More Growth Ahead for Ninth District States

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The nonfarm economies of five states in the Ninth Federal Reserve District are likely to grow through the end of 1986, according to a set of new economic forecasting models developed at the Federal Reserve Bank of Minneapolis.[1] The models' growth forecasts are based on expected growth in the national economy and recent trends in each of the five states. The models project that in 1985 and 1986 nonfarm economic activity in two eastern district states—Minnesota and Wisconsin—will grow about as fast as activity nationally, whereas nonfarm activity in three western district states—Montana, North Dakota, and South Dakota—will grow somewhat more slowly. Like other forecasts, however, these should be used with caution. The models themselves indicate that their forecasts are subject to great uncertainty and that each state therefore faces a significant chance of growing substantially faster or slower than the rate considered most likely.

Economic Growth Likely Through 1986 in the Nation . . .

Growth in the national economy will continue in 1985 and 1986, according to a national economic forecasting model linked to our new state models.[2] National economic growth is generally measured by changes in the standard measure of U.S. output, the inflation-adjusted value of the gross national product (real GNP). The national model projects that real GNP will grow between 3.5 and 4 percent in 1985 and 1986, an increase slightly more than the post–World War II average. Most components of the economy are forecasted to share in this growth, which will be led by strength in earned personal income, business investment, and consumer spending for housing and retail merchandise. U.S. employment growth may slow from its recent rapid rate, however, while unemployment declines only slowly.

Although slightly above-average growth in the national economy is the most likely outcome in 1985 and 1986, it is clearly very uncertain. The national forecasting model estimates that, in any particular quarter of those years, growth rates three or four percentage points above or below the forecasts for real GNP should not be too surprising, based on the historical variability of the national economy. On the high side, the model says that in each quarter there is about a 1-in-7 chance that real output will grow at a rate of 6 percent or more in 1985 and 8 percent or more in 1986, and the odds that growth will

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[1]The Ninth Federal Reserve District consists of Minnesota, Montana, North Dakota, South Dakota, the northwestern counties of Wisconsin, and the Upper Peninsula of Michigan. We have modeled the entire state of Wisconsin, as well as the four states with their borders completely in the district, because data on just the Ninth District part of Wisconsin are scanty and available only with long lags. (The rest of Wisconsin is in the Seventh Federal Reserve District.) Also because of data problems, we have not yet modeled the Upper Peninsula of Michigan, but we intend to soon.

We have so far omitted the farm sector from our models of these states because farm variables are too volatile for existing statistical techniques to forecast accurately. See the appendix at the end of this paper for further discussion of this problem.

Our models forecast using a statistical procedure known as *Bayesian vector autoregression.* This procedure essentially finds the basic patterns in the historical data available for each economic indicator and systematically combines this evidence with the forecaster's beliefs about how best to forecast. For a description of this procedure, see the paper by Todd in this issue.

[2]For a description of this national model and some of its forecasts, see the outlook paper by Litterman in this issue. Some of the model's forecasts not discussed there appear in our Table 1.

exceed 8 percent in some quarter of those two years are great. On the low side, in most quarters there is also a 1-in-7 chance that real output will decline, and the odds are great that it will decline in at least one quarter of 1985 or 1986. Even the odds of a recession-like decline (of at least 1 percent) in the level of real GNP before the end of 1986 cannot be dismissed; the national model estimates them at about 1-in-6.

. . . And in Five Ninth District States . . .

The nonfarm economies of five district states are also likely to grow in 1985 and 1986, according to our models. Unlike the national forecast, the local forecasts are not focused on projections of real output; data comparable to the real GNP data are not collected for states. Instead, our state models project two of the most comprehensive available indicators of state nonfarm economic activity: nonfarm employment and earned personal income. The models for two of our five states (Minnesota and Wisconsin) also forecast a somewhat less comprehensive, but widely followed indicator: retail sales. (This measure of consumer spending is not available for the other district states.) The data on all of these variables are adjusted for seasonal movements, and the dollar-denominated variables (personal income and retail sales) are adjusted for inflation as well.[3] (See the appendix at the end of this paper for a discussion of the structure of the models.)

In each state model the projections of these indicators are based both on the national outlook and on the recent performance of the state's nonfarm economy. However, the relative emphasis placed on those two influences varies. In the process of constructing each of our five state forecasting models we examined many alternative models. Some of these models put a higher weight on developments in the national economy than on developments in the state itself, and others did the reverse. (We measure the weight in terms of the error made when a model forecasts—what percentage of the error can be traced to unexpected changes in the national or the state economy.)[4] For each state we selected the model that, among the alternatives, seemed to best forecast nonfarm economic activity in the state. The best forecasting models for our eastern states—Minnesota and Wisconsin—turned out to closely link these state economies to the national outlook, while the best models for the western states—Montana, North Dakota, and South Dakota—instead mainly emphasized recent local developments.[5] This difference seems to correspond to a difference in the 1985–86 outlook for the district states. (See Table 1.)

Minnesota and Wisconsin

Our Minnesota model forecasts that 1985–86 growth in that state's nonfarm economy will at least match the nation's growth. The model projects Minnesota's nonfarm employment to grow at least 3.5 percent in both years, which is somewhat faster than is projected for total national employment. Meanwhile, Minnesota's nonfarm earned income and retail sales are projected to grow at very nearly the same rates as their rapidly growing national counterparts.

The expected growth in the national economy explains much of our Minnesota model's forecast of relatively strong growth. When forecasting more than a year ahead, the state's best forecasting model for nonfarm employment and earned income puts a 60 percent weight on national economic variables. It is not surprising, therefore, when our Minnesota model projects that these two state variables will grow at rates roughly similar to their national counterparts.

Minnesota's own recent economic trends also contribute to the forecast of relatively strong growth, however.

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[3]On an experimental basis, our models also include total unearned personal income, which is a less direct indicator of economic activity than nonfarm employment or earned income. We do not report our models' forecasts of this variable, but may do so in the future.

The past values of personal income (earned and unearned) in our models are the seasonally adjusted data published by the U.S. Department of Commerce, but we seasonally adjust the employment and retail sales data ourselves. We are preparing detailed descriptions of the method we use (which will appear in technical appendixes to this paper and the outlook paper by Litterman in this issue, available on request to the Research Department, Federal Reserve Bank of Minneapolis).

The measure of inflation that we use to deflate forecasts of our dollar-denominated variables is the GNP deflator. It is computed by the U.S. Department of Commerce in its national income and product accounts. We chose a national inflation measure instead of a local or regional measure primarily because we view inflation as a national phenomenon. In addition, the most commonly used measure of inflation in the Ninth District, the Minneapolis–St. Paul consumer price index, is flawed by its focus on a small geographic portion of the five states we forecast and by its sensitivity to changes in the way Twin City housing prices have been measured in recent years. (For a description of that sensitivity, see Davies 1982 or FRB 1982, p. 29.) No measure of inflation is perfect for all purposes, however, and later we may experiment with other variables, perhaps including the Minneapolis–St. Paul index.

[4]Specifically, we measure the relative importance that a model gives to national versus state influences on a state's economy by decomposing the (variance of) errors in the model's forecasts of the state's economic variables into components attributable to the unforeseen changes in national and state economic variables. For a description of how to do that, see Litterman 1979.

[5]The difference in national influence that we found among these economies is presumably explained in part by their different industrial composition. For instance, the importance of the agricultural sector differs among the states, and (other things equal) a large ag sector might tend to make a state's whole economy more independent of the national economy. However, we have not yet rigorously tested such hypotheses. See the paper by Todd in this issue and the references therein for a description of the procedures used to select the forecasting models.

Over the four most recent quarters for which data were available when the forecasts were made, retail sales and nonfarm employment and earned income grew between one and one and a half percentage points faster in Minnesota than in the United States. (See Table 1.) This strong local economic performance helped keep our Minnesota model's growth forecast at or above the national model's.

Table 1

Economic Growth in the Nation and the Ninth District in 1984–86

Annual Growth Rates*

	Actual	Forecast		
Indicator	In the Four Most Recent Quarters**	In the Remainder of 1984**	In 1985	In 1986
Nonfarm Employment				
United States	4.6%	3.8%	2.5%	2.9%
Minnesota	6.1	4.3	3.7	3.5
Wisconsin	3.8	2.8	2.3	2.6
Montana	1.6	.8	1.3	1.7
North Dakota	.2	1.3	1.8	2.5
South Dakota	1.2	1.0	1.3	1.4
Nonfarm Earned Income				
United States	6.1%	6.3%	5.9%	5.9%
Minnesota	7.7	5.4	6.2	5.8
Wisconsin	5.9	3.6	4.7	4.7
Montana	1.0	.8	2.6	2.7
North Dakota	3.4	1.3	3.1	3.5
South Dakota	7.5	2.3	3.7	3.5
Retail Sales				
United States	8.5%	2.9%	9.8%	9.1%
Minnesota	9.5	10.0	9.7	8.9
Wisconsin	4.6	10.6	5.5	9.1

*The growth rate in each period is the annualized percentage change from the level at the end of the previous period to the level at the end of the period indicated.

**The four most recent quarters with data available as of November 21, 1984, vary. They end in the second quarter of 1984 for earned income and in the third quarter of 1984 for employment. Partial third quarter data (for July and August) were available for retail sales. That data and our estimates for September were used as the most recent quarterly data for retail sales.

Sources: Basic data—U.S. Departments of Labor and Commerce
U.S. forecasts—Employment and retail sales, model used by Litterman in the national outlook paper in this issue, earned income, Litterman model and our U.S. model (see the technical appendix to this paper, available on request to the Research Department, Federal Reserve Bank of Minneapolis)

It is especially influential in the forecast of retail sales, the Minnesota variable that our model says is least affected, directly or indirectly, by national variables. (The model puts about a 90 percent weight on Minnesota variables when forecasting state retail sales one or two years ahead.)

Wisconsin's nonfarm economy is predicted by our models to be the second fastest growing among our five. The Wisconsin model predicts that nonfarm employment and earned income there will grow about 2.5 and 4.5 percent, respectively, in both 1985 and 1986. Growth in Wisconsin retail sales is projected to accelerate between the two years, from about 5.5 percent in 1985 to about 9 percent in 1986. Although most of these Wisconsin figures are a bit below the corresponding figures in our national forecast, they are generally not far below, and they still imply fairly strong growth for the state's nonfarm economy.

Most of Wisconsin's projected strength comes from the forecast of strong national economic growth. This is mainly because the best forecasting model for Wisconsin places even greater weight on national developments than the best Minnesota model does—over 95 percent for Wisconsin nonfarm employment and earned income and over 65 percent for the state's retail sales when forecasting a year or more ahead. Wisconsin's economic growth is projected to be slightly slower than Minnesota's partly because Wisconsin's nonfarm economy has not been quite as strong lately as the nation's or Minnesota's.

Montana and the Dakotas

The growth forecasts for Montana, North Dakota, and South Dakota are all somewhat alike and somewhat weaker than those for Minnesota and Wisconsin. In both 1985 and 1986, nonfarm employment in the western states is predicted to grow roughly between 1.5 and 2.5 percent while nonfarm earned income grows between 2.5 and 3.5 percent. Unlike the projected growth rates for the eastern states, all of these rates are below, some well below, the projected rates for the corresponding national variables.

The forecasts for Montana, North Dakota, and South Dakota reflect the relatively weak links between these states' models and the national economy: the models that seem to give the best forecasts for these states place less than a 25 percent weight on national variables when forecasting one or two years ahead. The somewhat slower growth predicted for the states is thus related to the recent slow growth of their economic indicators. The growth rates of nonfarm employment have been especially slow, with Montana's modest 1.6 percent increase in the four quarters ending in September 1984 the fastest among them. One notable exception to the recent weakness in these states is the rapid 7.5 percent growth in South Dakota's nonfarm earned income between mid-1983 and mid-1984.

. . . But Surprises May Be In Store

Like national economic forecasts, state economic forecasts are subject to great uncertainty. In fact, the uncertainty in state economic forecasts is often greater because in national forecasts the uncertainties in all the states' futures tend to average out. This makes objective quantification of uncertainty particularly important for state forecasts. We have tried to provide this quantification in two ways.

One is a fairly general measure: the typical size of the errors that our modeling procedure would have led to had it been used to forecast over the last 20 years. We calculated these errors as part of the process of constructing our models and compared them to the errors of some simple benchmark models of a type which often forecasts fairly well.[6] (See Table 2.)

The results suggest that decision makers not rely solely on our new models' most likely forecasts. Although our models would have been significantly more accurate than the benchmark models at forecasting most of our variables two years ahead, they still would have commonly missed nonfarm employment by about 4 percent, nonfarm earned income by about 5 percent, and retail sales by as much as 11 percent. Even the smallest of those typical errors could make a big difference to private and public sector decision makers—and could easily overturn the latest predictions of the relative rates of growth among our five states.

The other quantification of the uncertainty in our models' forecasts is more specific: it is a measure of the

6 We computed the benchmark forecast errors from out-of-sample forecasts of unrestricted univariate autoregressions. (See Litterman 1980.) So far, these are the only available standard of comparison for our models' forecasts; we know of no other series of forecasts of our state variables that is as long and has been produced by a consistent, well-documented technique. We could have used more sophisticated techniques to generate alternative benchmarks, but we chose not to because univariate autoregressions can be computed quickly and cheaply and often forecast about as well as the more sophisticated techniques.

Table 2

Typical Size of Errors in Forecasting Two Years Ahead

For Two Types of Ninth District State Models
Average Difference Between Forecast and Actual as a Percentage of Actual*

State	Nonfarm Employment		Nonfarm Earned Income		Retail Sales	
	Best Benchmark Model**	Our Model	Best Benchmark Model**	Our Model	Best Benchmark Model**	Our Model
Minnesota	5.8%	4.5%	6.0%	4.5%	11.6%	11.1%
Wisconsin	5.2	4.2	6.6	5.3	14.8	10.6
Montana	5.5	4.0	7.6	5.5	n.a.	n.a.
North Dakota	4.3	4.3	6.8	5.4	n.a.	n.a.
South Dakota	4.6	4.3	7.6	5.7	n.a.	n.a.

n.a. = not available

*Standard error of eight-quarter-ahead out-of-sample forecasts (made using data up to each quarter between the second quarter of 1964 and the first quarter of 1984)

**The benchmark models are univariate autoregression models. The number of lags in the best benchmark model varies: one for Wisconsin, Montana, and North Dakota; two for South Dakota; and three for Minnesota.

odds of significantly faster or slower growth in 1985 and 1986 than the models have just predicted. In order to calculate this measure, we first had our models compute not only each state's most likely future but also 1,000 alternative futures that random events of the kind the state has experienced would bring about.[7] We then estimated how likely any particular growth rates were by analyzing how often they appeared in these alternative futures.

A standard way to summarize the analysis of the alternative futures is to compute what is known as a *70 percent confidence band* around the most likely forecasted values of each variable. Here this band represents the range in which values of the variable fell in 70 percent of the alternative futures we computed. The band thus can be viewed as defining a range just broad enough to include the future values of the variable 70 percent of the time. Since the band width corresponds to a range of values around a forecast, the relative widths of bands show the relative uncertainty about forecasts: a narrow band (or a small range) represents less uncertainty and a wide band (or a large range) represents more. The area outside the band is, of course, significant too. It represents the values that the variable can be expected to take on 30 percent of the time—15 percent on the high side (above the band) and 15 percent on the low. In probability terms, this 15 percent can also be expressed as about a 1-in-7 chance.

In Charts 1–5 we display our models' confidence bands for the states' nonfarm employment forecasts.[8] They suggest that in each quarter of 1985 and 1986 nonfarm economic growth much stronger or weaker than that forecasted above is quite possible.[9]

This is particularly true for Montana, North Dakota, and South Dakota, the three states among our five with the slowest projected growth. These states have relatively wide confidence bands, implying greater uncertainty about their forecasts. For Montana and North Dakota, this means that, in most quarters of 1985 and 1986, there is about a 1-in-7 chance that nonfarm employment could grow more than 4.5 percent, significantly more than projected for either state or even the nation and Minnesota. At the opposite extreme, the bands suggest a similar chance that nonfarm employment could fall more than 2 percent in Montana or about 0.5 percent in North Dakota. Similar chances also exist in South Dakota for a rise as great as 3.5 percent or a decline of about 1 percent.

The 1,000 alternative futures that produced the confidence bands can also be used to estimate the likelihood of specific types of movements in the variables. We can, for example, estimate the chances that a variable will decline in one quarter or in two or more consecutive quarters by simply counting the occurrences of such events in the 1,000 forecasts and converting them to percentages. Using that method, our Montana, North Dakota, and South Dakota models rate as very likely—with probabilities near or above 90 percent—the chances that nonfarm employment will decline in at least one quarter before the end of 1986. Even the chances of two or more consecutive quarters of declining nonfarm employment seem to be significant in these states—at least 33 percent in North Dakota, 45 percent in South Dakota, and 50 percent in Montana.

For Minnesota and Wisconsin, which our models forecast to grow more rapidly, the chances of employment declines seem much lower. Our models suggest less than a 1 percent chance of two consecutive quarters of declining nonfarm employment in these states and small chances—4 percent in Minnesota and 10 percent in Wisconsin—that nonfarm employment will decline even in one quarter before the end of 1986. These much lower probabilities of declining nonfarm employment partly reflect the models' forecasts of stronger growth in these states, which raises the center of the confidence bands. In addition, they reflect the states' much narrower confidence bands for nonfarm employment growth, which indicates much less uncertainty about the initial forecasts.[10]

Uncertainty includes the possibility of significantly stronger-than-expected growth in Minnesota and Wisconsin too. For example, from the position of the confidence bands we can see that in most quarters of 1985 and 1986 the odds are about 1-in-7 that growth in

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[7]For a description of the simulation technique used, see the technical appendix to the outlook paper by Litterman in this issue, available on request to the Research Department, Federal Reserve Bank of Minneapolis. The technique omits some sources of randomness and so probably underestimates the true uncertainties in forecasting our state variables.

[8]Because of time and space limitations, we present confidence bands for only nonfarm employment, one of our two best state economic indicators. Earned income is the other; the confidence bands for it would tell a similar story.

[9]The possibility of much stronger or weaker results is normal in economic forecasting; all economic forecasts are imprecise and subject to uncertainty. An advantage of our Bayesian vector autoregression modeling procedure is that it permits us to objectively estimate the uncertainty. See the paper by Todd in this issue for further discussion of this point.

[10]The fact that the confidence bands for Minnesota and Wisconsin are narrower seems to conflict with the evidence in Table 2 that nonfarm employment in these states is not typically easier to predict. We have not yet resolved this conflict, but we suspect that the underestimation in our confidence band procedure (noted in footnote 7) is more severe for these states.

Charts 1–5

Uncertainty in the Forecasts of Ninth District Economic Growth

Annualized Quarterly Growth in Nonfarm Employment

1983–3rd Quarter 1984, Actual; 4th Quarter 1984–1986,
Forecast With 70 Percent Confidence Bands*

Chart 1 **Minnesota**

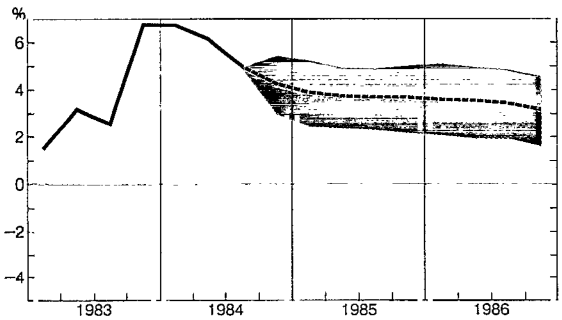


Chart 2 **Wisconsin**

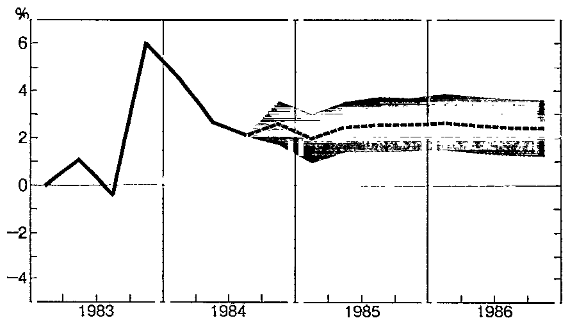


Chart 3 **Montana**

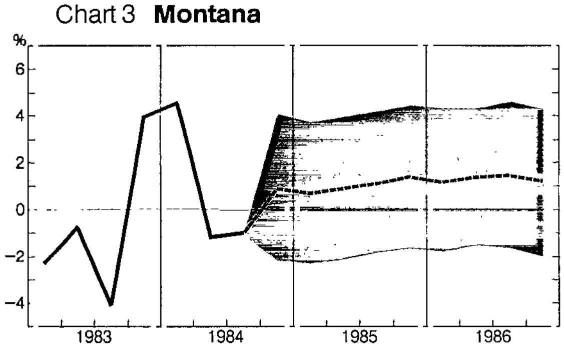


Chart 4 **North Dakota**

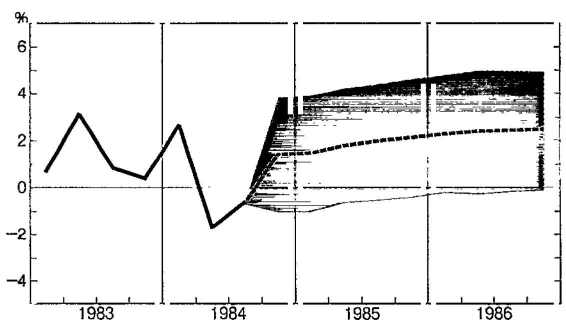
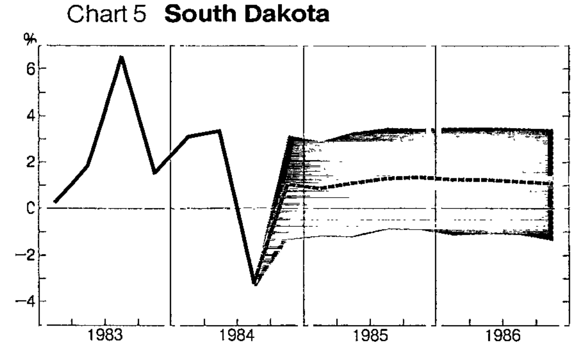


Chart 5 **South Dakota**



*Forecast of most likely growth, surrounded by a range within which the variable is likely to fall 70 percent of the time, based on 1,000 projections using alternative random errors

Source of basic data: U.S. Department of Labor nonfarm employment in Minnesota or Wisconsin will exceed a brisk 5 percent or 3.5 percent, respectively.

Summary

Five new forecasting models project continued growth for the nonfarm sectors of Minnesota, Montana, North Dakota, South Dakota, and Wisconsin in 1985 and 1986. Growth in Minnesota and Wisconsin is projected to be particularly strong, because our models more closely link those states to the national economy, which is also expected to grow well. However, great uncertainty surrounds all of these forecasts, and each of the state nonfarm economies could easily grow faster or slower than predicted.[11]

[11]We plan to maintain and improve the five new forecasting models and to regularly publish both forecasts of likely growth and measures of uncertainty for these five states (and soon the Upper Peninsula of Michigan as well). See the notice to readers, elsewhere in this issue, which describes our forthcoming quarterly publication.

Appendix
The Five New State Forecasting Models

The forecasts and measures of uncertainty discussed in the preceding paper come from new models built to predict nonfarm economic activity in five states of the Ninth Federal Reserve District: Minnesota, Montana, North Dakota, South Dakota, and Wisconsin. Each of these models includes only a few state variables likely to capture changes in general economic activity. Each state model is directly linked to a small U.S. model, which either forecasts the national variables needed in the state models or indirectly links the state models to other national models or forecasts. The state and U.S. models are all estimated using Bayesian vector autoregression procedures (described in the paper by Todd in this issue and in the references therein).

The Variables Included . . .

Though currently small and highly aggregative, our state models include some of the most comprehensive indicators of state economic activity available. Each state model includes data on nonfarm employment and two components of personal income. Where available, state data on consumer spending are also included.[1]

Monthly figures on state nonfarm payroll *employment* as far back as 1939 are available from the U.S. Department of Labor's Bureau of Labor Statistics. These figures are collected by surveying a sample of employers about all of the full- and part-time workers on their payrolls during the month.[2] This cross-industry survey of a state's labor input thus produces a fairly comprehensive indicator of state economic output. Currently our models forecast just total nonfarm payroll employment, seasonally adjusted. (For a description of our seasonal adjustment procedure, see the technical appendixes to the preceding paper and the outlook paper by Litterman in this issue, available on request to the Research Department, Federal Reserve Bank of Minneapolis.) Later we may be able to add forecasts of some of this total's major components, such as employment in the large manufacturing, services, or trade industries.

Other variables in our models are even more comprehensive than the employment variables. Quarterly, seasonally adjusted

[1]The data actually enter the models in logarithmic form. The transformation to logs, which converts multiplicative relationships to additive ones, is common in linear economic models. (Our models are linear.)

[2]For an explanation of the procedures used to collect this data, see the explanatory notes in any issue of *Employment and Earnings,* a monthly publication of the U.S. Department of Labor.

estimates of two components of state personal income back to 1958 are available from the U.S. Department of Commerce. The *earned income* component includes the wages and salaries of payroll employees, who are counted in our employment figures, plus the earnings of proprietors, who are not. The *unearned income* component includes other nonemployment income, such as income from transfer payments and ownership (dividends, interest, and rent). Furthermore, for the wage and salary workers covered by the employment figures, the personal income figures go beyond counting the number of individuals employed to measuring the value of their labor (to the extent this is reflected in their wage or salary).

Although more comprehensive, the two components of personal income for any state are not quite comparable: unearned income is measured for all state residents while earned income is measured for all state workers. For example, the earned income of a person who lives in western Wisconsin but is employed in Minnesota is counted as part of Minnesota's earned income, while the interest that the same person earns on a savings account is counted as part of Wisconsin's unearned income. This means that the sum of the two components for any state is not necessarily a meaningful estimate of total personal income there.

Partly for this reason and partly because the two types of income reflect different aspects of economic performance, we have kept the earned and unearned state personal income variables separated in our models. (And until we have more experience with these data, we will mainly report the forecasts of the larger, more widely followed earned income component.) We have also subtracted the farm component from earned income (see below), so the two measures of personal income in each state model are nonfarm earned income (by place of work) and total unearned income (by place of residence).

The models for two district states—Minnesota and Wisconsin—include an additional variable. Monthly *retail sales* estimates back to 1962 are available for these two states from the U.S. Department of Commerce. We have seasonally adjusted these data series and extended them back to 1958,[3] to match the starting date of the state personal income data. The Minnesota and Wisconsin retail sales variables are the most volatile and hard-to-predict variables in our models. We include them because they are likely to reflect some aspects of economic performance—consumption and perhaps consumer expectations and financial conditions—better than our other variables.

. . . And Excluded

Ideally models of Ninth District state economies would directly incorporate the farm sector.[4] That is because farming, which accounts for only about 2 percent of the income earned in the whole U.S. economy, is significantly more important in the economies of our five states. On average, it accounts for about 5 percent of Minnesota's and Wisconsin's earned income, between 5 and 10 percent of Montana's, and more than 10 percent of North Dakota's and South Dakota's. For now, at least, this ideal seems too difficult to achieve. The main reason is the great volatility and unpredictability of the farm sector.

Farm sector personal income is by far the most volatile component of total personal income in both Minnesota and the nation (Litterman and Todd 1982).[5] This is true in the other district states as well. In North Dakota and South Dakota, for example, the farm sector's share of personal income has bounced between 4 and 40 percent in just a few years.

The farm sector is not only volatile; it also seems to be relatively hard to predict.[6] This conclusion is supported by simple statistical models—called *univariate autoregressions*—that attempt to forecast a variable's future evolution from just the variable's own current trajectory and historical pattern of evolution. For many economic variables, this type of model forecasts about as well as any others,[7] so their forecasting errors can be used as a simple benchmark of predictability. We built a univariate autoregression model for each of the variables in our state models and for personal income from farming in each of our five states. Even when forecasting as far into the future as two years, these simple models predict most of our variables with errors that average about 10 percent or less. For personal income from farming, however, their errors average over 10 percent when forecasting just one quarter ahead and well over 50 percent when forecasting two years ahead. Some of the models' one-quarter-ahead errors actually approach 200 percent.

Rather than obscuring what our state models can forecast reasonably well—the nonfarm sector—by adding a component that they can't—the farm sector—we have decided to analyze the two sectors separately. For now, our models will concentrate on the larger nonfarm sector. Later, if their ability to forecast the farm sector improves, the models may be expanded to also include state farm sector variables.

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[3]We have done this in three steps. First we seasonally adjusted the available state retail sales data (for 1962–84). Then we estimated (by linear regression) the relationships between these data and both the seasonally adjusted state employment and personal income data and the seasonally adjusted national retail sales data. Finally, we used those relationships and the values of these related variables in 1958–62 to estimate seasonally adjusted monthly retail sales for that period. For a more detailed explanation of the procedure, see the technical appendix to the preceding paper, available on request to the Research Department, Federal Reserve Bank of Minneapolis.

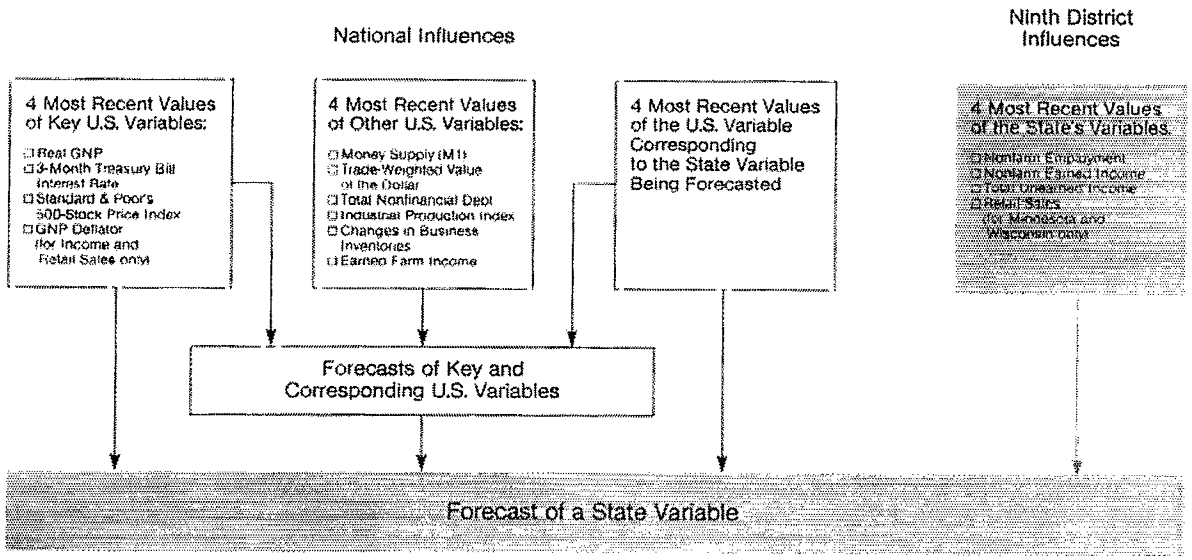
[4]By *farm sector,* we mean just production agriculture. Our models' nonfarm variables do include related off-farm agribusiness activities, such as income earned or employment in industries that sell goods and services to farmers or buy products from farmers.

[5]This was shown to be true at least among major industry groups (aggregated at the two-digit Standard Industrial Classification level).

[6]Note that volatility and unpredictability are not necessarily the same thing. Water levels in the Bay of Fundy, for example, fluctuate greatly, but in a fairly predictable way, with the tides.

[7]Hoehn, Gruben, and Fomby (1984) present some supporting evidence for state economic variables.

A Look Behind Our Models' Forecast of a State Economic Variable



Note: This chart gives the basic design of our forecasting equations. For the exact specifications, see the technical appendix to the preceding paper, available on request to the Research Department, Federal Reserve Bank of Minneapolis.

The Links to the Nation

Economic activity in every state is affected to some degree by economic activity in the nation as a whole. Inflation, for example, ignores state borders; it reduces the value of the dollar everywhere in the United States. In Ninth District states, the demand for and supply of many of the goods and services bought and sold are mainly determined outside the state in the rest of the U.S. economy. Therefore, economic activity in these states sometimes follows national economic activity quite closely. This is often true in Minnesota (Litterman and Todd 1982) and perhaps in Wisconsin (judging from some preliminary estimates of the type reported for Minnesota by Litterman and Todd). Even in Montana, North Dakota, and South Dakota, where national influences are more easily obscured by the larger, volatile farm sectors, data suggest that national influences on the nonfarm sectors are probably important.

Because of the national influences on state economies, we have built and linked to each of our state models a 14-variable quarterly national forecasting model. We can also use this national model to indirectly link the state models to other national models or forecasts by setting our national model to reproduce their results. We did this, for example, in the analysis reported in the paper above. The state economic projections discussed there were generated partly by setting our national quarterly model to follow the forecasts from a more sophisticated national model (described in the outlook paper by Litterman in this issue).[8]

To try to capture national economic influences on district states, we have included up to five variables from our national model in each equation of our state forecasting models. (See the accompanying chart.) Each state equation thus includes not only the four most recent quarterly values of the state's variables. It also includes the four most recent quarterly values of the real gross national product (GNP), the interest rate on three-month Treasury bills, Standard and Poor's 500-stock price index, and the national counterpart to the state variable that the equation is forecasting (U.S. employment in the state employment equation, for example). The equation of each dollar-denominated state variable (personal income and retail sales) includes as well the four most recent values of the GNP price deflator. Including four values of this deflator allows for lags in the transmission of inflation from the nation to the district states and picks up any significant effects of inflation on real state economic activity.

The forecasts of all these national variables contribute to the states' forecasts too. In fact, the national model must forecast its variables before the state models can forecast theirs. Since the

[8]The measures of uncertainty around those projections, however, were derived from just our simpler national model.

national variables affect the forecasts of the state variables but not vice versa, economists would say that the national variables are *exogenous* in our state variable equations (or are determined externally) while the state variables are *endogenous* (or determined internally).

Although exogenous in our state models, the variables that link our state forecasts to the national economy are endogenous in our national model. That model is self-contained; it has only endogenous variables and can produce national forecasts automatically, with no need for estimates of unexplained exogenous factors.

It does contain more variables than those listed above, however. The extra variables in the national model were selected from the variables found to be most useful in forecasting the national economy in a monthly model maintained at the Federal Reserve Bank of Minneapolis (used in the outlook paper by Litterman in this issue). Some of the extra variables are from the financial sector (the money supply, as measured by M1; the trade-weighted value of the dollar; and total nonfinancial debt). Some are from the real sector (industrial production and changes in business inventories).

As is clear in the chart, these extra national variables do not directly affect our forecasts of district state variables, but they do have an indirect effect. They help forecast the national variables that do directly affect the state forecasts.

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