the balance of payments, this advantage may not be a very significant one.

future oil embargoes, substantial sums may have to be expended and hardships may have to be endured. This means that the benefits of reducing the country's vulnerability to foreign oil embargoes must be weighed against the costs of bringing about such a result.

In such circumstances, economists often apply a simple rule: increase the activity so long as the additional gain that results exceeds the additional cost. In the present case, this means that it is worthwhile to increase activities such as research and development efforts, oil storage programs, tariffs or quotas, and conservation programs only to the point where the additional gain associated with insulation from embargoes equals the increased costs of such efforts. Beyond such a point, devoting more resources to the effort simply will not pay.

Where this point lies is always difficult to determine without further information.[5] This framework, however, does establish the probability that a number of policies designed to reduce our vulnerability to foreign embargoes—tariffs, research and development, and oil storage, for example—may indeed be justified *up to a point.* But perhaps more important, it can prove useful in analyzing the desirability of a much publicized goal—that of achieving complete energy self-sufficiency.

COMPLETE ENERGY SELF-SUFFICIENCY?

To reduce the nation's dependence on unstable sources of foreign energy is one thing; to eliminate it is another. This difference in degree can be extremely important. It is no doubt possible to achieve total energy self-sufficiency even in the near future if we are willing to pay the price for it. Imports of foreign energy can be prohibited by quota, extreme conservation measures can be imposed, or tariffs can be set high enough to discourage all imports of oil, causing the price of energy to rise until the domestic supply of energy satisfies domestic demand. (See Box 2.) All of this can be done, but is a policy of energy self-sufficiency, carried *to this extreme,* worth the costs? There are a number of reasons to suggest that striving for total self-sufficiency, at least in the near future, may not be worth the sacrifice.

Those Last Steps toward Self-Sufficiency. One reason is that as the U. S. approaches energy self-sufficiency, the cost of taking such additional steps may increase, while the advantage of making an already relatively self-sufficient nation still more sufficient may not be great. The additional costs are particularly important. The nation moves toward energy self-sufficiency by expanding domestic production and reducing domestic demand, but the further that either of these activities are pursued, the greater will be the sacrifice required. Expanding domestic supply in the near future will require that we turn to increasingly costly methods of energy production, and reducing domestic consumption will require that increasingly high-valued uses of energy be abandoned. The sacrifice required to change the thermostat from 75 to 65 degrees may not be great, but that required by an additional 10-degree twist of the dial may be substantial. It is for these reasons that total energy self-sufficiency, at least in the near future, may be too much of a good thing. Put simply, the gain from making those last steps toward energy self-sufficiency may not be worth the higher costs required to complete the trip. It may be better to settle for something less.

Risk-Free Sources of Foreign Energy. Not all of the oil currently being imported into this country comes from the politically volatile

[5] On the one hand, if the probability of a recurrence of last year's embargo is low, as many believe, then the fruits of even the smallest efforts to reduce the nation's vulnerability to foreign oil embargoes may not be worth the cost. On the other hand, if the probability of recurring embargoes is high, then substantial efforts may be justified.

BOX 2

THE "PRICE" OF ENERGY SELF-SUFFICIENCY

A rough idea of the energy prices required to achieve energy self-sufficiency by 1980 can be obtained from a number of supply and demand estimates presented below.

ENERGY EQUILIBRIUM IN 1980

	Millions of Barrels of Oil per Day Equivalent, at Prices Per Barrel*		
Fuel	*$7*	*$9*	*$11*
Domestic Supply			
Crude oil and natural gas liquids	10.6	10.7	10.9
(including Alaskan)	(2.0)	(2.0)	(2.0)
Natural gas	14.7	14.5	14.4
Coal	6.1	8.0	8.0
Uranium and hydroelectric	5.2	5.2	5.2
New technology	0.0	0.0	0.1
Total Supply	36.6	38.4	38.6
Domestic Demand	44.2	42.4	40.6
Net imports	7.6	4.0	2.0

SOURCE: *Energy Self-Sufficiency, An Economic Evaluation* (Washington: American Enterprise Institute for Public Policy Research, 1974), p. 8.

*A fuel is made "oil equivalent" by finding the number of barrels of oil which has the same heating value as a given quantity of that fuel.

These estimates, which were derived from a number of statistical studies, indicate the supply of different fuels and the total domestic demand for energy that can be expected at the prices of $7, $9, and $11 per barrel (in constant 1973 dollars). As economic theory would suggest, higher prices mean more energy will be produced domestically and less of it will be consumed.

But here is where part of the problem of energy self-sufficiency emerges. As should be noted from the Table, the expected supply of various types of energy in 1980 is relatively unresponsive to price increases. In addition, the reduction in domestic demand for energy that can be expected to result from a price increase is estimated to be quite small. This means that in order to reach the point at which domestic supply equals domestic demand, which is required if no energy is to be imported, we may have to pay prices significantly higher than $11 per barrel (in constant 1973 dollars). As can be seen, this is significantly higher than the price of energy that would be required if we relied on some imports.

Middle East. Much comes from countries that are less likely to institute embargoes. A sufficiently restrictive policy can eliminate imports from relatively secure sources just as well as it can eliminate those from insecure sources. But why bear the cost if little is to come out of it? The primary gain from reducing imports is the reduction in periodic disruptions resulting from embargoes, but if a source of supply is relatively secure, there is little reason to incur the higher costs required to eliminate such imports. This means that policies should be less restrictive toward secure sources of foreign energy than those required by insecure sources—yet another reason to question the advisability of total energy self-sufficiency.

Oil Storage. If the goal of complete energy self-sufficiency means eliminating all oil imports, then the advantage of oil storage policies is another reason why the goal may not be desirable. If the cost of storing oil and using it during embargoes is not excessive, it may well pay to store at least some oil to smooth out the disruptions when they occur.[6]

But if a policy of oil storage is undertaken, what does this mean for the goal of self-sufficiency? Simply stated, it reduces the need to eliminate all imports. A substantial part of the gain from reducing imports is the resulting reduction in the economic impact of embargoes. But if a storage policy is instituted, embargoes become less serious, thus reducing the gain to be obtained by eliminating all oil imports. This does not necessarily mean that all efforts to increase energy self-sufficiency should be abandoned in the presence of a storage policy. Some movement toward self-sufficiency may still be justified. However, it does provide yet another reason to question the goal of independence from all sources of foreign energy.

CONCLUSION

Uncle Sam's arsenal contains many weapons that can be used to reduce the nation's vulnerability to periodic oil embargoes. Some, such as voluntary conservation programs and mandatory conservation through rationing, are designed to reduce domestic consumption. Others, such as efforts to develop alternative sources of energy, are designed to increase domestic production. Still others, such as oil storage policies, are designed to soften the blow of periodic embargoes without significantly reducing overall imports. Because all are costly, however, a proper balance must be struck between the gains and costs resulting from their use. Reducing the nation's vulnerability to a sudden oil embargo is important, but so too are the substantial sacrifices required to do it. Since periodic oil embargoes can cause serious economic disruptions, it may well pay to reduce our dependence on foreign sources of energy, at least to a degree. But running the full distance to achieve total self-sufficiency in the next few years may simply not be worth the cost required.

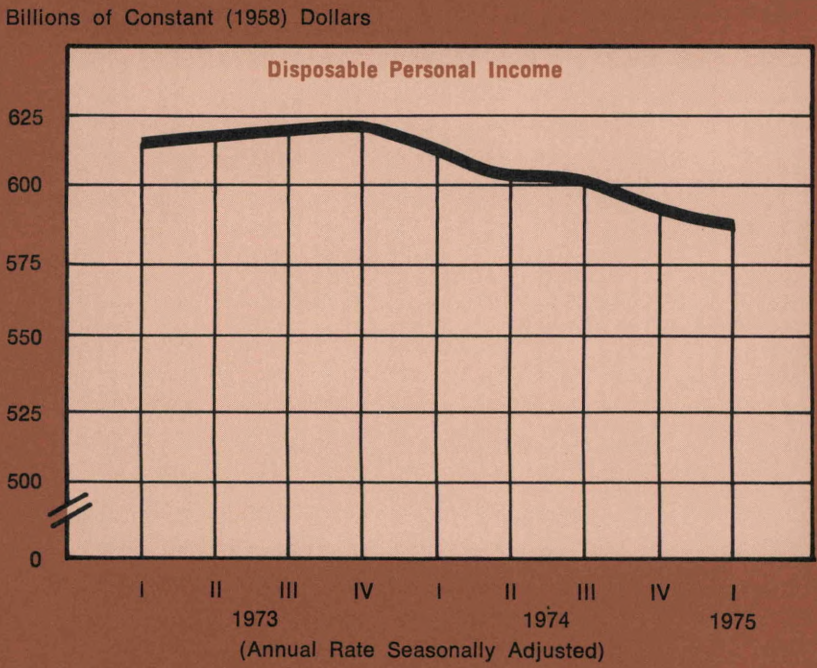
[6]Storage can take the form of either increasing domestic reserve capacity or stockpiling oil purchased abroad. The question of whether reserve capacity or storage from foreign sources is better is a simple cost calculation. If the landed price of foreign oil plus storage is less than the incremental cost of developing domestic capacity, then storage of foreign oil is preferable, and vice versa.

The Auto Industry: Slowdown in Sales, Stall in Jobs

By Clara Prevo

CHART 1

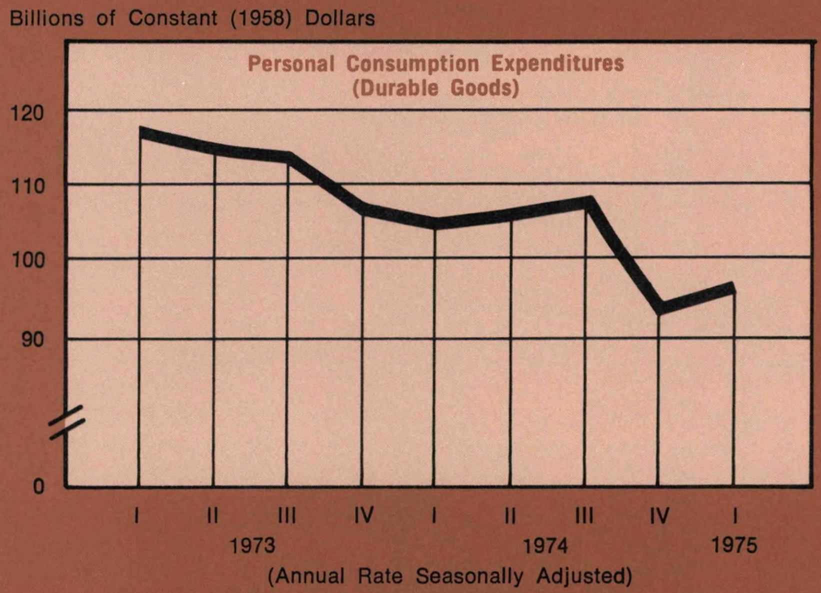
CONSUMERS HAVE RECENTLY SEEN THEIR INFLATION-ADJUSTED SPENDING POWER DROP . . .



SOURCE: U. S. Department of Commerce.

CHART 2

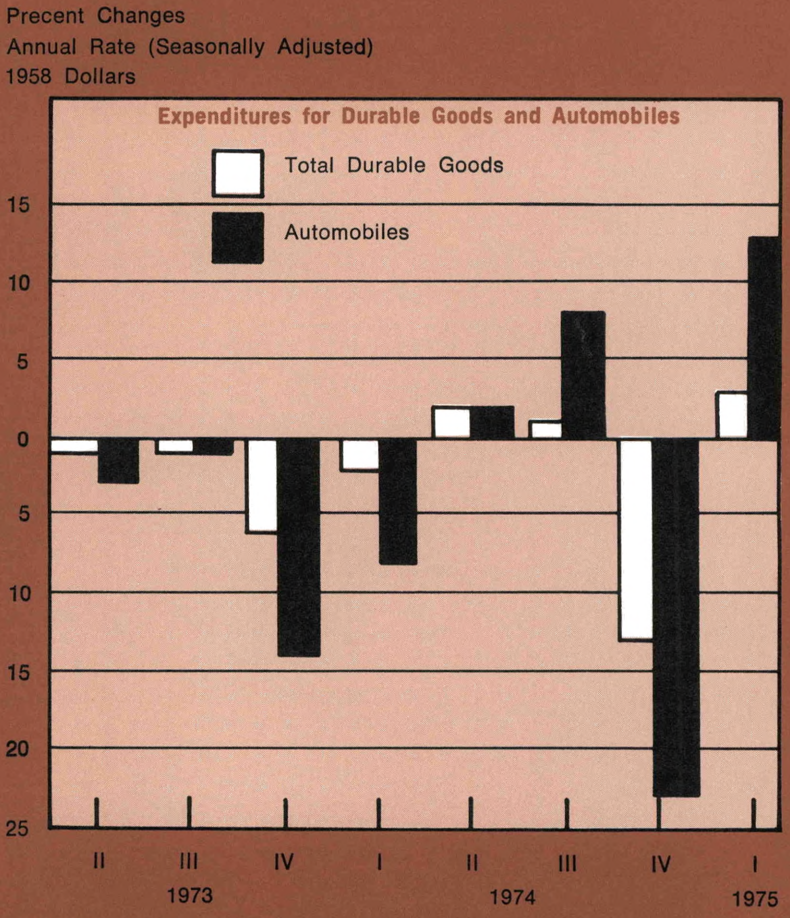
AND THEY RESPONDED IN PART BY CUTTING BACK ON THEIR PURCHASES OF DURABLES.



SOURCE: U. S. Department of Commerce.

CHART 3

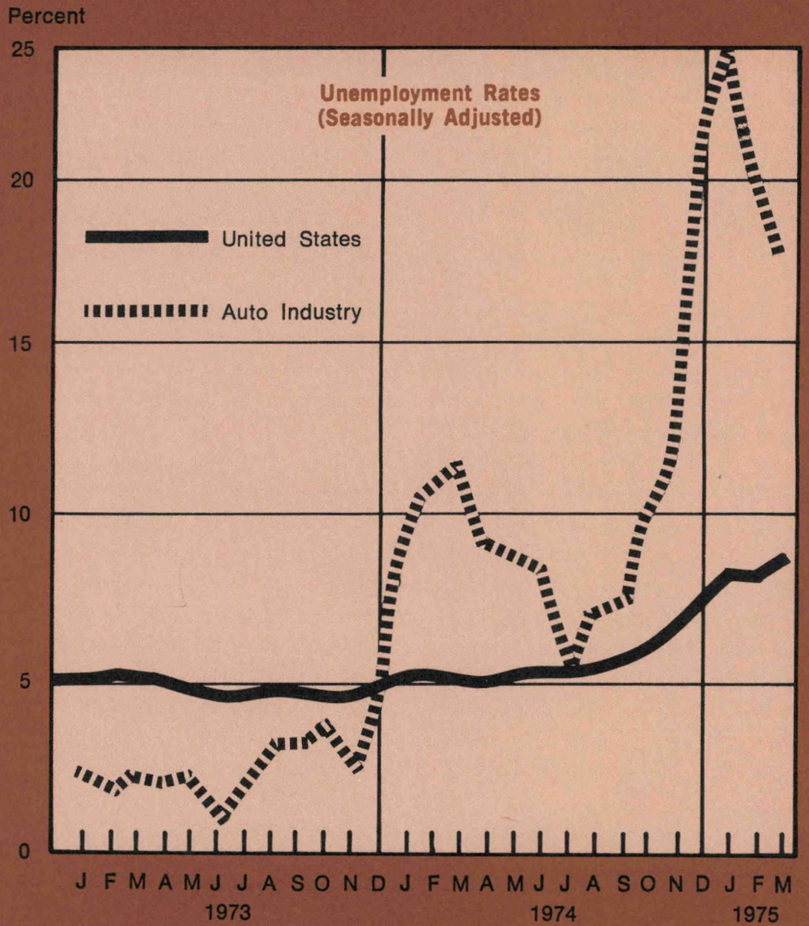
AUTOMOBILES WERE ONE OF THE BIG-TICKET ITEMS HIT HARD . . .



SOURCE: U. S. Department of Commerce.

CHART 4

WHICH HELPED PUSH THE JOBLESS RATE IN THAT INDUSTRY ABOVE THE OVERALL RATE.



SOURCE: U. S. Department of Labor, Bureau of Labor Statistics.

Forecasting the Economy with Mathematical Models: Is It Worth the Effort?

By Nariman Behravesh

The months following the Arab oil embargo of 1973–74 could well go down in history as the nadir of the art and science of economic forecasting. The embargo, oil price increases, and the ensuing recession jarred the U. S. economy, leaving economists with forecasts that were in many cases embarrassingly wrong. For example, errors associated with price level and real GNP predictions as much as tripled after mid-1973.[1] Quite a comedown for those who in earlier years had earned high marks for forecasting!

On average, forecasters who keyed their predictions only to mathematical or econometric models were proved less accurate than those who relied on pure judgment or a combination of judgment and econometrics.[2] The quality of the forecasters' judgment helped to determine the relative accuracy of economic predictions during this period. Less clear-cut, though, is the degree to which econometric models helped or hindered those who used them.

Some skepticism about econometric forecasting is clearly justified. Mathematical models are still in their formative stages. When used to forecast the economy, they tend to underestimate the peaks (high points) and troughs (low points) in business cycles and to miss the timing of these business cycle turns. Yet, most forecasters using econometric models can compensate for

[1]See Stephen K. McNees, "How Accurate Are Economic Forecasts?" *New England Economic Review* of the Federal Reserve Bank of Boston, November/December 1974, pp. 2–19.

[2]Ibid. A judgmental forecast is formulated without the help of an econometric model but depends on a variety of inputs including the forecaster's intuition, trend projections, and the use of leading indicators.

weaknesses inherent in the models. These models are invaluable for zeroing in on the effects of policy changes on the economy. Moreover, since considerable research in empirical economics is being directed at refining these models, forecasters will probably find them increasingly useful aids for prognostication.

INSIDE A PANDORA'S BOX

An econometric model used by a forecaster is a set of mathematical and statistical relationships that purports to describe economic behavior. These models are based on economic theory and, in the process of model-building, the relationships in the models are estimated and tested using the historical data (see Box).

Most econometric models used in predicting the status of the economy are quite large (40 to 400 equations). These so-called macroeconometric models are designed to predict economic variables such as the Gross National Product, the price level, the unemployment rate, and interest rates. Such variables, which are determined within the model, can be called *internal variables*. To a large extent, these internal variables may influence each other. For example, GNP is directly related to national income, which influences consumers' expenditures on goods and services, which in turn helps to determine GNP. However, these internal variables also depend on other variables such as Government expenditures, exports, tax rates, and lending rates of central banks—some of which may not be determined purely by economic forces. These variables can be called *external variables* because they are not explicitly determined by the model.[3] A forecaster intending to use a model to predict economic activity must supply the predicted values for these external variables.

[3]Determination of whether a variable is internal or external to the model depends on its builder. For example, some model builders may designate Government expenditures as an external variable since these expenditures are determined by a number of noneconomic forces that the model cannot consider. Other model builders may feel that Government spending depends primarily on economic activity and, therefore, should be included among the internal variables and described explicitly by the model. Econometric models must always have some external variables; otherwise, the forecaster faces an everything-depends-on-everything-else situation.

ANATOMY OF AN ECONOMETRIC FORECAST

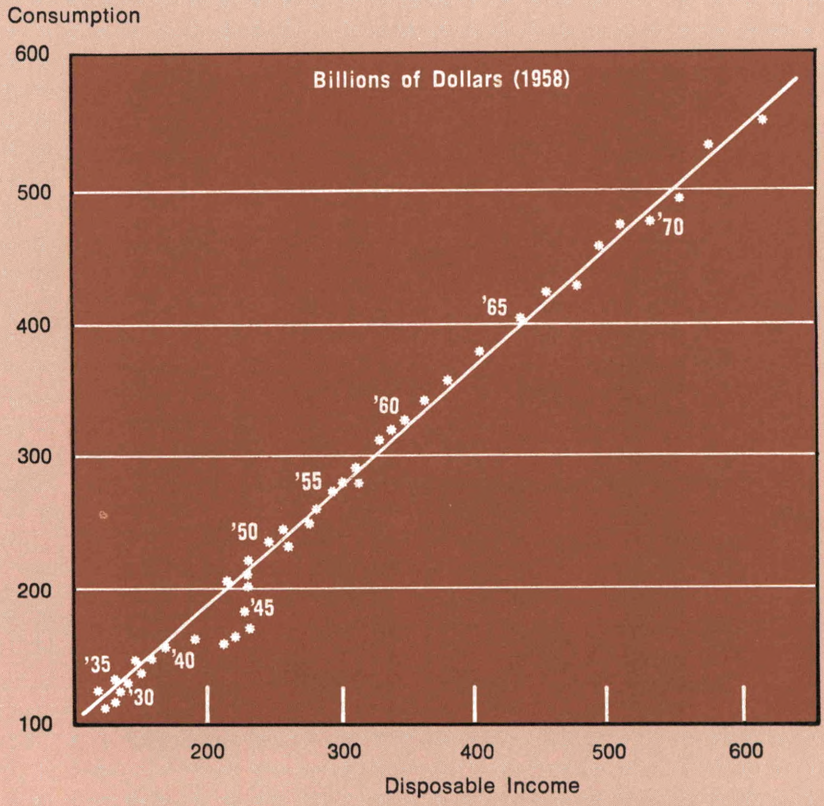
Building a Model. If we were interested in building an econometric model our immediate questions would be: What economic variables do we want to describe? What does economic theory have to say about these variables? What does the data show about these variables? Here is how these questions may be answered.

Suppose, for example, we want an overall description of consumption behavior in the U. S. economy. A review of relevant economic theories might turn up this assertion: Aggregate consumption is related to disposable or after-tax income. If the data for consumption and disposable income were graphed (see Diagram), the scatter of points would lie nearly on a straight line with a slope of about nine-tenths. Then it could be said that on average in the U. S., nine-tenths of disposable income is used for consumption expenditures.* In mathematical terms, this relationship would be:

$$\text{Consumption} = .9 \times \text{Disposable income.}$$

*The consumption relationship being described is a long-term one. The distinction between long- and short-term consumption will not be made in the interests of simplicity.

RELATIONSHIP BETWEEN CONSUMPTION AND DISPOSABLE INCOME.



Notice that this simple relationship is not an exact one. For example, in the Depression and war years, consumption was less than nine-tenths of disposable income (that is, in the Diagram, the observations for these years fall below the line). The opposite is true for the '60s. The inexactness of this simple model can be traced to factors such as changes in wealth, depressions, and wars that have not been taken into account. The model builder can rewrite the consumption equation to account for the approximate nature of the model:

$$\text{Consumption} = .9 \times \text{Disposable income} + \text{Error}$$

"Error" refers to all the factors that affect consumption which the model builder has not taken into account. By including some of these factors in the consumption equation, the size of the error can be reduced.** If this consumption model were used for forecasting,

**If more than one explanatory variable is used to describe consumption, plotting the data and fitting a line as we have done in Chart 2 would be difficult. However, there are statistical methods that can do the same thing.

the reduction of this error would be a step toward more accurate forecasts.

Another salient characteristic about the scatter of points in Chart 2 is that if consumption is below average (that is, below the line) in a particular year, then it is likely that it will be below average for a few years (the war years). The same is true when consumption is above average (the '60s). This tells us that consumption patterns vary slowly in response to changes in the economy—that is, the "error" or unexplained portion of the consumption model is not random. In fact, this error is systematic and correlated with its past and future values (econometricians refer to this type of error as serially correlated). Systematic or serially correlated errors are common in macroeconometric models and should be taken into account when these models are used for forecasting.

Forecasting with a Model. An econometric forecast is obtained by projecting the estimated model to include the year or years of interest. Suppose we were interested in predicting consumption expenditures in the United States in 1974 and 1975. If it were known that disposable income in those years was $650 billion and $750 billion (measured in 1958 dollars), respectively, then the simple model introduced above could be used to forecast consumption. This model would predict consumption in 1974 and 1975 to be $580 billion and $630 billion, respectively (also measured in 1958 dollars).

Such forecasts are approximate, since by ignoring the other factors that affect consumption in the simple model, these factors are ignored when this model is used to predict consumption. Sharp-eyed forecasters would have to decide if there were any factors that would induce more or less consumption in 1974 or 1975. For example, if it were expected that economic activity was slower than usual in these years, then consumption would also be subpar; therefore, we would want to adjust the predicted consumption levels downward. In this way we would be able to consider the "other factors" which affect consumption and which the simple model does not take into account. A more sophisticated forecaster would weigh the possibility that if consumption fell below average in any one year it may remain there in the following years (that is, economic variables may move slowly through time). To compensate, we would adjust consumption downward for a greater time. Thus, an econometric model tempered by the forecaster's judgment can yield better forecasts.

Multiequation Models. The model presented above has a number of shortcomings. From a behavioral point of view, it is a simplistic model of consumption. From a forecasting point of view, this single-equation model depends on forecasts of disposable income, which may be just as difficult to predict as consumption expenditure. Furthermore, disposable income is influenced by the level of consumption in the economy (since consumption contributes to GNP, which is directly related to disposable income). These types of problems are usually solved by adding more equations to the model.

Just as consumption forecasts required us to supply predictions of disposable income in the above model, forecasts of the internal variables of a large econometric model (such as GNP, prices, and unemployment) require predictions of the external variables (such as Government expenditures, taxes, and the money supply). Furthermore, in the same way that the consumption forecasts above could be modified to account for information not already included in the models, adjustments can be made to the forecasts of large econometric models.

THE CYCLES PRODUCED BY AN ECONOMETRIC MODEL

The value and reliability of macroeconometric models in forecasting business cycles can be studied in two ways. The first method compares the actual historical *values* of key internal variables such as real GNP with the values a forecaster would have obtained from the model. This method provides insight into the model's ability to duplicate the economic conditions which occurred, when it is supplied with the actual historical values of the external variables. The second method compares the size and duration of *fluctuations* for a predicted variable, such as real GNP, with the actual business cycle fluctuations of that variable. Such a comparison would allow the forecaster to judge the reasonableness of the business cycles produced by the model when he has to rely on forecasts of the external variables. The model under scrutiny here represents the state of econometric model-building in the late 1960s.

Chart 1 compares the actual values of real GNP from 1956 to 1965 with a historical forecast of real GNP by an econometric model.[4] The predicted values rise and fall at about the right time but don't trace out the cycles in real GNP very well. In fact, these forecast values underestimate both the peaks and the troughs in the actual series. One explanation for this difference may be that the peaks and the troughs in the actual series were caused by unanticipated occurrences that the model was not "smart" enough to capture. These unanticipated events or "shocks" may have consisted of major strikes, changes in international markets, or shifts in Government policies that were not explicitly built into the model.

The second method of analyzing the "tracking" record of an econometric model —looking at the long-run forecasts it generates—yields similar conclusions. Forecasters wishing to make long-run predictions must begin by predicting the long-run changes in the external variables.[5] As a result, these long-term forecasts are no more accurate than the predictions of the external variables supplied by the forecaster. For lack of better information, long-run forecasters usually assume that external variables will change slowly and with virtually no fluctuations. However, this implies that the long-run forecasts generated by an econometric model may also be fluctuation-free (Chart 2—dashed line). Clearly, such forecasts do not trace out anything resembling a business cycle.

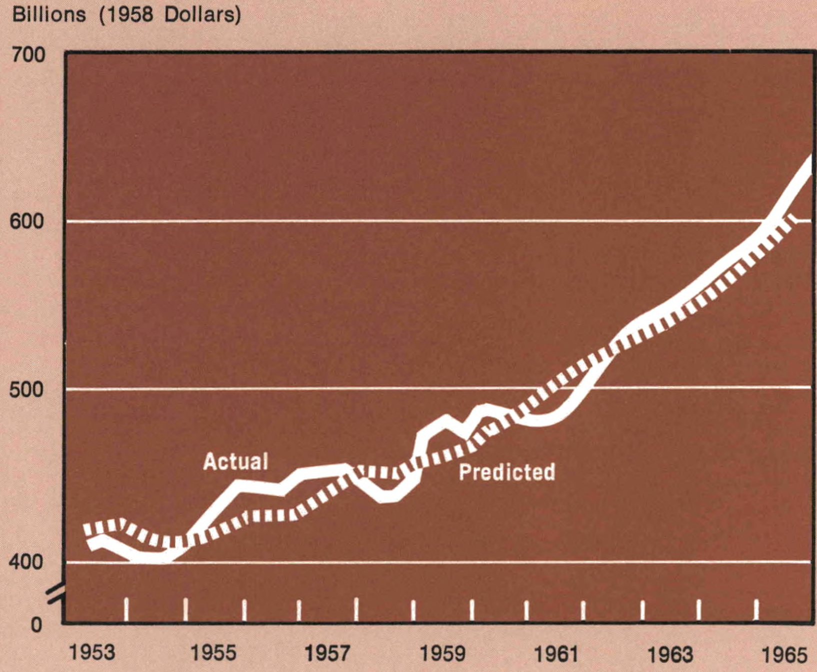
More realistic cycles can be traced by econometric models if the modeler tries to account for the occurrence and impact on the economy of events such as wars, strikes, and embargoes. One way of doing this is to impose random shocks on the models (Chart 2—dotted line). But these cycles are too frequent and short-lived compared to an actual series such as in Chart 1. These cycles are too short because the model moves the economy back to a "normal" position immediately after the shock is felt. However, in reality, the economy often takes more time to adjust to such disruptions. If the model user spreads the impact of these shocks over a number of

[4]Historical, or after-the-fact, forecasts used in the first method of analyzing the tracking record of econometric models require that the user provide values of the external variables of the models (such as Government expenditures, taxes, and exports). In these forecasts the external variables are set at their actual historical values. Data for these external variables are fed into an econometric model which then predicts the values of internal variables such as real GNP, prices, and unemployment.

[5]Unfortunately, usable forecasts of the external variables may be as difficult to get as predictions of the internal variables. Short-term forecasts of variables such as Government spending, taxes, and money supply growth may be easily obtained through Government budget estimates and other sources. However, getting accurate long-run forecasts of such external variables is a tougher undertaking. This, in turn, undermines the accuracy of all long-term forecasts, both econometric and judgmental.

CHART 1

MODELS TEND TO UNDERESTIMATE THE ACTUAL PEAKS AND TROUGHS OF A BUSINESS CYCLE.



SOURCE: B. G. Hickman, ed., *Econometric Models of Cyclical Behavior* (New York: National Bureau of Economic Research, 1972).

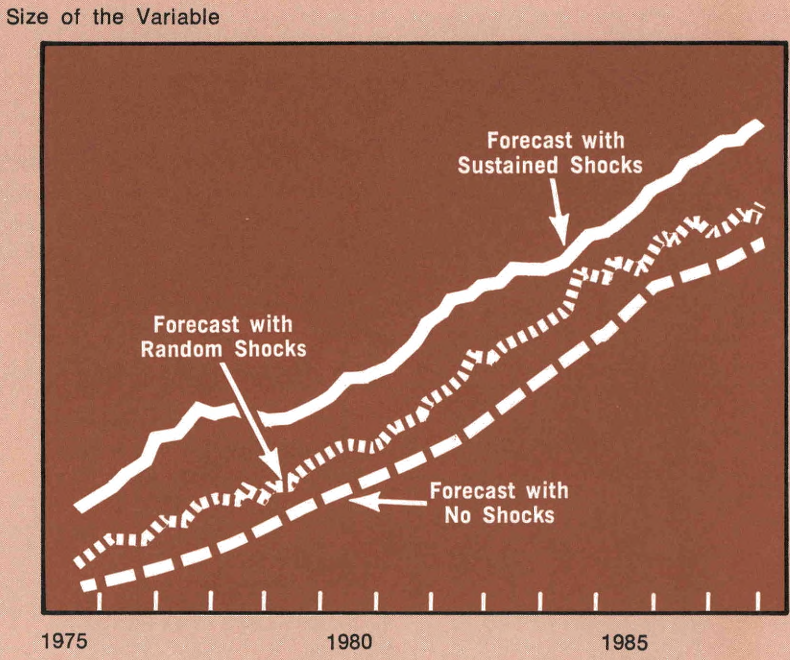
periods, the fluctuations in the predicted series are smoother and begin to resemble the actual fluctuations in the series. (Compare the solid line in Chart 2 with the actual series in Chart 1.)

Accordingly, model users must be wary of the fact that business cycles produced by econometric forecasts are less pronounced than those the economy normally experiences.[6] In part, this may be a result of the inability of the models to foresee and, therefore, cope with the impact of unanticipated events, especially those whose impacts are spread over a number of periods. Fortunately, judicious use of judgmental information can at least partially compensate for such model weaknesses.

[6]The smoothness of econometric forecasts relative to economic time series may be explained in two different ways. On the one hand, econometric models may not be good representations of economic structure and, therefore, cannot duplicate business cycle behavior. On the other hand, econometric models may be good representations of the economy if, indeed, business cycles are a result of shocks to an economy which would otherwise be stable. It can then be argued that no matter how good a model is, it will inevitably fail to predict some unanticipated shocks and, consequently, miss some business cycle fluctuations.

CHART 2

LONG-RUN FORECASTS OF REAL GNP WITH AND WITHOUT SHOCKS.



SOURCE: B. G. Hickman, ed., *Econometric Models of Cyclical Behavior* (New York: National Bureau of Economic Research, 1972).

THE TRACKING PERFORMANCE OF SOME MODELS

How accurately have forecasters relying solely on some of the major econometric models been able to spot the timing and magnitude of business cycle turns?[7] A look at the 1969 versions of three models which make quarterly forecasts provides some clues as to their ability to track past business cycles.[8] Although these models have changed significantly since 1969, the state of the art has probably not changed enough to make the types of results presented here obsolete.

[7]A turning point in the business cycle occurs when the economy shifts from a positive growth period to a negative growth period and vice versa. The former points are called peaks and the latter troughs in the reference-cycle terminology of the National Bureau of Economic Research.

[8]Victor Zarnowitz, Charlotte Boschan, and Geoffrey H. Moore, "Business Cycle Analysis of Econometric Model Simulation," in B. G. Hickman, ed., *Econometric Models of Cyclical Behavior* (New York: National Bureau of Economic Research, 1972), pp. 311–541. The models considered in this study are the Wharton Econometric Forecasting Unit model, the Office of Business Economics model, and the MIT-Penn-Fed model.

Spotting the Turning Points. Table 1 summarizes the accuracy with which these three models were able to predict the timing of turning points for six-quarter historical forecasts.[9] On average the historical forecasts spotted a turning point two-thirds of the time when the economy actually peaked or bottomed out. There did not seem to be a tendency on the part of the models to predict a turning point when one did not occur.

The models tended to predict turns too soon. This is especially true for historical forecasts that preceded the turning point by three quarters. The closer the turning point to the start of the forecast period, the better the chance of calling the turn. These results did not differ for upturns or downturns.

[9]A six-quarter historical forecast starting, for example, three quarters ahead of the turning point, would begin nine months before the quarter in which the turn occurred and would end six months after the quarter of the turn. It should be remembered that for a historical forecast the external variables are set to their actual historical values.

In order to correct such errors, it would help if the forecaster could pinpoint some of their sources. The forecasting mechanism of business cycles in many quarterly models is linked to investment and inventory cycles, both of which are leading indicators in business cycles.[10] However, investment and inventory cycles are not the only factors that account for business cycles in the economy. It is entirely possible that model builders haven't fully accounted for the complex linkages between such leading indicators and the economy. Generally, the closer the turning point, the more useful and reliable the information that signals the turn will be to the model. So, the closer the forecast is to the turning point the greater is the likelihood that the model will correctly spot the cycle peaks and troughs. In general, a

[10]Leading indicators are economic variables that will usually peak before the economy peaks and bottom out before the end of a recession. These indicators are identified and classified by the National Bureau of Economic Research.

TABLE 1

HOW THREE MODELS* SPOTTED TURNING POINTS: 1957–61**

	Too Soon	Too Late	On Time
Average of Forecasts Starting 3 Quarters Ahead of Turning Point	43%	26%	31%
Average of Forecasts Starting 2 Quarters Ahead of Turning Point	37	28	35
Average of Forecasts Starting 1 Quarter Ahead of Turning Point	28	33	39
Average of All Forecasts	36	29	35

*The three models in question are the 1969 versions of the Wharton, Bureau of Economic Analysis, and MIT-Penn-Fed models.

**Victor Zarnowitz, Charlotte Boschan, and Geoffrey H. Moore, "Business Cycle Analysis of Econometric Model Simulations," in B. G. Hickman, ed., *Econometric Models of Cyclical Behavior* (New York: National Bureau of Economic Research, 1972), pp. 311–541.

TABLE 2

HOW THREE MODELS* FARED IN PREDICTING THE SIZE OF PEAKS AND TROUGHS: 1957–61**

	Too Large	Too Small	Correct
Average of Forecasts Starting 3 Quarters Ahead of Turning Point	21%	54%	25%
Average of Forecasts Starting 2 Quarters Ahead of Turning Point	15	62	23
Average of Forecasts Starting 1 Quarter Ahead of Turning Point	15	55	30
Average of All Forecasts	17	57	26
Average of Forecasts during Contractions	14	57	29
Average of Forecasts during Expansions	21	56	23

*The three models in question are the 1969 versions of the Wharton, Bureau of Economic Analysis, and MIT-Penn-Fed models.

**Zarnowitz, Boschan, and Moore, "Business Cycle Analysis of Econometric Model Simulations," in Hickman, ed., op. cit., pp. 311–541.

modeler must assume that short-run forecasts are more accurate than longer-run ones.

Predicting the Size of Peaks and Troughs. The Achilles heel of many macroeconometric models is their proclivity to smooth out business cycles and, in so doing, undershoot the size of both peaks and troughs. The three models under consideration did, in fact, smooth over past cycles (see Table 2). These models tended to underestimate both peaks and troughs. The closer the beginning of the forecast was to the actual turn, the better the chance the models had of correctly predicting the size of a peak or trough. On average, the models were better at foretelling the depth of the slide during a recession than they were at gauging the peak to which the economy rose before experiencing a contraction.

Models undershoot the size of the peaks and troughs for several reasons. In part, this may be a result of the model's tendency to predict a turning point too soon. If the models called a peak or a trough too early, then at the peak or trough the predicted series would underestimate the actual rise or decline that occurred. Undershoots can also result because the models ignore the cumulative effect of the "other factors" that are overlooked in the model structure. Here again, the closer the starting point of the forecast to the actual turning point, the better and more plentiful the information signaling the turn, and so the more accurate the forecasts.

SHARPENING THE FORECASTS

On the whole, this evidence suggests that, without adjustments by the forecaster, the tracking record of econometric models leaves some room for improvement. There are two general ways to hone the tracking and predictive abilities of econometric models. The first is numerically adjusting an existing model prediction to correct for past misses and to impose the forecaster's judgment. The second strategy is refining and improving the model itself.

Forecasters can improve their results by anticipating and mathematically correcting the tendencies of the models to smooth out economic fluctuations. This can be accomplished by looking at past error patterns (that is, the difference between the actual and the predicted series, such as in Chart 1), and adjusting the forecast to compensate for these errors. If, for example, a model tends to understate GNP growth during expansions and to overstate GNP growth during contractions, the model user can adjust GNP growth predicted by a model upward or downward to counteract this tendency. A great deal was learned about this process and about econometric models from the larger than usual forecasting errors made in the months right after the Arab oil embargo.

Most econometric forecasters will also use their judgment to anticipate the impact on the economy of events they expect to occur. This information is then used for the necessary adjustments to the forecast. For example, during the Arab oil embargo econometric forecasters tried to estimate the effect of the boycott on production and consumption activities and to fine-tune their models correspondingly.[11] The virtue of econometric models is that these adjustments are fed through the model so that an embargo's impact on the economy can be measured. Thus, correction of past error patterns and imposition of informal judgment on econometric models should, in general, yield better forecasts.

The second method of improving econometric forecasts, which entails changing the structure of the model and updating it, could also result in improved forecasts. Econometric forecasts can be refined by trying to incorporate other types of predictive information, such as anticipatory data, into the models. For example, a recent study has shown that incorporating the plant and equipment investment anticipations of the Bureau of Economic Analysis into a model can reduce the forecasting errors of business-fixed investment.[12] To a lesser degree, incorporation of the University of Michigan's consumer sentiment index into a model will improve consumer expenditure forecasts. Including this anticipatory data also improves the ability of models to predict turning points.

Still another way of upgrading the overall performance of econometric models entails "reestimating" the models continuously by adding new observations to the data base and recalculating the equations used for prediction. Most macroeconometric models that are used commercially are reestimated every three to five years. Given their size, reestimating them more often is costly and impractical. Nevertheless, within a three- to five-year period institutional and behavioral changes in the economy could possibly invalidate part of the model. For example, the high rates of inflation in 1974 may have altered economic behavior. Econometric models which were estimated before then would have missed this change. Small macroeconometric models can be reestimated every quarter when national income data are released. However, this type of reestimation alone is not sufficient to reduce significantly the forecasting errors of the models. Upgraded econometric forecasting requires adjusting the model by employing judgment and the analysis of past errors.

Finally, some research in economics is being directed at improving the structure of the models and at using economic data more efficiently in estimating and quantifying

[11]See Donald L. Raiff, "Forecasting in a 'Shortage' Economy," Federal Reserve Bank of Philadelphia, 1974 (unpublished paper).

[12]F. Gerard Adams and Vijaya G. Duggal, "Anticipations Variables in an Econometric Model: Performance of the Anticipations Versions of Wharton Mark III," *International Economic Review* 15 (1974): 267–83.

these models. It is likely that functional relationships can be discovered and refined which will allow modelers to predict specific internal variables more precisely.

WHY USE ECONOMETRIC MODELS AT ALL?

Although econometric models, on their own, cannot track business cycles very well, they do provide an explicit and well-organized framework within which the forecaster can apply judgment to improve their predictive ability. Judgmental forecasters have some implicit model of economic behavior in mind to rely on in formulating their predictions. However, such models are rarely made public along with the judgmental forecasts. The advantage of econometric models is that one can readily pinpoint and, therefore, try to correct weaknesses in the model structure and the assumptions underlying the forecast.

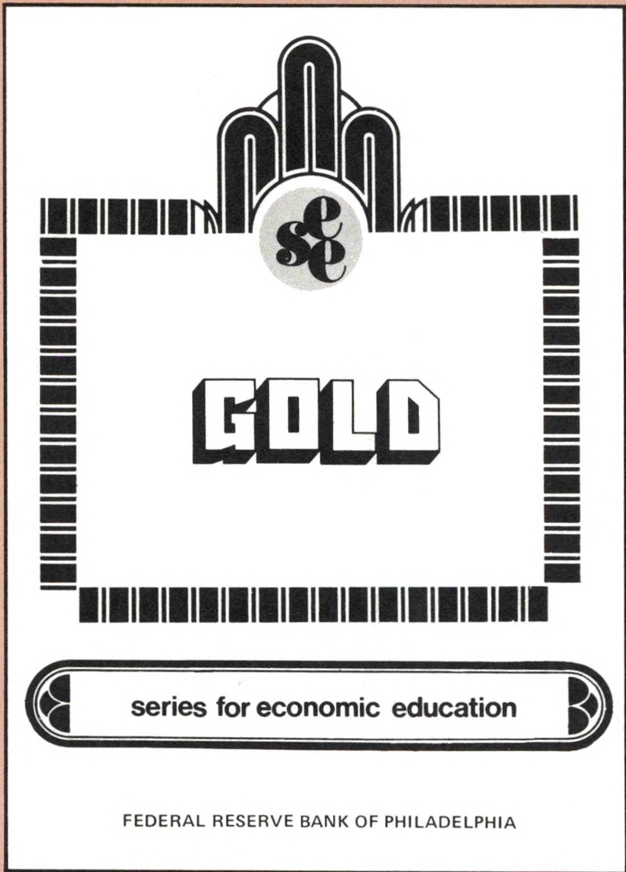
Another important advantage of econometric models is the way in which adjustments feed through the entire model to provide forecasts that are, at all times, consonant with forecasters' theories of how the economy is structured. Obtaining consistent forecasts under a variety of assumptions is more difficult for a judgmental forecaster because the relationships between economic variables in a judgmental "model" are not as clearly defined as those in an econometric model.

Econometric models also help serve up policy menus for economic policymakers. It is relatively easy for an econometric model to provide a range of forecasts made under a variety of policy assumptions. As the impact of changes in Government expenditures and the growth in the money supply are traced through the model, the policymaker can determine the effect of various policies on the economy.

Finally, once a large econometric model has been built, it can be employed for predicting a multitude of economic variables with a small expenditure of time and effort. For example, some current models regularly predict as many as 400 variables. The judgmental forecasting of the same number of variables, on a regular basis, may be very time-consuming.

CONCLUSION

Pure econometric forecasting does not provide very accurate predictions of the timing, size, and duration of business cycles. This is especially true for longer-run econometric forecasts. Nevertheless, forecasters who adjust these models to impose judgmental information and to correct model errors can substantially improve their accuracy. Furthermore, flexibility and continued improvements of econometric forecasting relative to judgmental forecasting do make the efforts channeled into econometric model-building and predicting worthwhile.



On December 31, 1974, Americans were permitted to buy and sell gold for the first time in some 40 years. Since then questions have been raised about the once-hallowed, almighty metal's worth and importance. For example, has its status in the United States and in the international monetary system changed? If so, in what manner? A pamphlet recently produced by the Philadelphia Fed's Department of Public Information considers the role of gold—past, present, future.

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