The Philadelphia Story: A New Forecasting Model For the Region

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Forecasts of the national economy have long been a staple of the planning and budgeting process for large corporations and the federal government. But for small firms and state and local governments, a forecast of the regional economy may be more important to their planning process. This demand for regional forecasts challenges the professional forecaster to develop models that produce accurate predictions of the major economic variables for states and metropolitan areas. Several years ago, the Philadelphia Fed developed a small forecasting model for each of the three states in the Third Federal Reserve District — Pennsylvania, New Jersey, and Delaware.[1] This article introduces a similar model that forecasts major economic variables for the Philadelphia metropolitan area and the city of Philadelphia.

For the metro area as a whole, the model suggests continued job growth through mid-year

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[1]Theodore M. Crone, "A Slow Recovery in the Third District," Federal Reserve Bank of Philadelphia, Business Review (July / August 1992).

2000. For the city of Philadelphia, the outlook is not so bright. The model predicts that the city will lose a significant number of jobs between the second quarter of 1999 and the second quarter of 2000.

GOOD REASONS TO FORECAST THE PHILADELPHIA ECONOMY

The Philadelphia metropolitan area is a natural choice as a region for developing an economic forecast. It is one of the nation's largest metro areas, and it has a diverse economy. Moreover, the area's business cycle is similar, though not identical, to the national cycle.

Metropolitan areas in general represent logical geographic divisions for forecasting economic activity because "the general concept adopted for the determination of a standard metropolitan area was that each area should represent an integrated economic unit with a large volume of daily travel and communication between a central city and the outlying parts of the area."[2] The Philadelphia metropolitan area is the fourth largest in the United States and still conforms to the classic description of a metropolitan area — an integrated economy with a densely populated central city to which a large number of workers commute from surrounding suburbs. In 1990, almost a quarter of a million people commuted to the city of Philadelphia to work — about one-third of the wage and salaried workers in the city. The Philadelphia metro area has a population of almost 5 million and supplies more than 2.25 million nonfarm jobs, slightly less than 2 percent of the national totals in both cases. The area has more people and jobs than 30 states, and the city of Philadelphia alone has a larger population and more jobs than 12 states. The Philadelphia metro area contains more than 40 percent of the population in the Third Federal Reserve District and about 50 percent of the jobs.

The Philadelphia economy is not only large, it's also diverse. We would expect the distribution of jobs in few, if any, metropolitan areas to exactly mirror the distribution in the nation as a whole, but the distribution in Philadelphia comes close. Jobs in the Philadelphia area are somewhat more concentrated in financial and nonfinancial services than in the nation as a whole, and the other major job categories (construction, manufacturing, transportation and utilities, trade, and government) are somewhat underrepresented in the Philadelphia economy.[3] Despite these differences, the distribution of jobs in the Philadelphia area mirrors the national distribution fairly closely when compared to the other nine largest metropolitan areas in the country. (See Measuring the Relative Importance of Industries Across Metropolitan Areas.)

Even though the structure of the Philadelphia economy has closely resembled the national economy in recent decades, significant shifts have occurred in the last 30 years. Prior to the 1980s, the Philadelphia area had a larger proportion of its jobs in the manufacturing sector than the nation. But Philadelphia has been losing manufacturing jobs at a much faster pace than the nation, so the region's economy is now less manufacturing oriented than the U.S.

[2] U.S. Bureau of the Census, County and City Data Book, 1949. Washington, DC: U.S. Government Printing Office, p. iv. The Philadelphia metropolitan area includes five counties in Pennsylvania (Philadelphia, Bucks, Chester, Delaware, and Montgomery) and four counties in New Jersey (Burlington, Camden, Gloucester, and Salem).

[3] The Philadelphia area has about 6.8 percent more of its jobs in nonfinancial services and about 1.1 percent more in financial services than the nation. The area has an especially high concentration of jobs in the insurance industry, legal services, health services, social services, and private education. The underrepresentation in Philadelphia ranges from 0.5 percent for transportation and public utilities to 3.1 percent for government (federal, state, and local).

Measuring the Relative Importance Of Industries Across Metropolitan Areas

One measure of a metro area's relative specialization in a given industry is the "location quotient." This quotient is calculated as the proportion of an area's employment (or output) in a given industry divided by the proportion of the nation's employment (or output) in that industry. A location quotient equal to one indicates that the industry in question is neither over- nor underrepresented in the region relative to the nation. Industries with location quotients greater than one have relatively more importance in the region than in the nation. The reverse is true for industries with location quotients less than one. The table presents location quotients for the major industry divisions in the 10 largest metropolitan areas. Since output measures are not available at the metropolitan level, these location quotients are based on nonfarm employment.

Philadelphia's location quotients range from 0.75 for construction and mining to 1.23 for nonfinancial business and personal services.* This means that the proportion of jobs in construction and mining in the Philadelphia metro area is 25 percent less than the proportion nationwide. Similarly, the proportion of jobs in nonfinancial services in Philadelphia is 23 percent higher than the proportion in the United States. Three of the other top 10 metro areas (Los Angeles, New York, and Boston) have a lower percentage of their jobs in construction and mining than does Philadelphia. And New York, Washington, and Boston have a higher percentage of jobs in nonfinancial services than Philadelphia. Every one of the other nine metro areas in the table except Chicago has at least one location quotient that is lower than Philadelphia's lowest, and every one has at least one location quotient that is higher than Philadelphia's highest. For each of the major industry divisions, Philadelphia's location quotient ranks between fourth and seventh among the top 10 metropolitan areas. None of Philadelphia's location quotients are at the extremes among the nation's largest metro areas.

TABLE

Location Quotients for Major Industries in the 10 Largest Metropolitan Areas

Metro Area	Construction and Mining*	Manufacturing	Transportation and Public Utilities	Trade	Finance, Insurance and Real Estate	Nonfinancial Services	Government
Los Angeles	0.59	1.14	1.09	0.95	0.98	1.10	0.87
New York	0.61	0.52	1.11	0.75	2.19	1.25	1.00
Chicago	0.77	1.07	1.19	0.96	1.31	1.07	0.76
Philadelphia	0.75	0.89	0.91	0.94	1.20	1.23	0.80
Washington	1.00	0.27	0.89	0.80	0.94	1.32	1.45
Detroit	0.77	1.39	0.87	1.01	0.92	1.04	0.70
San Francisco/ Oakland	0.90	0.68	1.38	0.93	1.41	1.12	0.93
Houston	2.00	0.74	1.36	0.97	0.91	1.03	0.82
Atlanta	0.98	0.73	1.64	1.14	1.14	1.00	0.80
Boston	0.61	0.77	0.83	0.92	1.43	1.32	0.75

*Because there are so few jobs in the mining and extractive industries in the Philadelphia area, the Bureau of Labor Statistics combines the employment data for this sector with data for the construction industry.

economy.[4] The loss of manufacturing jobs has been a major factor in keeping Philadelphia's overall job growth below the U.S. average.[5] Nonfarm job growth in the metro area has averaged less than 1 percent a year since 1967, compared with 2 percent a year for the nation.

Although trend growth in the Philadelphia area has been slower than the national average, the business cycles have been similar. Since the late 1960s, both the nation and the metro area have suffered five periods of sustained job losses (losses lasting two consecutive quarters or more). The national and regional downturns have occurred at approximately the same time, but downturns in the Philadelphia area have tended to begin a bit earlier and last a bit longer. In most cases, the differences in timing have been narrow. At all but two of the 10 turning points, the cyclical high or low employment levels in the metro area were within one quarter of the cyclical highs and lows in the nation (Figure 1).[6] Job growth in the metro area is also much more volatile than job growth in the nation, and there have been isolated quarters in some expansions when the metro area has lost jobs.

USING NATIONAL AND REGIONAL DATA TO FORECAST THE PHILADELPHIA ECONOMY

Since the cyclical patterns of the national and regional economies are similar, one way to forecast the metro area's economy would be to take a national forecast and assume that the Philadelphia economy would follow the same pattern,

[4]Since their peak in 1967, manufacturing jobs in the Philadelphia metro area have declined almost 50 percent, while the nation has lost about 4 percent of its manufacturing jobs. Manufacturing jobs in the nation did not peak until 1979. Some of the reasons for the decline of manufacturing jobs in the Third District states are outlined in Theodore M. Crone, "Where Have All the Factory Jobs Gone—and Why?" Federal Reserve Bank of Philadelphia, Business Review (May/June 1997).

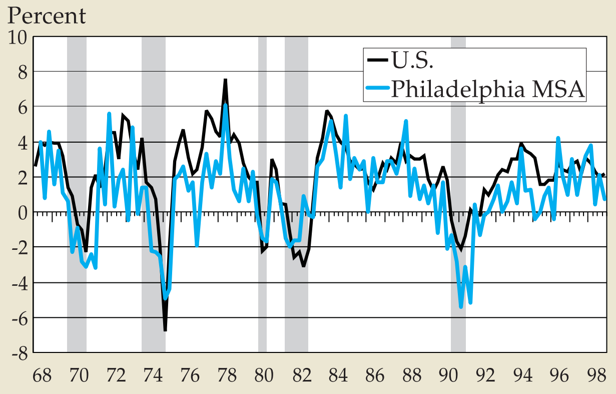
[5]The loss of manufacturing jobs is not the only factor, however. Nonmanufacturing jobs have been increasing in the area, but not nearly as fast as in the nation. Nonmanufacturing jobs in the Philadelphia area have increased almost 80 percent since 1967, but nationally they have risen more than 130 percent.

[6]The history of job growth in the city of Philadelphia has been somewhat different. For most of the past 30 years, the city has been losing jobs. Nevertheless, the national and metro area patterns are reflected in the city data. When national job growth has been strong, losses in the city have been less severe, and when the nation was losing jobs, losses in the city were even larger. The city's tax structure sets its economy apart as a distinct segment of the metro area's economy. For evidence of how the city's tax structure affects its job growth relative to the nation's, see Robert P. Inman, "Can Philadelphia Escape Its Fiscal Crisis With Another Tax Increase?" Federal Reserve Bank of Philadelphia, Business Review (September/October, 1992).

FIGURE 1

Quarterly Job Growth

(Seasonally Adjusted Annual Rate)



Shaded areas represent national recessions.

but at a somewhat slower pace. For example, we might assume that in expansions, job growth in the Philadelphia area would be half as strong as growth at the national level, and that in economic downturns, job losses would be half again as great in Philadelphia as in the nation. But this type of forecast would ignore the relationship between job growth in the Philadelphia area and other measures of the national economy, such as industrial production and housing construction. Job growth in the Philadelphia area may be systematically related not only to overall job growth in the nation but also to which segments of the national economy are growing.

Moreover, growth in the Philadelphia area has its own momentum. In the 1970s, annual job growth in the Philadelphia metropolitan area was almost 2 percent below the national average; in the 1980s, it was only one-third of 1 percent below the national average; and in the 1990s, it has been somewhere in between. To capture as many of these relationships as possible, forecasters build models that relate several national and regional variables to one another, then estimate the strength of the relationships from historical data. We have built such a model using variables for the nation, the metro area, and the city.

Our Focus Is the Region. We are most interested in a forecast of nonfarm employment and the unemployment rate for the metropolitan area and the city. Nonfarm employment is the most comprehensive, timely measure of economic activity available for the metro area or the city.[7] And economic analysts regularly point to changes in nonfarm employment and the level of the unemployment rate as indicators of the strength or weakness of regional economies, and not without justification. At the national level, changes in these two variables are important factors in determining official business cycles.[8] At the metropolitan level, there are no official business cycles, and changes in employment and the unemployment rate are the best indicators of the cycle.

Our forecast model includes two other regional variables: housing permits and initial unemployment claims, both for the metro area.[9] Housing permits and initial unemployment claims follow a cyclical pattern, but they tend to lead the general business cycle at the national level. That is, housing permits tend to decline and initial unemployment claims tend to rise before the onset of a downturn or recession. For this reason, changes in permits and initial unemployment claims are useful in forecasting more comprehensive measures of the economy, such as employment and the unemployment rate.[10]

Thus, our Philadelphia model contains six regional variables: four for the metropolitan area and two for the city of Philadelphia. These six variables are the ones we are most interested in forecasting. We supplement these with eight national variables, which are mainly used to

[7]We would like to have a broad measure of regional output such as "gross regional product" that would be analogous to gross domestic product — the most comprehensive measure of output for the nation. Unfortunately, we do not have such a measure. Personal income data are available for the metropolitan area, but they are published with a considerable lag and only on an annual basis, so we cannot use them in our quarterly model.

[8]Geoffrey H. Moore, Business Cycles, Inflation, and Forecasting, NBER Studies in Business Cycles No. 24, Cambridge, MA: Ballinger, 1983. Peaks and troughs in nonfarm employment and the unemployment rate do not always coincide with the official beginning or end of national business cycles, however.

[9]Housing permits are also available for the city of Philadelphia, but the numbers are very small and the pattern is erratic, so we did not use the city housing permits in our model.

[10]There is independent interest in forecasts of housing permits because they are the best regional measure of residential construction, and our model produces a forecast of housing permits for the Philadelphia area.

help forecast the metro-area and city variables.[11] We include all the national counterparts to the regional variables in the model. We also include some national variables, such as real gross domestic product, because they are comprehensive measures of the U.S. economy. Finally, we include some financial variables, such as the difference between the yield on 10-year Treasury bonds and the federal funds rate (the overnight interbank loan rate) because they have been found useful in forecasting the national economy and are valuable in forecasting some of the metro-area and city variables in our model.[12]

A Small Time-Series Model. Our Philadelphia model differs from the large structural models used by most major consulting firms to predict the nation's economy. These structural models attempt to specify a full range of economic relationships among many variables, and economic theory plays a critical role in how the variables are allowed to interact. Good structural models of this type require a large number of variables.[13] Since few regional variables are available on a quarterly basis, these large structural models are not a practical option for forecasting the Philadelphia economy.

In the late 1970s and early 1980s, researchers at the Minneapolis Fed developed small time-series models that overcame the need for such a large number of economic variables and that were useful for forecasting state and regional economies.[14] Our Philadelphia model is a variant of those models.

Time-series models emphasize the statistical regularities among economic variables over time rather than the underlying theoretical relationships, but they are not totally divorced from theory. For example, theory suggests which variables should be included in the models. Moreover, some basic assumptions can help solve the problem of "overfitting," which occurs when we try to forecast a particular variable, say, the metro-area unemployment rate, using a relatively large number of other variables.[15] If we use too many variables, the model we estimate based on past relationships may explain the historical data well but may not produce a very good forecast. In other words, we can overfit the model by estimating influences of one variable on another that reflect not only the stable relationships among the variables but also those relationships that were peculiar to the period from which the data were drawn. When the model is used to forecast, these temporary patterns will be projected into the future, diminishing the accuracy of the forecast.

A common way to limit the number of explanatory variables in time-series models is to allow the national variables to affect the regional

[11]The national variables in the model are real gross domestic product, nonfarm employment, the unemployment rate, industrial production, housing permits, initial unemployment claims, the difference between the yield on 10-year Treasury bonds and the federal funds rate, and the inflation rate. All the variables in the model except the unemployment rates, the inflation rate, and the spread in interest rates are included as logarithms of the quarterly levels.

[12]See Ben S. Bernanke, "On the Predictive Power of Interest Rates and Interest Rate Spreads," Federal Reserve Bank of Boston, New England Economic Review (November/December 1990).

[13]The national models produced by DRI and Macroeconomic Advisers, for example, consist of more than 250 variables.

[14]See Paul A. Anderson, "Help for the Regional Economic Forecaster: Vector Autoregression," Federal Reserve Bank of Minneapolis, Quarterly Review (Summer 1979).

[15]In our Philadelphia model we have 92 observations for each variable (quarterly data from 1976 to 1998). Our explanatory variables include four lagged values for each of the 14 variables in the model, so there are 56 potential explanatory variables in each equation. If we allow all the potential explanatory variables to help account for the historical pattern of a particular variable, we may end up overfitting the model for forecasting purposes.

ones, but not vice versa. In effect, this assumes that the regional variables, such as the unemployment rate for the metro area or the city, have no independent effect on the national economy. We apply the same principle to the metro-area and city variables. The metro-area variables are allowed to affect the city variables, but not vice versa.[16]

Researchers at the Minneapolis Fed made some other major assumptions that helped address the overfitting problem. Most important, they assumed that the best predictor of a given variable, say, this quarter's unemployment rate, is its value in the most recent past.[17] So, the first stage in developing a model is to forecast each variable using only its own past values. Past values of other variables are added to the equation only if including them lowers the forecast error for the time beyond the period in which the model is estimated. For example, using data up to the fourth quarter of 1988, we would estimate a model in which the equation for the unemployment rate contains only past values of the unemployment rate. We would then estimate a model in which the equation for the unemployment rate also contains the past values of another variable, such as initial unemployment claims. If the model that includes unemployment claims results in a smaller forecast error in the period after 1988, initial unemployment claims are included in the final equation for the unemployment rate.[18] This process limits the number of variables that influence each of the regional variables in our model (Table 1).

We decided on which variables to include in the Philadelphia model and how much influence they would have on the regional forecast in this way: We included any variable that reduced the out-of-sample forecast errors over the past 10 years. Thus, we assumed that the pattern of relationships among the variables in the near term would follow this recent historical pattern more closely than the pattern over the entire period for which we have data.[19]

THE NEAR-TERM FORECAST FOR THE METRO AREA AND THE CITY

Even though we have included many national variables in our forecast model, our primary interest is in the variables for the metropolitan area

[16]In technical language, the model is "block recursive." Any national variable can be affected only by its past values and the past values of the other national variables. Any metro-area variable can be affected by its past values and the past values of the national or other metro-area variables. And each of the city variables can be affected by the past values of any variable in the model.

[17]In the literature, this is known as one of the Minnesota priors. Another Minnesota prior is that recent values of a variable are more important than distant values in determining its current level. Because of the role of prior beliefs in developing these time-series models, they are called Bayesian vector autoregression models. For a full technical description of the models, see Thomas Doan, Robert Litterman, and Christopher Sims, "Forecasting and Conditional Projection Using Realistic Prior Distributions," Econometric Reviews, 3 (1984), pp. 1-100.

[18]We also restrict the degree to which a variable such as initial unemployment claims influences the unemployment rate to provide the best "out-of-sample" forecast of the unemployment rate. For each equation in our model, we test the forecast value of each of the variables one by one. We add a variable and re-estimate the model using data through the end of 1988; we then calculate the root mean squared errors of the forecasts after that date. We then re-estimate the model through the first quarter of 1989, and so on quarter by quarter, producing forecasts and calculating the out-of-sample forecast errors from those models. In our final model, we incorporate those variables that result in the lowest root mean squared error based on the four-quarter-ahead forecasts over a 10-year period.

[19]We also experimented with a model in which the parameters would change over time to pick up any change in the relationship among the variables. This model with time-varying parameters lowered the out-of-sample forecast errors for some of our regional variables but increased the errors for others. Therefore, we did not incorporate time-varying parameters in our model.

TABLE 1

National and Other Regional Variables That Affect Each of the Regional Variables in the Philadelphia Model*

Variable Being Forecast

	Metro-area nonfarm jobs	Metro-area unemployment rate	Metro-area housing permits	Metro-area initial unemployment claims	City nonfarm jobs	City unemployment rate
National Variables Used in Forming the Forecast	Gross domestic product Nonfarm employment Unemployment rate Industrial production Housing permits Initial unemployment claims Spread between 10-yr Treasuries and fed funds rate Inflation rate	Unemployment rate Housing permits Initial unemployment claims Inflation rate	Unemployment rate Housing permits Spread between 10-yr Treasuries and fed funds rate	Housing permits Inflation rate	Gross domestic product Housing permits	Unemployment rate Housing permits Inflation rate
Metro-Area Variables Used in Forming the Forecast	Unemployment rate Housing permits Initial unemployment claims	Initial unemployment claims			Unemployment rate Housing permits	Housing permits Initial unemployment claims

*Each equation also contains four lags of the variable being forecast.

and the city of Philadelphia, especially nonfarm employment and the unemployment rate. From the second quarter of 1998 to the second quarter of 1999, nonfarm jobs increased 1.3 percent in the Philadelphia metro area and 1.2 percent in the city, the first meaningful job growth in the city since 1987. By the second quarter of 1999, the unemployment rate in the city had fallen to 5.4 percent, its lowest level in almost a decade, and the unemployment rate in the metropolitan area was just 4.0 percent.

What does our forecast model predict for the second half of 1999 and the first half of 2000? For the metropolitan area, our new Philadelphia model is predicting job growth of 1.6 percent between the second quarter of 1999 and the second quarter of 2000, and the unemployment rate is predicted to fall slightly to 3.8 percent (Table 2).[20] The model forecasts that total housing per-

[20]For the national variables, our model predicts real GDP growth of 2.0 percent from 1999:II to 2000:II, and

TABLE 2

Forecasts from the Philadelphia Model

Variable	Previous period 1998:II-1999:II	Forecast 1999:II-2000:II	Root mean squared error of four-quarters-ahead forecast 1989-1998* Percentage points
Metro-area nonfarm job growth	1.3%	1.6%	1.2
City nonfarm job growth	1.2%	-1.5%	1.3
	Previous period 1999:II	Forecast 2000:II	
Metro-area unemployment rate	4.0%	3.8%	0.6
City unemployment rate	5.4%	5.3%	0.8
	Previous period 1998:III to 1999:II over 1997:III to 1998:II	Forecast 1999:III to 2000:II over 1998:III to 1999:II	
Metro-area housing permits**	1.0%	-2.6%	

*The square root of the average of the squared values of the errors in the forecasts for four quarters ahead for the years 1989 to 1998.

**Since housing permits at the metropolitan area level are so volatile from quarter to quarter, we report growth on a four-quarter-average basis.

mits issued in the metro area from the third quarter of 1999 through the second quarter of 2000 will be 2.6 percent lower than in the previous four quarters. The forecast for the city of Philadelphia is not as rosy. Our model predicts that job losses will resume, and the city will give up most of the jobs it has gained since the end of 1997. The unemployment rate in the city, however, is expected to be just 5.3 percent in the second quarter of 2000. Unlike the situation with most published forecasts from large structural models, no forecaster's independent judgment was used to alter the forecasts generated by our model.

How accurate are these forecasts likely to be? No forecasting model is 100 percent accurate, and our Philadelphia model is no exception. Moreover, forecasts of smaller segments of the economy tend to be less accurate than forecasts of the national economy as a whole. One way to gauge the accuracy of a forecast is to look at the forecast errors from the model over the recent past. In Table 2, we have reported the root mean squared errors over the past 10 years of the forecasts produced by our model.[21] Using the root mean squared errors as a guide, we can say that about two-thirds of the time, metro-area job growth will be within 1.2 percentage points of what we report in Table 2.[22] The dashed line in Figure 2 shows the four-quarter-ahead forecast for metropolitan employment from 1989 to 1998, with a band of 1.2 percent (shaded area) on either side of the forecast. The solid line shows the actual level of employment in this period; it was within the band around the forecast more than 75 percent of the time. Based on the root mean squared error, city job growth will likely be within 1.3 percentage points of what we report in Table 2. For example, our model is forecasting a substantial decline in city jobs (1.5 percent), but based on the forecast errors over the past 10 years,

DRI and Macroeconomic Advisors are forecasting growth of 2.3 percent. Our model's predicted unemployment rate for 2000:II is within 0.2 percentage point of their forecasts. Our time-series model is predicting considerably faster job growth than these large macro models (about 230,000 new jobs per month versus 130,000 new jobs for the two commercial forecasters).

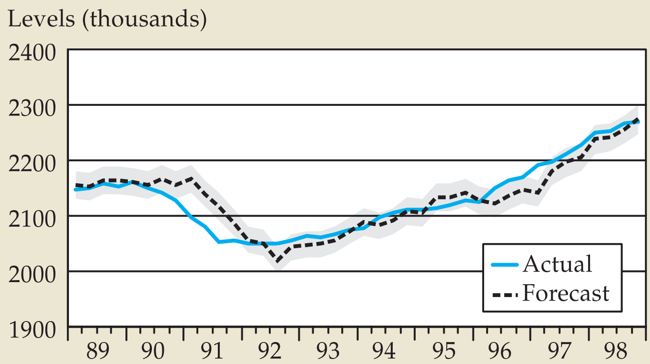
[21]We concentrated on the root mean squared errors of the forecasts for the period four quarters ahead of the actual data. This statistic is calculated by squaring the four-quarter-ahead forecast error for each quarter from 1989:I to 1998:IV, adding these squared errors, dividing by the total number of forecast errors (40), and then taking the square root. This measure of accuracy puts more emphasis on large errors than on small ones.

[22]This assumes that the recent forecast errors are a good estimate of future ones and that the errors are normally distributed.

FIGURE 2

Four-Quarter-Ahead Forecasts and Actual Employment Levels

(Philadelphia Metropolitan Area)



there is some chance (about 15 percent) that job losses will be negligible or that the number of jobs in the city will increase, not decline, over the next four quarters.

CONCLUSION

It remains difficult to accurately forecast the economy for metro areas and individual cities, but the development of time-series models has made the process easier and, in many cases, well worth the effort. The size and diversity of the Philadelphia metropolitan area make it a natural candidate for which to develop a forecasting model. For many local businesses, organizations, and governments, a reasonable forecast for the area's economy can be helpful to the planning process. The time-series model we have developed provides an additional tool to the economist in charting the course of the Philadelphia economy. The historical errors in the forecast are a reminder, however, that this tool should not be used alone.

[23]Technical details about the model are available in Theodore M. Crone and Michael P. McLaughlin, "A Bayesian VAR Forecasting Model for the Philadelphia Metropolitan Area," Working Paper 99-7, Federal Reserve Bank of Philadelphia.