

Two Capsules on the Auto Sector . . .

. . . Forecasting Automobile Output

As a share of GNP, the auto sector has been on the decline since the early 1970s. Auto output accounted for only about 2½ percent of GNP from 1980 to 1985, down from almost 3 percent in the 1970s. Judged in terms of its contribution to GNP *fluctuations*, however, the auto industry remains a key sector of the economy. In the last six years changes in auto output accounted for 29 percent of the quarter-to-quarter change in GNP, slightly more than its 27 percent contribu-

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Comparison of *Ward's* to Alternative Models

Model	Bias* (percent)†	Accuracy* (percent)†	Predictive power‡
<i>Ward's</i>	0.381 (5.0)	0.498 (6.6)	0.859
Extrapolative	0.028 (0.4)	0.686 (9.0)	0.690
Econometric model	0.283 (3.7)	0.524 (6.9)	0.838
Combination model	0.209 (2.8)	0.368 (4.9)	0.886

* "Bias" is the mean error and "Accuracy" is the mean absolute error

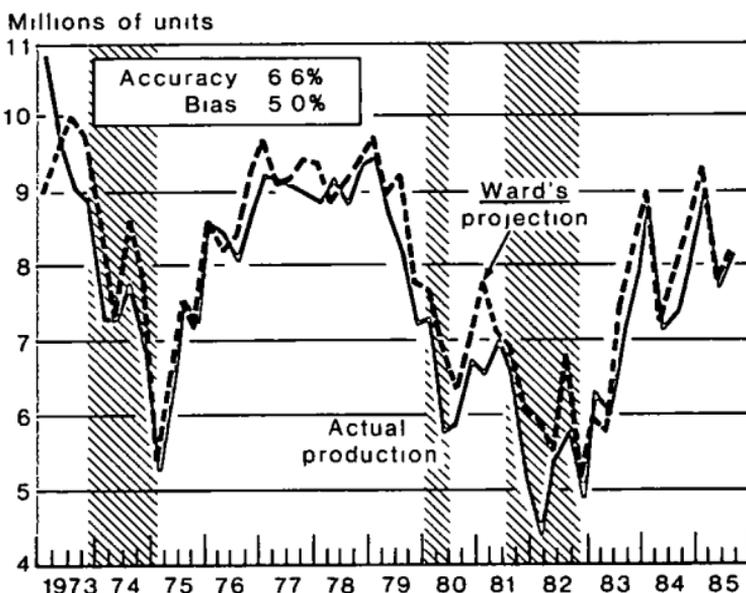
† Millions of units at an annual rate. The numbers in parentheses are the bias and accuracy as a percent of actual production

‡ "Predictive power" is the coefficient of determination ($i.e.$, the R^2). It measures the percent of variation in actual production explained by each model

Chart 1

Ward's Projections and Actual Automobile Production

Seasonally adjusted annual rates



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

Sources: Various issues of *Ward's Automotive Reports* (1973-85) and unpublished data from the Bureau of Economic Analysis

tion in the 1970s¹ In addition to its strong direct effect on the economy, the auto sector continues to have substantial spillover effects. Purchases of raw materials by the auto industry account for 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 buying and using automobiles has been running above 10 percent of GNP in recent years.²

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 capsule 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 alternative methods, but they do not provide the best overall predictions. In 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 their domestic production plans for the next three to six months. Chart 1 plots domestic auto production and the *Ward's* projections made 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

¹ In absolute value, the average change in real auto output was \$4.5 billion from 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

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

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 * 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 † The *Ward's* projection is the most significant variable in this "combination" model, although all the other variables, except "other price", remain significant

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 (-4.5)	-7931.4 (-1.7)
Income	12.9 (6.6)	5.4 (2.6)
Prime rate	-97.8 (-3.2)	-90.0 (-3.7)
IS ratio	-19.9 (-6.1)	-8.7 (-2.7)
Own price	230.4 (5.0)	93.8 (2.1)
Other price	6.0 (2.1)	1.9 (0.8)
<i>Ward's</i> projection		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 All 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

* Not applicable

* The coefficient on the own-price variable is positive, which suggests that it is capturing supply-side effects

† 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

best viewed as production "targets" rather than forecasts⁴

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

$$\text{Auto output} = 0.275 + 0.909 \text{ Ward's} + 0.277 \text{ error} (-1) \\ (0.59) \quad (15.67) \quad (2.54)$$

Sample period=1973-I to 1985-III, SEE=0.431, $\bar{R}^2=0.838$
(The t-values are in parentheses.)

The statistical results from this regression suggest three problems with the *Ward's* projections. First, they provide statistical confirmation that *Ward's* systematically over-predicts.⁵ Second, the errors are serially correlated, that is, they tend to persist from one period to the next. This means

- ⁴ The projections are supposed to be "actual production schedules", as reported by production planners, taking into account both production capacity and market 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 production plans. Third, as part of its marketing strategy each firm has an incentive to exaggerate its plans. An optimistic outlook may help promote sales and increase the stock market value of the firm. Furthermore, by reporting strong production plans each firm may hope to dissuade production by its competitors and thereby capture greater market share.
- ⁵ If the projections were unbiased, with no tendency to predict too high or too low, then the constant term would be close to zero and the slope coefficient

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. The table (page 40) compares *Ward's* with three alternative 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

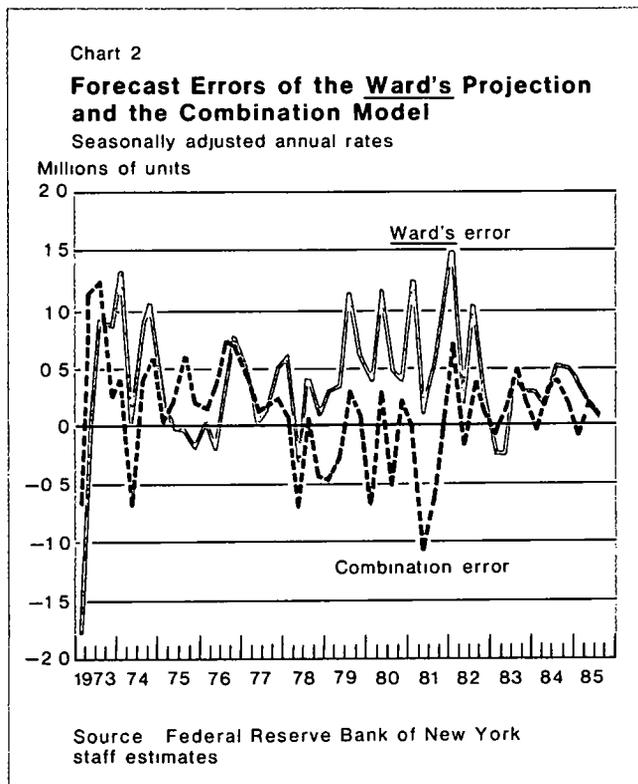
To take advantage of the relative merits of the *Ward's* and econometric models, we tried to improve the forecast by combining them. The last row of the table (box) shows the results for a "combination forecast", constructed by adding the *Ward's* projections as a variable to the econometric model. The 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.

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.

Footnote 5 continued

would be close to one. A formal F-test of this joint hypothesis shows that *Ward's* does significantly over-predict. The F(2,49) value is 12.51, which is more than double the 1 percent critical value.

- 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 1980-85, the track record of *Ward's* actually deteriorates over time while the combination model improves.



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