1981 Winter Simulation Conference Proceedings
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A PLANNING MODEL TO FORECAST MARKET DEMAND FOR TWO LINES OF DURABLE PRODUCTS

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ABSTRACT

This paper describes a planning model which forecasts annual domestic market demand by end use for a Westinghouse division manufacturing two lines of durable goods. This model takes an unusual approach in solving the problems that arise in analyzing any mature market: it combines traditional econometric techniques with a structured theory of the market. The structured approach was used where data such as saturation or replacement rates was available. The adequacy of the structured portions was determined by historical industry data and the division's marketing experience. Where appropriate inputs for the structured model could not be found, traditional econometric techniques were employed. This combination of approaches allows the model to reflect the overall market structure, market maturity, economic influences, and division insights. A computer program has been written to allow periodic updates and easy simulation of alternative economic scenarios for planning purposes.

1. INTRODUCTION

Modeling the market for a durable good presents a unique problem -- its "market" is actually the sum of two or more distinct parts. We can usually assume the product (which might be a major appliance, a furnace, a water heater, etc.) stays with the building in which it is originally installed until it is worn out. This fact implies that the market can be divided into at least two segments: (1) installations in new buildings and (2) replacements for worn-out units. This presents a problem for someone modeling the entire market since growth in these two segments is driven by different forces. New installations are directly related to new construction, which in turn is tied to the economy. Replacements, however, are based primarily on the condition of the stock of existing units.

When a product is fairly new, replacements account for an insignificant part of total sales. Then, as the market matures (i.e., when "everybody" has one), sales of new units fall off, and replacement becomes a major part of the market. If a model is to track the changing relationship between these two segments, each one must be considered separately.

The preceding observations became the basis for developing a planning model to forecast domestic market demand for a Westinghouse division which manufactures two lines of durable goods. These two lines will be referred to as Lines A and B. Line A consists of over half a dozen individual product types, but was examined in the aggregate. Line B was examined by its three product types: x, y, and z.†

Previous attempts to model this market have been based on quarterly historical installations by type of unit. Applying traditional econometric methods to these data failed to produce a reasonable model. (This is not too surprising given the discussion above.) This failure led to the approach documented in this paper. Instead of a purely econometric model, a more structured model was designed, based on inputs such as saturation rates and product lives.

Historical data was gathered for Line A from the appropriate industry association (IA1) publications. It was available by product type and by end use (where installed) for 1958 to 1978. Data for Line B was gathered from its industry association (IA2) publications, available by product type only, for 1972 to 1978.

†A product type might be distinguished from others of the same line by size, fuel source, quality or some similar factor.

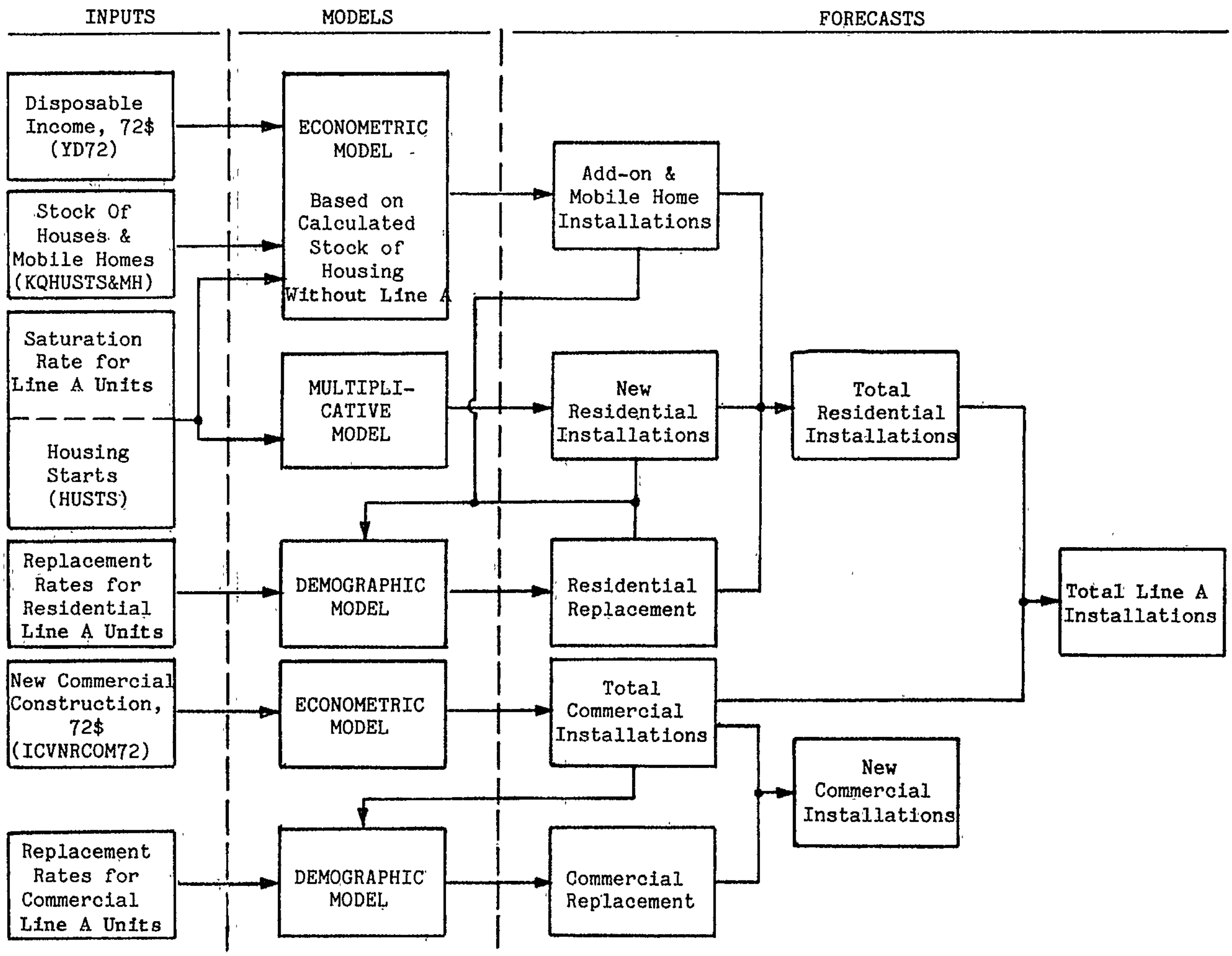


Figure 1. Schematic Diagram of Model for Line A

These data, plus the division's "feel" for the market, determined how well the structured model performed historically. For some sub-models, inputs needed to retain the structured approach, such as a particular saturation rate, could not be obtained. In these cases, modeling reverted to traditional econometric methods, employing macroeconomic variables supplied by Data Resources, Inc. (DRI). The following two sections describe the models for Line A and for Line B. The final section tells how the model can be used by management in strategic planning.

2. MODEL FOR PRODUCT LINE A.

The first step in developing a structured model is to build a theory of what drives the market. For new construction, housing (or commercial/industrial starts) and saturation rates can adequately explain demand. For replacement, demand can be estimated by how many units have been installed in the past, along with some measure of the life expectancy of those units. Ideally, the model would track sales of Line A units both by product type and by end use. Unfortunately, due to inconsistencies in the industry data, the market could only be analyzed for total Line A units of all types by end use.

The primary end use categories are residential and commercial.

2.1 RESIDENTIAL.

New Residential. The model for new residential units is multiplicative, combining housing starts and a corresponding saturation rate (see Figure 1). Although this module is structured, it still reflects economic influences through housing start expectations. The DRI housing start variable for single- and multi-family dwellings is called HUSTS. The relevant saturation rate was obtained initially from government census figures (1974 to 1977), but was extended back to 1953 and forward to 1990 using division judgment. This rate gives the percent of new single- and multi-family dwellings in which Line A units were installed.

Replacement. Inputs to the replacement module are the modeled total residential installations in prior years and the residential replacement rates (see Figure 2). The replacement rates, which reflect average or expected product lives, were obtained from engineering estimates based on both equipment design and field experience. More

Figure 2

Replacement Rates for Residential Line A Units
(Percent)

	AGE OF UNIT IN YEARS								
	16	15	14	13	12	11	10	9	8
1950-1955	16	22	24	22	16				
1955-1960	16	22	24	22	16				
1960-1965		16	22	24	22	16			
1965-1970			16	22	24	22	16		
1970-1975				16	22	24	22	16	
1975-1980					16	22	24	22	16
1980-1985					16	22	24	22	16

rigorous approaches for estimating replacement rates have been used elsewhere. (See, for example, R. B. Fechtel, et al., Energy Capital in the U.S. Economy, Part B, MTSC., Inc., November 1980, pp. A.7-A.11.) In this case, however, the cost of such a rigorous method was not justified.

For a given year, the replacement chart shows what percent of units of a certain age are due to be replaced. For example, in 1976, 16% of the units replaced were 12 years old, 22% were 11 years old, 24% were 10 years old, etc. The rates are given for five-year periods to provide for a trend toward shorter product life. The model ages the installed units, computing how many are to be replaced in each year. Hence, this model assumes that those units that need to be replaced are replaced, and that they are replaced with a similar product.

Add-on/Mobile Homes. Mobile homes might logically be included either with add-ons or with other new installations. (Typically, a Line A unit is installed when a mobile home is new, yet very few come with "factory installed" units.) Since we did not have a good data source from which to determine mobile home saturation rates, we included mobile homes with add-ons. The add-on/mobile-home module is based on an estimate of the stock of all types of housing which do not have Line A units, i.e., the potential market. This stock variable (KWOA) is computed by calculating the stock of housing with Line A units (an accumulation of new residential installations), and subtracting that from the total stock of houses and mobile homes (DRI variable KQHUSTS&MH). Given the potential market, a corresponding saturation rate was needed to complete the model. When none could be found, an econometric model had to be substituted.

The best linear model tried employed the independent variables KWOA (stock of housing without Line A units) and YD72 lag 1 (disposable income in 1972 dollars, lagged one year). This model had respectable statistics (R-bar squared = 0.8024, Durbin-Watson = 1.59), but the forecast dropped below zero in the 1980s. Although division personnel felt that this market was maturing and would decrease gradually in the forecast period, there was no reason to think the market would disappear entirely. Hence, the linear model was replaced with its logarithmic counterpart. The R-bar squared for the log model was much better (0.8701), but the Durbin-Watson statistic was poor (1.08). The behavior of the forecast, however, was reasonable enough to allow acceptance of the latter model.

Total Residential. Total residential installations are computed as the sum of new, replacement, and add-on/mobile homes. The residential model and a forecast computed in early 1980 are plotted in Figure 3.

2.2 COMMERCIAL

New Commercial. Although the theoretical commercial module was similar to that for residential, data problems prevented me from retaining that structure. Specifically, gross inconsistencies were evident in IAI's split between new and replacement installations. Hence, an econometric model was estimated for total commercial installations. Then, new installations were computed as the difference between total and replacement.

Replacement. Initial attempts to model commercial replacement were based on the assumption that the

Figure 3
Residential Line A Model

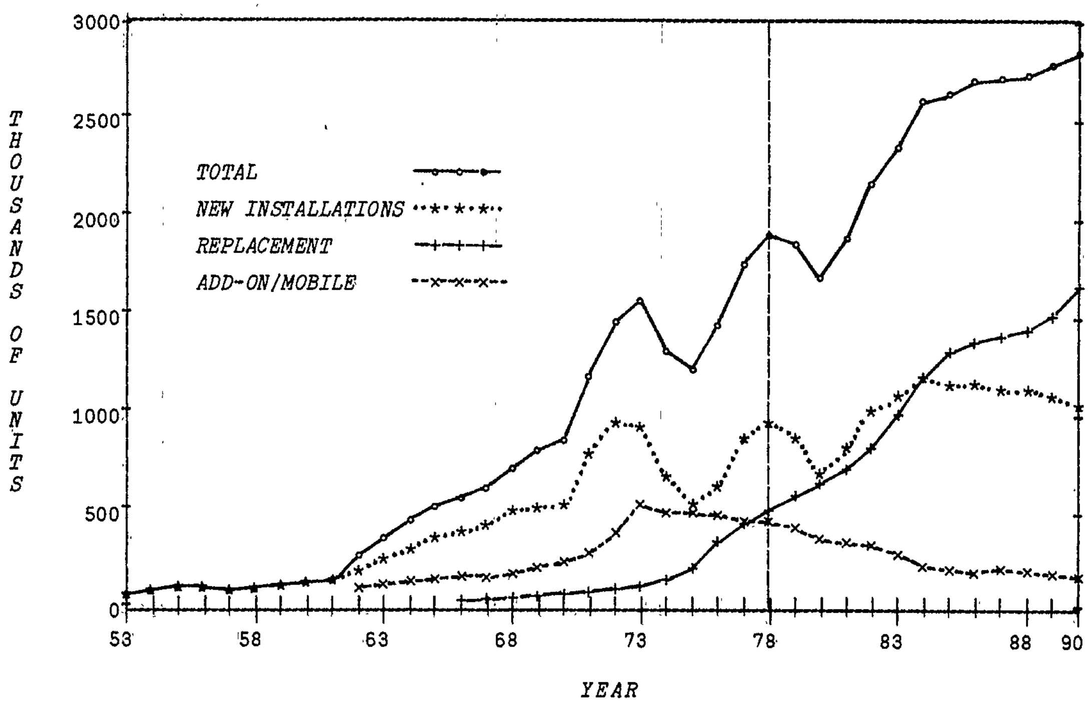
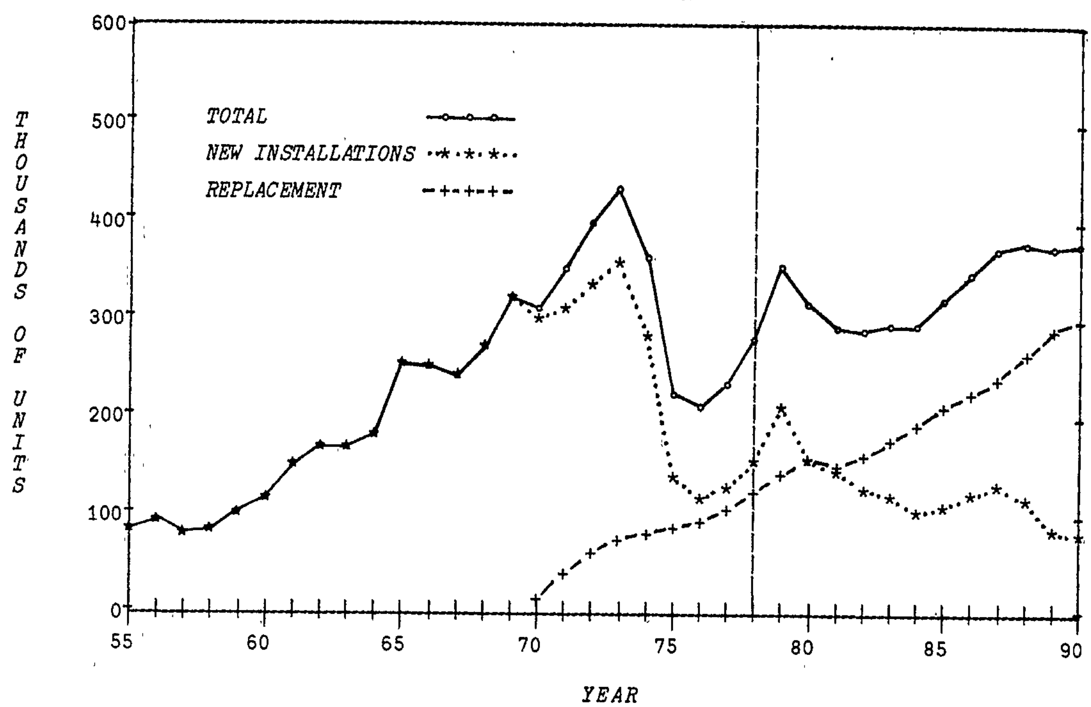


Figure 4
Commercial Line A Model

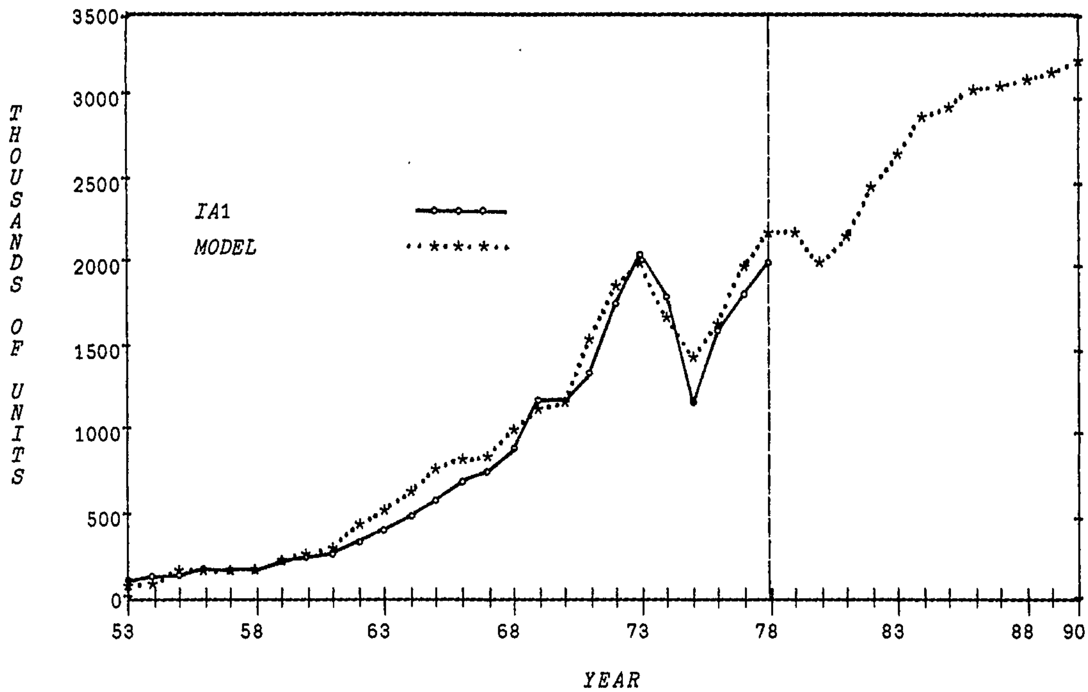


residential replacement rates could apply equally well to the total and commercial categories. Hence, commercial replacement was calculated as the difference between total Line A replacement and residential replacement. This method failed to give reasonable results. Instead, the commercial replacement rates were estimated by the division and applied to the modeled commercial installations. The rates (or rather, the product lives) were then adjusted up and down until a back-forecast was developed which, when added to total residential, resulted in a reasonable approximation of total industry historical annual shipments.

Total Commercial. As stated above, there were data problems involved in modeling new commercial, so total commercial was ...odeled

Figure 5

Line A Model vs. Industry Historical Installations



instead. The best econometric model was based on the DRI variable ICVNRCOM72 (investment in new commercial construction in 1972 dollars). The results for this model paralleled those for add-on/mobile. The R-bar squared was fairly high (0.82), the Durbin-Watson was low (0.40), but the forecast tapered off, conforming to division expectations. The commercial model is plotted in Figure 4.

2.3 TOTAL LINE A

Total Line A is calculated as the sum of total residential and total commercial installations. As implied above, the entire modeling process for the Line A portion was guided by a lack of confidence in the industry breakdowns by end-use segments. However, IA1's historical total Line A figures are based on actual manufacturers' shipments. Hence, the goodness of fit of the total Line A model can be compared to the actual historical shipments. Figure 5 shows that, overall, the model compares well with history. In addition, the general trend of the forecast is in line with division expectations.

3. MODEL FOR PRODUCT LINE B.

The total Line B market, as it applied to this division, is composed of only a subset of its industry's market. Data for this market (IA2 figures) are split into product types, x, y, and z. Given the previous trouble with modeling the Line A portion by type, my first try to model Line B ignored this segmentation. However, in doing the analysis, I found that market behavior could not be adequately explained without the breakdowns. This is primarily due to a large difference in the life-expectancies of the three unit types. In addition, retaining the breakdowns highlights the current dramatic drop in demand for product y resulting from recent economic events.

3.1 NEW INSTALLATIONS

As for the Line A model, the main stumbling block to a totally structured model for new Line B installations was a lack of appropriate inputs. The government census figures do provide a saturation rate for Line B. Unfortunately, it is for the total Line B market in the strictest sense, not simply this division's portion. Hence, the total new Line B had to be computed as modeled total minus modeled replacement (see Figure 6).

To get segmentation once total new installations were computed, the division provided historical and expected percents of total for products x, y, and z. The predicted percentages were based on the division's expectations for the pattern of the switch away from product y. Applying these percents to total new gave new Line B by product type. The model breakdowns and total new installations are plotted in Figure 7.

3.2 REPLACEMENT.

As indicated at the beginning of this section, Line B replacement had to be computed by product type because of the wide dispersion in product lives. Since segmentation was incorporated into the model, an additional market phenomenon could also be included -- substitution of one type unit for another. Once the number of units due to be replaced are calculated in the usual manner, the substitution rates can be applied to determine what types of replacement units are actually installed. For example, in 1980, the division

Figure 6

Schematic Diagram of Model for Line B

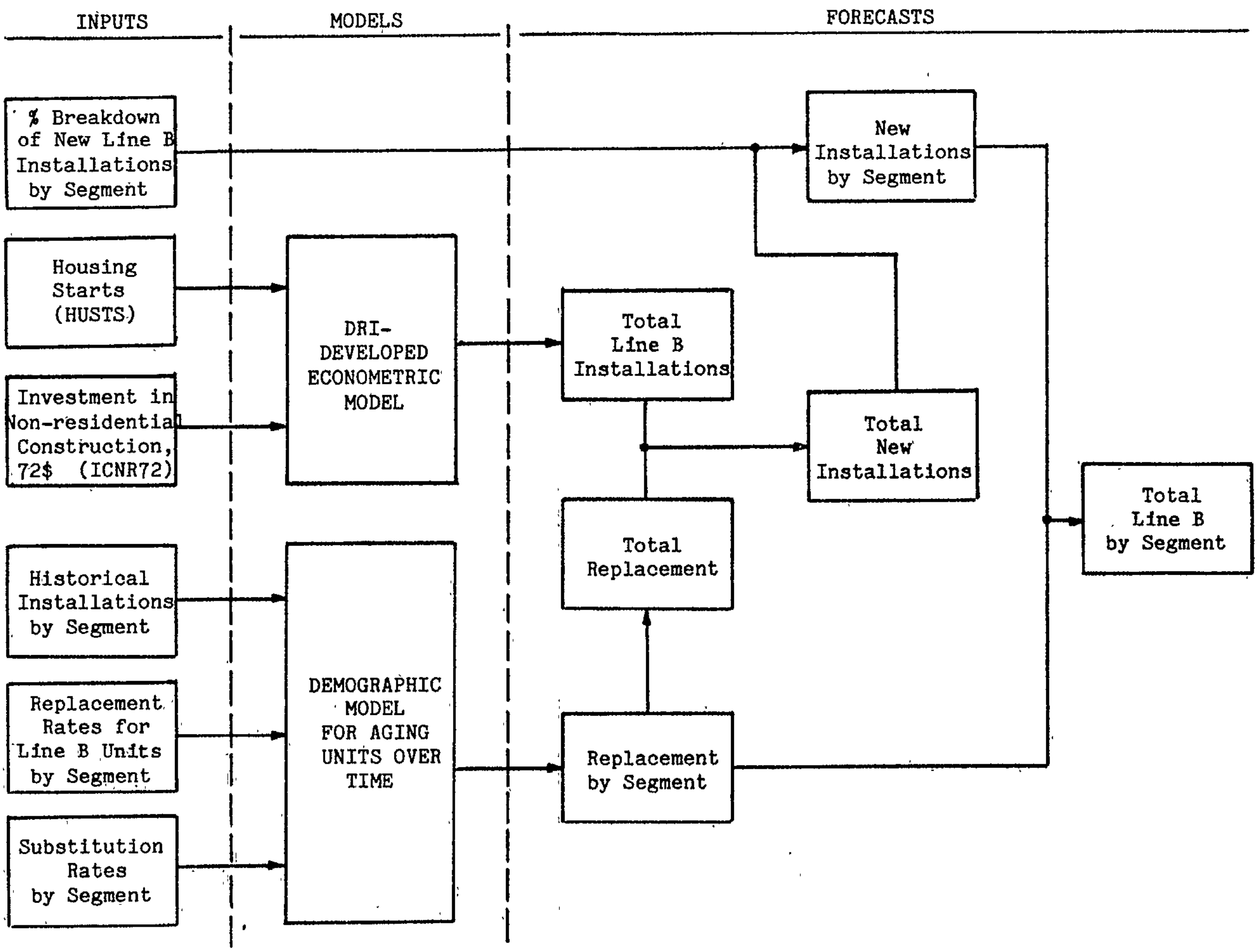


Figure 7

Model for New Line B Installations

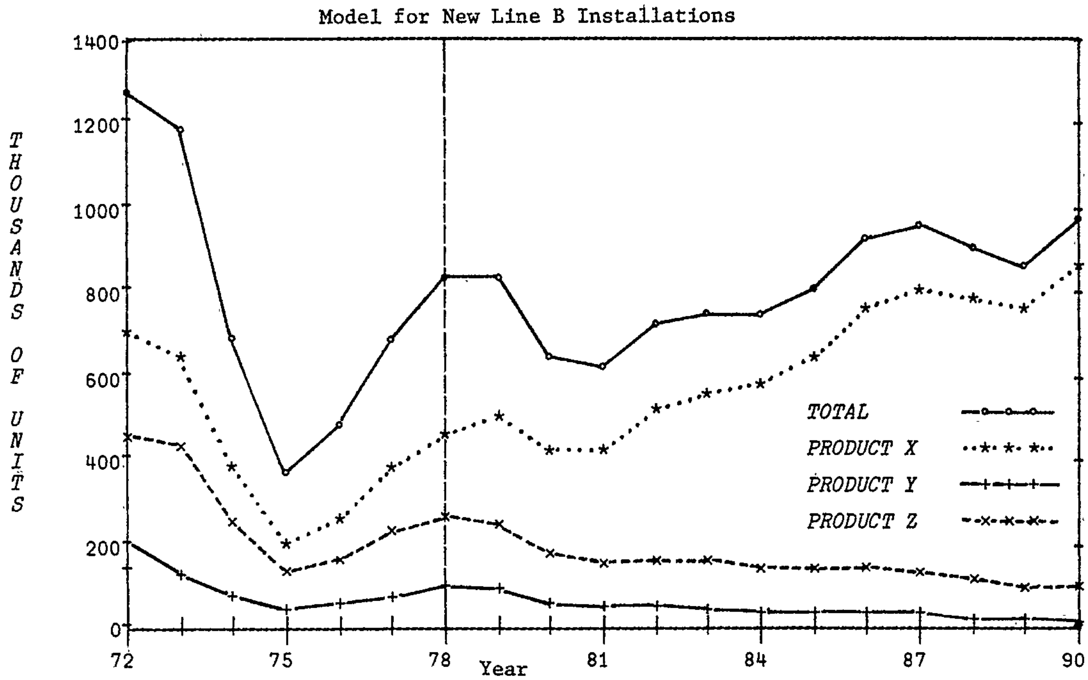


Figure 8
Model for Line B Replacements

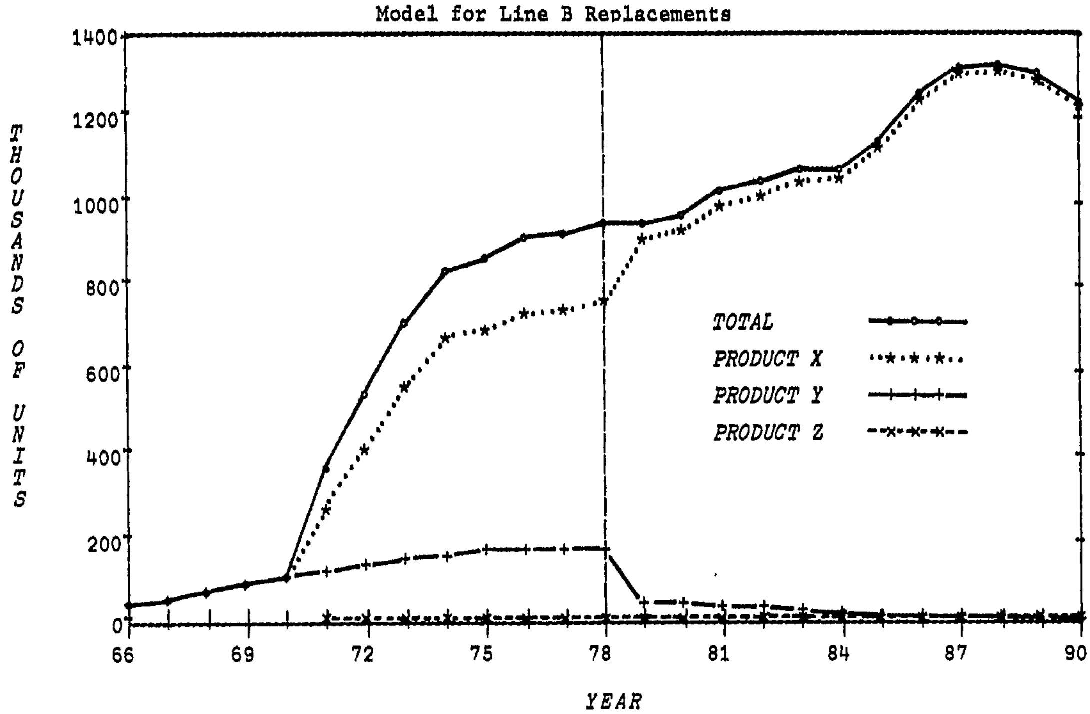
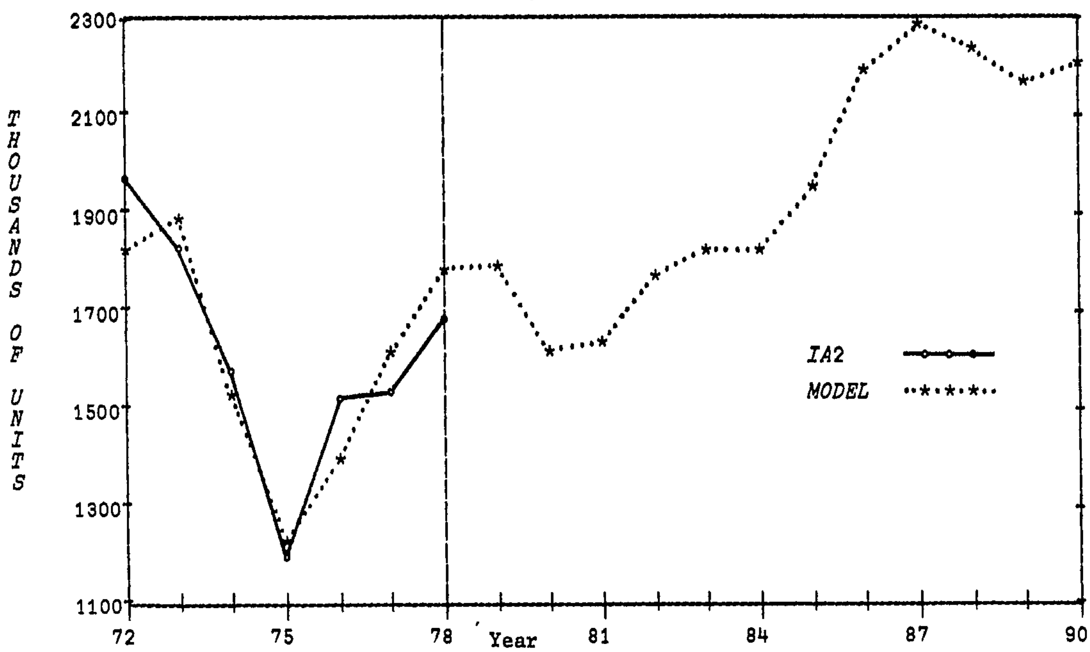


Figure 9
Line B Model vs. Industry Historical Installations



expects that only 18% of the y units needing to be replaced will be replaced with another y unit. Seventy percent of them will be replaced with x units. (The remaining 12% represent unit types other than x, y, or z.)

Before 1977, the substitution phenomenon was insignificant. Recently, however, economic and technological changes have made substitution rates a critical factor in determining the replacement market. The replacement market is plotted in Figure 8.

3.3 TOTAL LINE B.

Since no adequate model could be found for new Line B installations, an econometric model was needed for total Line B. Concurrent with this project, Cindy Cunningham of DRI had developed a quarterly total Line B forecast model for the division which performed very well. (The 1978 back-forecast for Line B was only 5.9% higher than the industry figure.) Rather than develop a second model, hers was annualized and incorporated into this one. It is based on a polynomial distributed lag of HUSTS (single- and multi-family housing starts), and on ICNR72 (investment in non-residential construction in 1972 dollars). Figure 9 plots the annualized DRI model verus industry

(IA2) actuals.

4. CONCLUSIONS.

A computer program has been written to generate the model's forecast through 1990 and print it out in compact form for presentation to management. The forecast can be periodically revised as DRI's forecast of economic variables changes to reflect the latest outlook. In addition to providing a "most likely" forecast, the model can also be used to simulate alternative economic conditions. DRI provides several alternative forecasts for each base case forecast. By inserting alternative forecasts of the appropriate DRI variables into this model, management can see the effect of various extreme economic possibilities on the market. In addition, if other changes to the structural parts of the model become apparent, adjustments can easily be made. For example, replacement rates for future years may be changed if life-expectancies shorten or lengthen.

By combining traditional econometric techniques and a structured approach, this model obtains considerable advantage over one based on a single approach. Clearly, pure econometrics could not describe the replacement phenomenon. Yet the economy does effect the number of new installations. Only a combination of methods can adequately reflect overall market structure, market maturity, economic influences, and business insight.