Forecasting Automobile Output

FEDERAL RESERVE BANK OF NEW YORK

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As a share of GNP, the auto sector has been on the decline sin the early 1970s. Auto output accounted for only about 21/2 percent of GNP from 1980 to 1985, down from almost 3 percent in the 1971 Judged in terms of its contribution to GNP *fluctuations,* however the auto industry remains a key sector of the economy. In the 1 six years changes in auto output accounted for 29 percent of i quarter-to-quarter change in GNP, slightly more than its 27 percent contribution in the 1970s. [1] In addition to its strong direct effect the economy, the auto sector continues to have substantial spillover, effects. Purchases of raw materials by the auto industry account more than half of the rubber and lead consumed in the United States as well as a major portion of the steel, aluminum, platinum, copper and zinc. On the consumer end, spending associated with buy, and using automobiles has been running above 10 percent of GI in recent years. [2]

Estimates of the Econometric and Combination Models

Our econometric model is based on a simple supply and demand model. Demand for autos increases when real disposable income rises, the price of new autos falls, or the price of other durable goods increases. The supply of autos expands when inventories are low relative to sales or when the cost of borrowing declines. Low interest rates also increase the demand for autos.

Estimates for both the econometric model and the combination model are presented at right. Each variable is lagged one quarter, since the actual value of each variable would not be known at the time of each forecast. All the variables are significant and have the correct sign in the econometric model.[a] Adding the *Ward's* projection to the econometric model significantly improves the overall fit, reducing the standard error of the model by 100,000 autos.[b] The *Ward's* projection is the most significant variable in this "combination" model, although all the other variables, except "other price," remain significant.

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[1] In absolute value, the average change in real auto output was *$4.5* billion fro *1980* to *1985,* compared with *$15.8* billion for total real GNP.

[2] Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures (1984), pages 60 and 72.

[a] The coefficient on the own-price variable is positive, which suggests that it is capturing supply-side effects.

[b] A formal F-test shows that the *Ward's* projections add significantly (at the 1 percent level) to the explanatory power of the econometric model. The opposite test, of whether the econometric model improves the *Ward's* projections, was also supported by the data (at the 5 percent level). Together these tests confirm the results reported in the table in the text: the best forecast combines the *Ward's* projections with an econometric model.

The forecast comparisons reported in the text are not the within sample predictions of these models. Instead, each model is estimated recursively over the sample, using data from 1967-II to the quarter of the forecast. The prediction errors from these one quarter-ahead projections are then used to compare the out-of sample forecasting power of the models.

Variable	*Econometric*	*Combination*
Constant	*-22301.8*	*-7931.4*
	(-4.5)	(-1.7)
Income	*12.9*	*5.4*
	(6.6)	*(2.6)*
Prime rate	*-97.8*	*-90.0*
	(-3.2)	(-3.7)
IS ratio	*-19.9*	*-8.7*
	(-6.1)	(-2.7)
Own price	*230.4*	*(93.8)*
	(5.0)	*(2.1)*
Other price	*6.0*	*1.9*
	(2.1)	*(0.8)*
Ward's projection	a	0.55
		(5.3)
R^2	*0.862*	*0.914*
SEE	*532*	*420*
Durbin Watson	*2.26*	*1.82*

The sample period is *1973-I* to *1985-III.* The t-values are in parentheses. Ail independent variables, except the *Ward's* projections, are lagged one period. The dependent variable is units production (in thousands at an annual rate) and the other variables are defined:

Income = real disposable income in *1972* dollars.
IS ratio = ratio of retail auto inventories to sales.
Own price = the CPI for new autos divided by the overall CPI
Other price = the implicit deflator for non-auto durable goods sales, divided by the overall CPI.

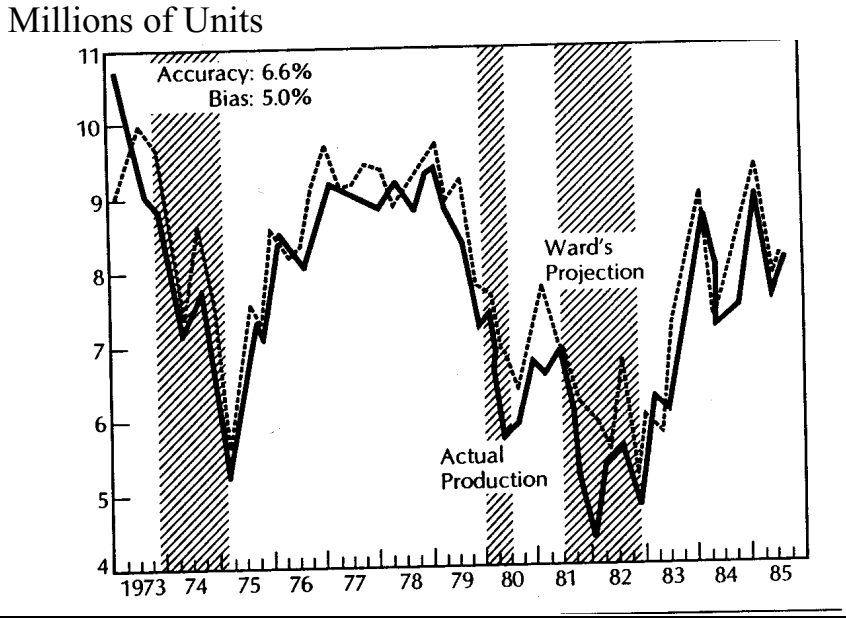
a: Not applicable

Because of its far-ranging importance, the auto sector is central to any assessment of prospects for the economy as a whole. The auto production plans published in *Ward's Automotive Reports* provide a timely two-quarter projection of this important sector, and, as a result, have become a popular tool in forecasting. In this paper we examine the usefulness of the *Ward's* projections for forecasting auto output over the near term. Adjusted for systematic over-prediction, the projections compare favorably with those from some alter native methods, but they do not provide the best overall predictions. particular, combining the *Ward's* projections with a simple econometric model significantly improves the accuracy of the forecast.

ANALYSIS OF THE WARD'S PROJECTIONS

Each month *Ward's* asks eight U. S. auto makers to state the domestic production plans for the next three to six months. Chart 1 plots domestic auto production and the *Ward's* projections made

CHART 1
WARD'S PROJECTIONS AND ACTUAL AUTOMOBILE PRODUCTION



Source: Various issues of Ward's Automotive Reports (1973-85) and unpublished data from the Bureau of Economic Analysis.
Shaded areas represent periods of recession, as defined by the National Bureau of Economic Research.
"Accuracy" is the mean absolute error and "bias" is the mean error, each as a percent of actual production.

at the beginning of each quarter.[3] Although the *Ward's* projections generally track the up and down movement of production they have two shortcomings. First, they are not very accurate, with an average error of about one-half of a million cars at an annual rate. Second, they systematically over-predict auto output, by an average of 0.42 million cars at an annual rate, or 5.5 percent of actual production. The *Ward's* projections, therefore, may be best viewed as production "targets" rather than forecasts.[4]

[3] The raw data are monthly, but the analysis has been simplified by aggregating the three months of each quarter. In addition, the data is adjusted using seasonal factors from the Bureau of Economic Analysis.

[4] The projections are supposed to be "actual production schedules," as reported by production planners, taking into account both production capacity and mark outlook. There are at least three possible reasons for systematic over-prediction First, the normal amalgam of strikes and bottlenecks may thwart plans. Second, the market may be weaker than the (generally optimistic) outlook embodied in the pr. duction plans. Third, as part of its marketing strategy each firm has an incentive each firm may hope to dissuade production by its competitors and thereby capture greater market share

We can analyze the *Ward's* projections more rigorously by estimating the relationship between actual production and the *Ward's* projections:

Auto output = 0.275 + 0.909 *Ward's* + *0.277* error (-1).
(0.59) (15.67) (2.54)

Sample period= 1973-I to 1985-III. See = 0.431, R2 =0.838
(The t-values are in parentheses.)

The statistical results from this regression suggest three problem with the *Ward's* projections. First, they provide statistical confirmation that *Ward's* systematically over-predicts.[5] Second, the error; are serially correlated; that is, they tend to persist from one period to the next. This means the errors, as well as the projections themselves, can be used to forecast production. It also implies that better forecasts could be achieved by adding economic variables to the equation. Third, the large standard error means that even adjusted for systematic over-prediction the projections are not very accurate.

WARD'S IN COMPARISON WITH OTHER FORECASTS

Despite these limitations, the *Ward's* projections are useful for forecasting auto output. Table 1 compares *Ward's* with three alter native models: an extrapolative forecast in which next period's production is assumed to equal current production; an econometric model of the auto sector including income, price, and cost variables; and a combination of the *Ward's* projections and the econometric model. (Details of the econometric and combination models are given in the box.) Since there is no single criterion for a "good" forecast, we present three standard measures: a good forecast should have little bias (small average over- or under-prediction), high accuracy (small average absolute errors), and high predictive power (explain a large portion of the variation in production). Overall, the *Ward's* projections perform about as well as the econometric model and are clearly superior to the extrapolative model; among the three basic forecasts they rank the worst on bias but the best on the other measures.

A BETTER FORECAST

To take advantage of the relative merits of the *Ward's* and econometric models, we tried to improve the forecast by combining them. The last row of Table I shows the results for a "combination forecast," constructed by adding the *Ward's* projections as a variable to the econometric model. The combination model is better than its components by all three criteria: it has the least bias, the greatest accuracy, and the most predictive power. This suggests that both the *Ward's* projections and the econometric model contain information valuable in forecasting.

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[5] If the projections were unbiased, with no tendency to predict too high or d low, then the constant term would be close to zero and the slope coefficient won be close to one. A formal F-test of this joint hypothesis shows that Ward's do significantly over-predict. The F(2,49) value is 12.51, which is more than double tl 1 percent critical value.

TABLE 1
COMPARISON OF WARDS TO ALTERNATIVE MODELS

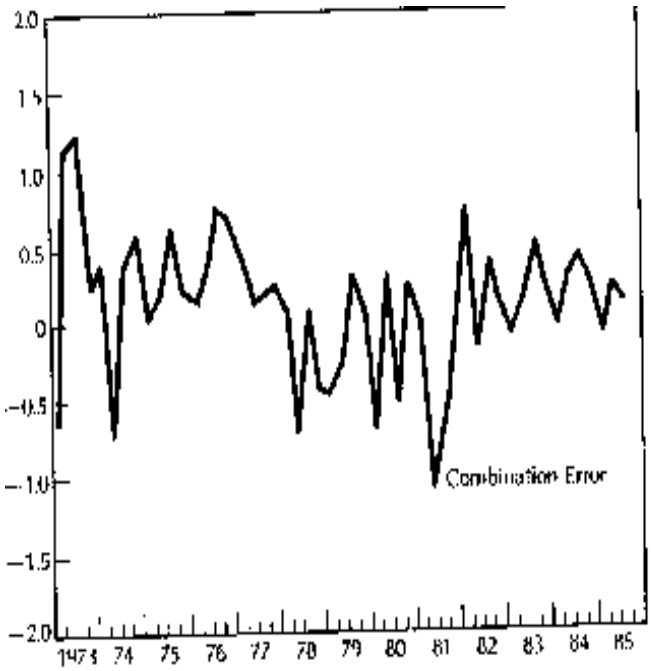
Model	*Bias* [a] *(percent)* [b]	*Accuracy* [a] *(percent)* [b]	*Predictive power* [c]
Wards	*0.381*	*0.498*	*0.859*
	(5.0)	*(6.6)*	
Extrapolative	*0.028*	*0.686*	*0.690*
	(0.4)	*(9.0)*	
Econometric model	*0.283*	*0.524*	*0.838*
	(3.7)	*(6.9)*	
Combination model	*0.209*	*0.368*	*0.886*
	(2.8)	*(4.9)*	

a "'Bias" is the mean error and "Accuracy" is the mean absolute error.
b Millions of units at an annual rate. The numbers in parentheses are the bias and accuracy as a percent of actual production.
c "Predictive power" is the coefficient of determination *(i.e.,* the R2). It measures the percent of variation in actual production explained by each model.

Chart 2 plots forecast errors for the combination model and compares them with the *Ward's* projections. The combination forecast shows small errors and no tendency to over- or under-predict.[6] Of course, more complicated models might provide better forecasts. It seems clear, however, that the Ward's projections will remain useful for assessing the outlook for the auto sector and the economy as a whole.

[6] The *Ward's* projections appear to have performed better in the last two years. This is more a reflection of the unexpected strength of demand than a fundamental change in forecast accuracy. In fact, if we compare the period *1973-79* with *198085,* the track record of *Ward's* actually deteriorates over time while the combination model improves.

CHART 2
FORECAST ERRORS OF THE WARDS PROJECTION AND THE COMBINATION MODEL
Seasonally Adjusted Annual Rates
Millions of Units



Source: Federal Reserve Bank of New York Staff estimates