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AN ECONOMETRIC MODEL OF THE CARPET INDUSTRY

by

Michael Bermish

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1979

This manuscript has been read and accepted for the Graduate Faculty in Economics in satisfaction of the degree of Doctor of Philosophy.

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CHAPTER I

INTRODUCTION

Improved Forecasting for the Carpet Industry

The purpose of my study is to improve the technology for forecasting carpet industry sales. Such a study is of interest not only to the traditional manufacturer of carpets but to a rather diversified conglomerate of new participants in the carpet industry. These new entries into the industry include resilient floor producers, wholesale distributors, building material manufacturers and home furnishing conglomerates who offer the consumer a complete "package" of home furnishings.

Improved demand forecasting is particularly important to the carpet industry at this time. Prior to 1973 simplistic forecasting models for carpets were used and due to consistent industry growth were favorably received. However, after 1973 the carpet industry began showing substantial cyclical movement. Much slower industry growth and actual sales declines during business cycle slumps are now apparent for the carpet industry. Furthermore, increased competitiveness and technological developments have severely depressed the industry's profitability leaving little room for errors in forecasting carpet demand. These changes emphasize the current need for improved forecasting for the carpet industry.

Slower growth in the carpet industry stresses the need for better demand forecasting. Prior to 1973 the carpet industry was characterized as one of the nation's outstanding growth industry. After registering small net increases during the 1950s, carpet demand accelerated from $667 million in 1958 to nearly $3 billion in 1972, a growth rate of nearly 12 percent a year (Table 1). Even during business cycle downturns, as in 1961 and 1970, the industry still registered growth. Simplistic forecasting models for carpets in a consistant growth environment were quite satisfactory. However, by 1973 the industry's growth slowed to 10 percent and during the recession years, 1974 and 1975, the industry experienced 9 percent and 11 percent declines. The industry recovered in 1976 with a growth of 10 percent. Contrary to past historical trends, the carpet industry not only experienced slower growth during a business cycle slump but actually experienced declines (17 percent during the last recession). Simple trend analysis is insufficient for forecasting an industry which during the 1970s showed substantial cyclical movement.

Between 1969 and 1976 the carpet industry experienced low levels of profitability because of the industry's highly competitive nature and the industry's shift toward

TABLE 1

QUANTITY & VALUE OF SHIPMENTS OF
RUGS, CARPETS AND CARPETING

Year	Quantity (thousands of sq. yds.)	Value (thousands of nominal dollars)
1958	NA	666,475
1962	280,475	952,705
1963	317,355	1,066,419
1964	369,104	1,236,901
1965	431,557	1,382,364
1966	469,197	1,497,588
1967	482,587	1,567,104
1968	586,155	1,972,347
1969	642,645	2,186,562
1970	680,479	2,215,111
1971	755,159	2,395,519
1972	934,945	2,936,650
1973	1,025,389	3,360,521
1974	939,133	3,336,551
1975	834,037	3,092,176
1976	920,996	3,574,634
1977	1,025,572	4,118,758

SOURCE: U.S. Department of Commerce, Bureau of the Census, Current Industry Reports, Carpets & Rugs, 1958-1977.

NA=not available

capital intensive-high energy based fiber synthetics. The highly competitive nature of this industry is clearly shown through the industry's concentration ratios (Table 2). In 1972 the top four carpet companies consisted of 25 percent of total industry shipments. More over, by 1974 six firms-Burlington, Champion International, Barwick, Armstrong, Bigelow-Sanford and Mohasco-had shipments totaling $1,140 million, 33 percent of the industry[1]. However, the largest share of the market did not exceed 9 percent in 1974. A consequence of the industry's highly competitive nature is its low profitability. Tables 3, 4 and 5 exhibit three measures of profitability for four major carpet manufacturers. All three measures of profitability exhibit significant declines in profitability throughout the first half of the 1970s. By 1977 the industry's profitability significantly improved, a direct result of higher industry sales. An inaccurate assessment of consumer demand over the business cycle resulting in either large inventories or lost sales will place added strain on the industry's profitability. Consequently, accurate forecasting of carpet demand is necessary since low industry profitability leave little room for forecasting errors.

The carpet industry's shift toward capital intensive-high energy based synthetics is another reason

TABLE 2

1972 CONCENTRATION RATIOS
VALUE OF CARPET SHIPMENTS

	Woven (%)	Tufted (%)	All Other (%)	Total Industry (%)
Top 4 companies	62	21	50	25
Top 8 companies	80	34	70	39
Top 20 companies	95	57	87	61
Top 50 companies	100	80	98	82

SOURCE: U.S. Department of Commerce, Bureau of the Census, Census of Manufacturers, 1972.

TABLE 3

NET PROFIT MARGIN*

	Bigelow	Columbus	Masland	Mohasco
1968	5.00	4.52	2.63	3.23
1969	3.94	2.08	2.02	3.07
1970	2.78	(1.39)	1.48	2.61
1971	2.33	1.56	1.11	3.20
1972	2.38	3.35	2.05	3.42
1973	3.64	3.51	1.65	2.78
1974	2.05	0.77	0.33	1.09
1975	1.37	0.99	1.37	1.82
1976	3.17	1.05	2.36	2.21
1977	4.18	7.25	2.26	1.66

SOURCE: Sperry & Hutchinson Company Financial Division.

*Net profit margin equals net profits after tax divided by total sales.

TABLE 4

RATE OF RETURN ON EQUITY*

	Bigelow	Columbus	Masland	Mohasco
1968	10.8	28.0	8.7	7.9
1969	8.6	7.1	5.2	8.4
1970	5.7	(4.1)	3.5	6.7
1971	5.2	5.4	2.9	7.7
1972	5.5	13.5	6.6	9.3
1973	8.5	12.6	6.2	8.6
1974	4.8	2.6	1.3	3.7
1975	2.9	3.2	5.3	5.0
1976	7.3	2.9	9.5	7.5
1977	10.0	25.1	22.7	11.2

SOURCE: Sperry & Hutchinson Company Financial Division.

*Calculated as net profits after tax divided by net worth.

TABLE 5

RATE OF RETURN ON ASSETS*

	Bigelow	Columbus	Masland	Mohasco
1968	6.95	8.81	4.13	3.98
1969	5.39	3.53	3.14	4.45
1970	3.69	1.89	2.11	3.50
1971	3.31	2.46	1.66	4.57
1972	3.48	6.24	3.28	4.95
1973	5.63	6.47	2.75	4.13
1974	3.06	1.33	.57	1.66
1975	1.98	1.54	2.55	2.81
1976	5.09	1.51	4.61	3.85
1977	6.83	6.72	8.41	2.82

SOURCE: Sperry & Hutchinson Company Financial Division.

*Rate of return on assets is calculated as net profits after tax divided by total assets.

for the carpet industry's low profitability. During the 1960s and early 1970s technological advances in man-made fibers coupled with improved tufting processes cut production costs dramatically and lowered the absolute and relative price of carpets to within reach of the average consumer (Table 6, 7). The carpet manufacturer was trading low prices for a larger share of consumer's discretionary income thereby making his profitability highly volatile to consumer demand. General inflation and the energy crisis of the mid-seventies threw the carpet industry into havoc. Highly sophisticated tufting processes and man-made fibers production are high energy users. Although the dramatic increase in energy costs in the mid-seventies raised production costs and its absolute price, the relative cost of carpeting continued to decline (Table 7). As a result, declining consumer demand for carpets during this period further depressed profit margins and accentuated the carpet industry's vulnerability to shifts in consumer demand. More accurate econometric forecasting of consumer demand for carpets will lessen the shock on the carpet industry's profitability of unexpected fluctuations of consumer demand.

Slower growth in the carpet industry reflects the decline in importance of one of the three main sources of carpet demand, replacement of hard floor covering with

TABLE 6

ABSOLUTE CONSUMER PRICE INDICIES FOR SOFT FLOOR COVERINGS

Year	Index	Annual Percent Change
1969	1.035	1.5
1970	1.028	-0.7
1971	1.023	-0.5
1972	1.015	-0.8
1973	1.028	1.3
1974	1.116	8.6
1975	1.191	6.7
1976	1.244	4.5
1977	1.273	2.3

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index Detailed Report, 1969-1977

TABLE 7

RELATIVE* CONSUMER PRICE INDICIES
FOR SOFT FLOOR COVERINGS

Year	Index	Annual Percent Change
1969	.967	-2.2
1970	.919	-5.0
1971	.878	-4.5
1972	.854	-2.7
1973	.843	-1.3
1974	.855	1.4
1975	.819	-4.2
1976	.806	-1.6
1977	.780	-3.2

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index Detailed Report, 1967-1977

*Relative to all consumer durables.

soft floor coverings. Table 8 shows dollars spent on hard and soft floor coverings for selected years. Instead of soft floor covering gaining ground on hard floor coverings, 1975 and 1976 saw a percentage increase in shipments of hard over soft floor coverings. Consumers are no longer readily replacing hard floor coverings with soft floor coverings. As a result, increased significance is placed on the remaining two markets[2] for carpets. Carpet manufacturers need a better understanding of the demand factors effecting these markets. However, both markets are showing substantial cyclical movement reflected in the industry's overall slower growth. Simple trend analysis does not explain the cyclical movements apparent in these markets. A more rigorous forecasting model which will include cyclical movements is needed.

Studies on the Demand for Consumer Durables

Traditional consumer durable demand studies focus on the importance of income and price elasticities. G. Chow's estimate of income and price elasticities for automobiles range as high as 2.0 and -1.1 respectively. M. L. Burnstein in a study on consumption of refrigerator services estimates slightly higher income and price elasticities. Similar estimates were derived for income and price elasticities by J. Carman in a study on household furniture. These studies provide separate estimations

TABLE 8

HARD FLOOR COVERING SHIPMENTS VS.
SOFT FLOOR COVERING SHIPMENTS FOR
SELECTED YEARS
(in millions of nominal dollars)

Year	Hard Floor Coverings	Soft Floor Coverings	Hard Floor Coverings Percent of Total Floor Coverings
1953	162.2	501.5	32
1958	151.9	666.5	23
1960	159.3	820.5	19
1963	168.1	1,081.7	16
1965	227.8	1,496.6	15
1968	199.6	1,962.8	10
1973	316.1	3,395.0	9
1974	327.2	3,305.3	10
1975	427.0	3,240.0	13
1976	504.8	3,794.9	13

SOURCE: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufacturers, 1953-1976.

of income and price elasticities for "stock" demand and "flow" demand. Furthermore, separate estimates for disposable and expected income were derived. W. Reynold's study on wholesale carpet demand disregards these distinctions. Reynolds' estimates are with the necessary assumption that replacement demand cannot be separated out of total demand. Furthermore, Reynolds only uses personal disposable income. His estimates for price elasticity is also in the same range as above. However, his estimates for income elasticity is much higher, as high as 4.0.

Gregory Chow[3] attempts to estimate the demand for automobiles where actual stock of automobiles bought is a function of the desired stock and actual stock in the last period times a depreciate rate. He estimates demand under two assumptions: (a) instantaneous stock adjustment and (b) slow stock adjustment. The estimation of his equations depend principally upon price and income, either disposable income or expected income[4]. Under the assumption of instantaneous stock adjustment of actual to desired stock of automobiles, Chow estimates a price elasticity between the range -0.6 and -1.1 and using disposable income estimates income elasticity between the range of 1.5 and 1.7. However, when Chow uses expected income he estimates income elasticity to be between 1.8 and 2.0[5]. Under the assumption of a slow stock adjustment[6] of actual to desired stock of automobiles, both price and income elasticities for both disposable and expected income are estimated in the range of -0.7 and 1.8 respectively. However, the disposable income variable explains a substantially larger fraction of the variance than the expected income variable. Chow's estimates were derived from data between 1921 through 1953. The equations forecast well when extrapolated for the years between 1954 through 1957.

M. L. Burstein[7] estimates the demand for refrigeration by constructing a unit of refrigeration from Sears mail order sales which includes quality improvements. Using different levels of depreciation (from 10 percent to 25 percent), Burstein estimates the consumption of refrigeration services by forecasting on the same two variables[8], price and income. He estimates the price elasticity between -1.07 and -2.06 and the income elasticity between .84 and 2.54. However, when a time trend variable is added the price elasticity falls to unity and the income elasticity falls to .83[9]. Both variables remain statistically significant. When the time trend variable is added, the problem of multicollinearity arises. When Burstein estimates the equations in first difference form to avoid this problem. the estimate for the income elasticity range from .70

using disposable income and 1.6 using expected income. He estimates the equations using data between 1931 through 1941 and 1948 through 1955 (Sears suspended refrigerator sales between 1942-1947). In a cross section study for 1954 stock of consumption of refrigeration services, Burstein also arrives at an estimate of price elasticity in the range between -1.0 and -2.0 and the income elasticity in the range between 1.0 and 2.0.

James Carman's[10] study on consumer durables focuses on the demand for household furniture. He derives estimates for price and income elasticities for the periods 1921 to 1941 and 1946 to 1959 for both a stock and market demand concept. The stock demand concept looks at the dynamic behavior of consumers purchases of furniture as a desire to achieve an equilibrium stock of furniture rather than to consume "new" furniture. He estimates the income elasticity to be between the range of .5 to 1.0. He estimates the price elasticity to be approximately -0.2. The market demand concept looks at actual furniture sales in each period. This concept is useful for management decisions in determining responses to changes in income and price. Income and price elasticities range from .8 to 2.2 and -.66 to -1.75 respectively. For both estimates Carman found income elasticities to be less elastic during the post war period. He rationalizes this result as a decision by consumers not to treat their furniture expenditures as a luxury but rather as a function of their discretionary income.

The first comprehensive study on the carpet industry was conducted in 1968 by William Reynolds[11]. He attempts to estimate wholesale carpet shipments in square yards between 1947 and 1963. Reynolds concludes that now there is no available or logical method for which to incorporate Chow's and Burstein's separation of a stock from a flow concept because of two reasons: (a) carpeting has an almost interminable life span and varies with quality[12] and (b) carpets can be moved from room to room and does not depreciate in the same way as automobiles or refrigerators. As a result, a separate measure for replacement demand is neither calculable nor necessary. Reynold's estimate of wholesale carpet shipments is a function of income and price[13]. Between 1947 and 1963 his estimates of income and price elasticities are 4.0 and -1.0 respectively. However, he significantly improves his results when he regresses the same equation over a shorter time interval, 1951 to 1963. For this period his income and price elasticity is 3.5 and -1.3 respectively. The equations are in first difference form in order to account for any time trend. Reynolds concludes that given the high degree of income and price elasticities, low product differentiation and a fairly large number of firms, the individual firm's demand curve approaches a horizontal demand curve.

<u>Recent Forecasting Models for Carpeting and Household Furniture</u>

Present carpet demand forecasting methods are woefully inadequate. The econometric models used have both technical and theoretical problems. A more complex model encompassing both the supply and demand side has been built for the household furniture industry, a consumer durable similar to carpeting. Although carpet and household furniture industries have many similarities, forecasting carpet demand involves many complications which differentiate the two industries.

Recent carpet demand forecasts are performed by fiber suppliers, i.e., Allied Chemical and Monsanto, large chemical firms which produce man-made fibers for use in carpet manufacturing. Their econometric models for wholesale carpet demand usually consist of one or two exogenous variables, consumer spending on durable goods[14] and housing starts[15]. Residential starts determine the "need"[16] for carpeting, as reflected in new floor space available for floor coverings. Consumer spending on durable goods is a proxy for a consumer's "willingness" to purchase carpeting as reflected in consumer's overall willingness to purchase consumer durables.

However, these simplistic models encounter two main problems, autocorrelation and misspecification. Using consumer spending on all durable goods as an exogenous variable trying to explain demand for a consumer durable (carpeting) results in serial correlation and an inefficient predictor[17] on the exogenous variable. Using housing starts as a proxy for the need for carpeting for the total need for carpeting is a misspecification. Housing starts only reflects the need for new residential floor space. Residential contract demand and commercial contract demand are not explained by this model. Misspecification is also reflected in the absence of an income variable, a proxy for ones "ability" to purchase carpeting.

Recently, a more complex model[18] has been successfully built for the household furniture industry, a consumer durable similar to carpeting.[19] This model simultaneously determines supply and demand for wholesale and retail household furniture. The model consists of two sets of simultaneous equations, i.e., two simultaneous sets of equations determining equilibrium price (supply) and demand. Demand for retail household furniture sales is a function of: (a) income, (b) prices which consumers face and (c) derived demand reflecting the "need" for household furniture, e.g., residential construction. Retail household furniture price is a function of: (a) retail demand and (b) prices which retailers face. Demand for wholesale household furniture is a function of: (a) demand for household furniture on a retail level and (b) prices which retailers face. Wholesale household furniture prices is a function of: (a) wholesale demand and (b) prices of factors of production. The model can be stated in the following functional form:

Wholesale Price (supply) and Demand for Household Furniture

Dhf=f($D\hat{r}s$, Pw)

Pw=F(Dhf, Pf)

Retail Price (supply) and Demand for Household Furniture

Drs=f(I, Pc, Rc)

Pc=f(Drs, Pw)

Dhf=Demand for household furniture at the wholesale level.
Drs=Demand for household furniture at the retail level.
$D\hat{r}s$=Estimated demand for furniture at the retail level.
Pc=Prices of household furniture consumer's face at the retail level.
Pw=Prices wholesalers receive for household furniture.
I=Income.
Rc=Residential construction variable.
Pf=Prices of factors of production.

In equilibrium, household furniture demanded on the retail level is equal to household furniture supplied on the wholesale level. Each set of simultaneous equations satisfies the identification specifications associated with simultaneous equations[20]. For the retail demand equations the endogenous and exogenous variables are Drs, Pc and I, Pw, Rc respectively. For the wholesale demand equations the endogenous and exogenous variables are Dhf, Pw and $\hat{D}rs$, Pf respecitvely. When the models are solved as a complete solution, the identification specifications are also satisfied.

As home furnishing products, carpeting and household furniture are similar in factors which determine wholesale and retail supply and demand. However, forecasting carpet demand is complicated by discontinuities with its past history and major data problems. The retail end market subdivisions further complicates the estimation procedure. Consequently, the carpet model will differ in many ways from the above model. Since it is important to identify these complexities before proceeding to the carpet model itself, the subsequent section will clarify the complications in carpet demand forecasting.

<u>Complications for Forecasting the Carpet Industry</u>

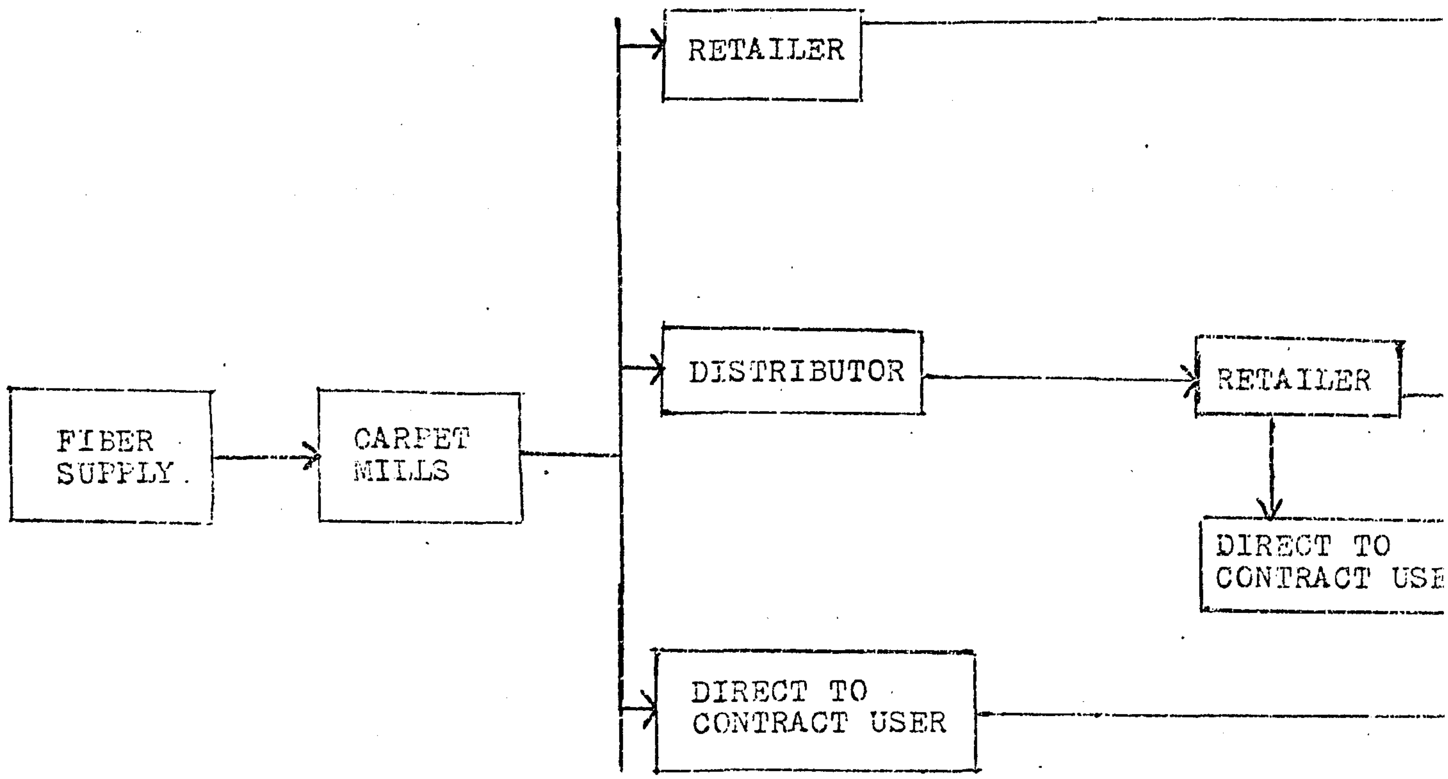
There are many complications in forecasting carpet demand. The carpet industry has different end markets for some of which there are no satisfactory historical data. Also there are no historical data on carpet retailer inventories, an important variable affecting manufacturer's orders. Furthermore, the carpet industry has experienced sharp discontinuities with its past history, e.g., sharp increases in production costs, a changing role of hard floor coverings and its effect on the replacement market, and the changes in consumer confidence due to general inflation expectations. T. discontinuities with past history place skepticism a restrictions on the use of historical data in foreca current carpet demand.

Data on the carpet industry's three distinct markets are unavailable. However, forecasting each market, each with its own particular economic factor affecting its market, are important. Chart I looks at the flow of the carpet industry from fiber suppl through the channels of distribution to its end mar The carpet industry's three distinct end markets ar (1) residential, (2) contract residential, and (3) c commercial [21]. Recent estimates give residential 68. percent, contract residential 16.1 percent and contr commercial 15.7 percent of the total carpet market. Hence, the "contract" market, within its broad defi accounts for nearly 32 percent of the total market. Historically, government data is only collected on a total carpet shipment basis without any breakdown a the three end markets.

This problem becomes even more acute when the markets are further subdivided. Table 9 lists selec end markets with their percentage share of the total supply of carpets. Each selected end market also h distinct economic factors which affect its market. However, such data on selected end markets are unava

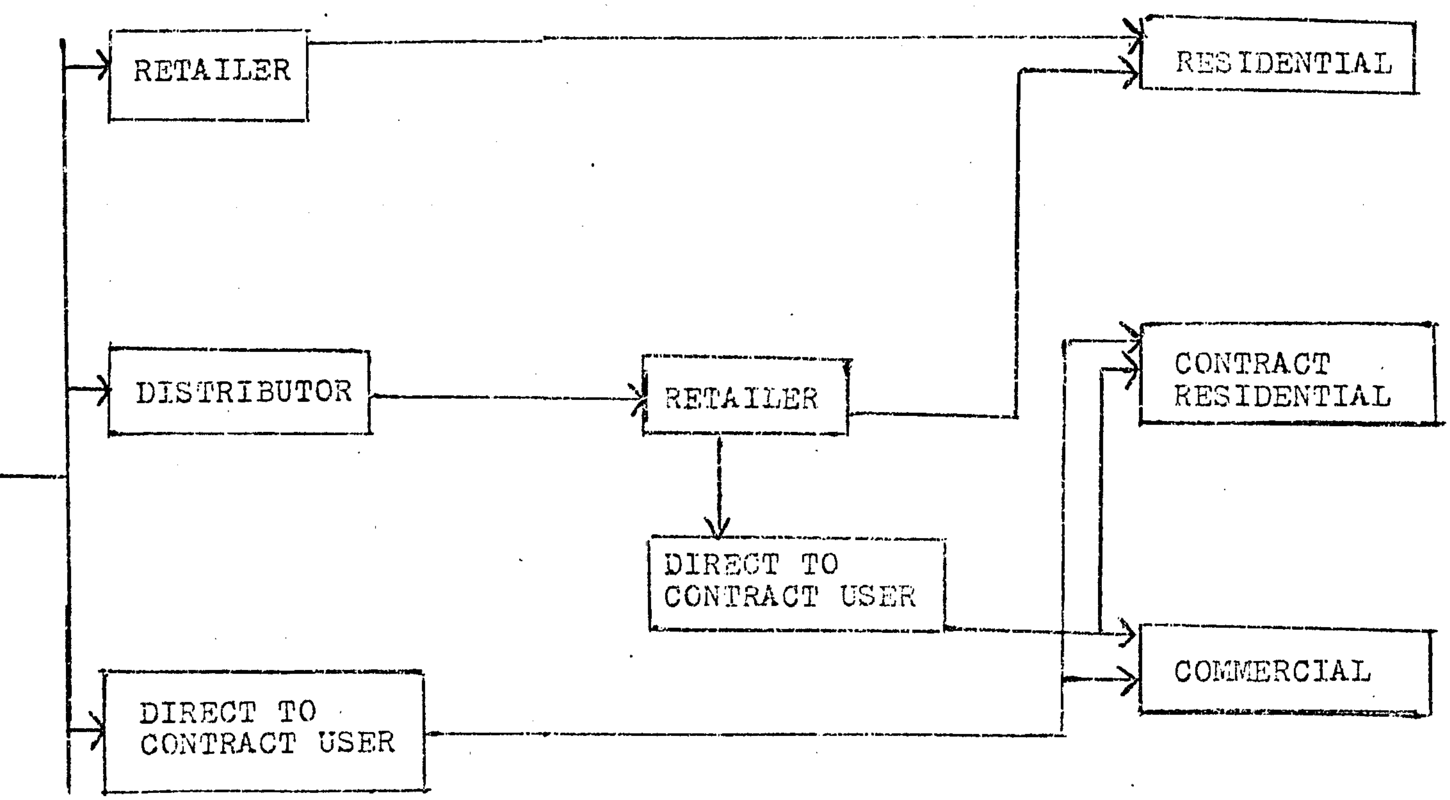
CHART I

CARPET INDUSTRY: CHANNELS OF DISTRIBUTION



SOURCE: Allied Chemical, 1977

S OF DISTRIBUTION



cal, 1977

TABLE 9

SELECTED END MARKETS
FOR CARPETS

A. CONSUMER

Use	Percent of Total
Living room, dining room, hall	37
Bedrooms	17
Other	14
Total	68
B. CONTRACT RESIDENTIAL	
One and two family homes	11
Mobile	2
Multi-family	3
Total	16
C. COMMERCIAL	
Office	4
Store	4
Hospitality	4
School	1
Health Care	1
Other	2
Total	16

SOURCE: Allied Chemical, 1977

and forecasting these end markets from aggregate data are misleading.

Inventory data for the carpet industry, an important variable effecting carpet sales, are also nonexistant. For all consumer durables, inventory swings contribute to the volatility in industry sales. Retail inventory swings affect major channels of distribution. This is especially the case for the carpet industry. Wholesale carpet orders and sales in one period are affected by inventory changes in the previous period. Larger inventories relative to sales are negatively correlated with future wholesale carpet orders. Inventory data, either for distributors or retailers are not available which restricts the accuracy of forecasting wholesale carpet sales.

A further complication in forecasting the carpet industry is its apparent discontinuity with past history. The dramatic upturn in carpet prices since 1973 places skepticism on the use of earlier carpet price data for current carpet demand forecasting. From 1973 carpet production costs have increased significantly relative to previous years. Table 10 shows the wholesale price index (WPI) for carpets and annual percent changes. From 1966 to 1972 the WPI for carpets declined in five out of seven years. From 1973 through 1977 the WPI for carpets rose an average of nearly 5 percent annually with a 10

TABLE 10

WHOLESALE PRICE INDICIES FOR
SOFT FLOOR COVERINGS

Year	Index	Annual Percent Change
1966	1.049	-0.5
1967	1.000	-4.7
1968	1.007	0.7
1969	1.007	0.0
1970	.990	-1.7
1971	.967	-2.3
1972	.961	-0.6
1973	1.010	5.1
1974	1.109	9.9
1975	1.146	3.3
1976	1.179	2.9
1977	1.219	3.4

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, _Wholesale Prices and Price Indicies, 1966 to 1977_ percent increase in 1974. The main reason behind these dramatic price increases is the increased dependency on synthetic fibers. Nearly 99 percent of all carpet fibers are now synthetics. Synthetic fibers are energy based. The sharp escalation in energy prices after 1973 caused sharp increases in the cost of fibers and, consequently, the cost of carpets. Furthermore, changes in the relative importance of hard floor coverings has shifted the carpet market toward replacement demand. Data on the replacement segment of carpet demand for end markets are not only unavailable, its dramatic increase in importance in recent years places skepticism on estimations of its relative importance from aggregate data. A 1975 study on floor covering[22] pinpoints the key factor for the rapid increases in soft floor covering sales. Due to low costs for carpeting and new innovative designs, carpeting was not only replacing old carpeting, but also hard floor coverings even before they are worn out. However, by early 1970 the carpet industry was unable to sustain its growth by replacing hard floor coverings. By 1973 hard floor covering's share of the total floor covering market was only 9 percent, from a substantial 32 percent share in 1953 (table 8). This important determinant of the carpet industry's growth has all but vanished. In addition, recent technological improvements on hard surface floor coverings has altered its traditional role from a poorer substitute for carpeting to a major floor covering competitor. Because of its low cost and easy installation hard floor coverings have in recent years made inroads on carpet's share of the market. These factors sharply increases the role of replacement demand as a significant factor towards carpets continued growth. However, the absence of data on replacement demand reduces our understanding of total carpet demand.

Consumer confidence in the general economy, an important determinant of carpet demand, has also changed dramatically in recent years. No longer are consumer attitudes toward durables so easily predictable. From 1960 to 1973, when the annual percent increases for inflation averaged nearly 3 percent, the University of Michigan's index of consumer sentiment showed slight variation from the 90 and above level (table 11)[23]. However, uncertainty set in with inflation after 1972, averaging nearly 8 percent annually. Since 1972, consumer confidence averaged 76 with a low point of 64 in 1974. Since carpet manufacturers are vying for a share of consumer's discretionary income, unexpected shifts in consumer confidence due to inflationary expectations will have profound effects on carpet sales volatility, further complicating industry forecasting.

TABLE 11

COMPARISON OF CPI AND
CONSUMER CONFIDENCE INDEX

Year	CPI	Consumer Confidence Index
1960	.886	.934
1961	.896	.928
1962	.906	.948
1963	.918	.948
1964	.930	.992
1965	.944	1.024
1966	.973	.938
1967	1.000	.941
1968	1.042	.931
1969	1.098	.882
1970	1.163	.765
1971	1.212	.811
1972	1.253	.904
1973	1.331	.761
1974	1.477	.640
1975	1.613	.705
1976	1.705	.854
1977	1.815	.868

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index Detailed Report, 1960-1977; U.S. Department of Commerce, Bureau of Economic Analysis, Business Conditions Digest, 1960-1977

NOTES

[1]Floor Coverings T-38, Predicasts, Inc., July 1975

[2]The other two sources of carpet demand are: (1) new floor covering space reflected in new housing (2) replacement market, e.g., new carpeting replacing old carpeting.

[3]Gregory C. Chow, "Statistical Demand Functions for Automobiles and Their Use in Forecasting", The Demand for Durable Goods, ed. Arnold C. Harberger (Chicago: University of Chicago Press, 1960), pp. 149-178

[4]Friedman's expected income is a weighted moving average of disposable income in which current income gets one-third of the total weight and past incomes getting progressively less weight.

[5]The equation using expected income explain up to 10 percent addition variance.

[6]A lag dependent variable is added.

[7]M.L. Burstein, "The Demand for Household Refrigeration in the U.S.", The Demand for Consumer Durable Goods, ed. Arnold C. Harberger (Chicago: University of Chicago Press, 1960), pp. 99-145

[8]Burstein assumes for the most part instantaneous adjustment.

[9]When Burstein uses expected income, adding a time trend reduces the income elasticity to 0.5 and statistically insignificant.

[10]James A. Carman, Studies in the Demand for Consumer Household Equipment, Research Program in Marketing, (University of California: Institute of Business and Economic Research, 1965)

[11]William A. Reynolds, Innovation in the U.S. Carpet Industry 1947-1963 (New York, Chicago, San Francisco: Van Nostrand Company, Inc., 1968)

[12]Reynolds also concludes that due to innumerable opinions it is practically impossible to ascertain whether quality of today's carpets is better than the quality of earlier carpets.

[13]Reynolds uses disposable income. Studies done on carpeting show a low proportion of carpets were bought on an installment basis. The price variable is relative to hard floor covering prices.

[14]Usually excluding automobile consumption.

[15]Housing starts are usually lagged two or three quarters.

[16]The concept of "need" is analogous to "derived demand" for consumer durables.

[17]Large sampling variances for our values will occur.

[18]Unpublished study by the National Association of Furniture Manufacturers, Washington, D.C.

[19]They both fall into the category of "household furnishings".

[20]For a simultaneous equation model the number of variables excluded from the equation must be at least as great as the number of equations in the model less one. Since each equation has at least one exogenous variable excluded with two equations, both simultaneous systems are identifiable.

[21]Residential carpeting is defined as any carpeting purchased by a family, a household or an individual for (non-business) personal use only. Nonresidential contract carpeting is defined as carpeting installed in government buildings, schools, dormitories, hospitals, hotels, motels, office buildings and other nonresidential structures. Residential contract market is defined as carpeting installed as part of a building contract for a single family tract built houses, low and hi-rise apartments, mobile homes, recreational vehicles and modual homes.

[22]<u>Floor Coverings T-38</u>, Predicasts, Inc., July 1975

[23]Except for the 1970 recession where consumer confidence dropped to 77 percent.

CHAPTER II

The Structural Model Using Ordinary Least Squares

The structural model using ordinary least squares for the carpet industry consists of three equations, i.e., one equation for the residential retail market, one equation for the contract market and one equation for the wholesale market. The structure of each equation conforms to the traditional framework of consumer demand analysis. The demand for each market is determined by income, price and demand derived by other factors not related to income or price.

The structural model for the carpet industry is as follows:

(1) Residential Retail Equation.

DRS=f(I, Rc, Pc)

DRS=Demand for retail floor coverings.
I=Income.
Rc=Residential construction (derived demand variable).
Pc=Consumer price for floor coverings.

(2) Contract Carpet Equation.

DC=f(Cp, Nrc, Pc')

DC=Demand for commercial carpeting.
Cp=Corporate profits.
Nrc=Residential and/or nonresidential construction (derived demand variable).
Pc'=Consumer price for contract carpeting.

(3) Wholesale Carpet Equation.

DW=f(Yd, Tc, Pw)

DW=Demand for wholesale carpeting.
Yd=Income.
Tc=Residential and nonresidential construction (derived demand variable).
Pw=Wholesale price for carpeting.

Each equation will be estimated using ordinary least squares. The equations will be estimated primarily in log form in order to interpret the coefficients in percent changes and/or elasticities. The coefficient of the variables belonging to the best fitting equation will be subsequently interpreted. The best fitted equation will be tested to determine its stability and its forecasting accuracy. Each equation will also be estimated using two stage least squares as an alternative method of estimation. The statistical results for the best fitted equations using two stage least squares are presented in Appendix I.

Residential Retail Equation: Variables Tested

The variables tested in the residential retail sales equation conform to the traditional framework of consumer demand analysis. Consumer demand is determined by the level of income, the relative price of retail floor coverings and demand derived by other factors not related to income or price.

The Endogenous Variable

Residential Retail Floor Coverings Sales

Data on retail floor coverings stores includes all types of soft floor coverings (carpeting) and hard floor coverings (vinyl, tile).[1] The data are collected on a monthly basis by the U.S. Department of Commerce, Bureau of the Census, and are furnished upon request in a monthly letter entitled "Monthly Retail Trade Survey". The data are available on a monthly basis from 1967 through the present, are seasonally unadjusted and in current dollars. However, because of small survey panels the data are subject to sampling errors. The U.S. Department of Commerce cautions the user of these data in its monthly letter:

> "As stated in previous correspondence, although dollar volume sales estimates are developed for this particular kind of business, the survey panels are small compared to the panels for the major kind-of-business groups, and the estimates are not published since they are subject to relatively high sampling error. The estimates have the additional limitation that corrections made to major group totals may not be carried to estimates for unpublished kinds of business."

However, the month to month percentage changes from these estimates have a smaller sampling variability than the actual estimates and are more reliable.

The Exogenous Variables

Income Variable

The level of consumer income reflects the consumer's ability to purchase various goods and services. Carpeting is a luxury item and postponable. As income rises, more money is available for luxury purchases. Consumers will be unwilling to postpone such purchases. Subsequently, retail demand for carpeting increases. Furthermore, due to imperfect capital markets, consumer's ability to self-finance durable expenditures is important. Two variables which aptly reflects consumer's ability to purchase goods and services are disposable personal income and discretionary income.

Disposable personal income is the income people have for spending on all items. It is the total income received by a household, i.e., wages, interest and dividends minus the personal taxes which each household pays. Household disposable income is spent on both necessary goods and services such as food, clothing, rent and luxury or postponable goods such as automobiles, furniture and carpeting.

Since carpeting is a luxury good, consumer's disposable personal income might not truly reflect the consumer's ability to purchase postponable goods. Disposable personal income may rise, but costs of necessary goods and services may rise as fast or faster and leave little if any residual income for postponable purchases such as carpeting.

A more accurate gauge of the consumer's ability to purchase postponable goods such as carpeting is consumer's discretionary income. Discretionary income proposes that not all income can be spent on luxury items including income which is saved. The Conference Board defines discretionary income as equal to the sum of disposable income and net household credit minus net contractual savings, essential expenditures, fixed commitments, imputed income, and discretionary savings.[2] This definition provides a realistic apprasial of the consumer's ability to purchase postponable goods and services and hence its economic importance.

Both variables will be tested in order to determine which variable most closly correlates with retail carpet demand. Disposable personal income is collected on a quarterly basis by the U.S. Department of Commerce, Bureau of Economic Analysis, and is available in a publication entitled "National Income and Products Accounts of the U.S.". Discretionary spending is calculated on a quarterly basis by the Conference Board and is available upon request. The data are available from 1952 to 1977.

Derived Demand Variables

Derived demand variables explain the demand for carpeting not related to income or price. The derived demand for retail carpeting is reflected through the amount of new floor space available to be covered. New available floor space is measurable either in a flow or stock concept. Furthermore, the demand for carpeting is explained through the complimentary relationship between carpeting and other household furnishings.

The flow of available floor space is measurable by either investment in residential structures or total private housing starts. Both variables include single and multi-family housing units. Each variable can be viewed as a leading indicator as to the future demand for carpeting. However, both variables may not be completely reliable as measures for additional available floor space. More and more housing contractors include residential contract carpeting as part of the construction package. Therefore, the amount of real additional floor space available as measured by either of these two variables might be biased upward.

The stock of available floor space is measured by the total carpet stock of housing, i.e., single and multi-family housing units. The total stock of housing is calculated by subtracting a percentage depreciation from last periods housing stock and adding a certain percentage of housing starts.[3] The percentage change in the capital stock of housing measures carpet demand derived from additional available floor space. However, a substantial percentage of new available floor space are initially covered by contract carpeting. Therefore, the coefficient for the capital stock of housing might be biased downward.

There exists a complimentary relationship between carpeting and other home furnishing goods. The complimentary relationship is derived through the consumer's need for a "totally" furnished household. Although the direction of causality between carpeting and home furnishing goods has not been statistically determined, the retail equation will assume household furniture purchases leads floor covering purchases.

Each derived demand variable will be tested in order to determine whether the stock, flow and/or complementary aspects of carpeting significantly correlates with carpet purchases. Investment in residential structures is calculated quarterly by Data Resources, Inc. based on data collected by the U.S. Department of Commerce and published in "National Income and Product Accounts of the U.S.". The data are available from 1947 to 1977. Data on private housing starts, i.e., single and multi-family units are collected on a quarterly basis by the U.S. Department of Commerce, Bureau of the Census and published in "Construction Report C20, Housing Starts". The data are available from 1947 to 1977. The capital stock of housing is calculated using the equation described on the previous page. The data are available from 1959 to 1977. Household furniture shipments[4] is calculated on a quarterly basis by the National Association of Furniture Manufacturers based on data collected by the U.S. Department of Commerce, Bureau of the Census and published in the "Annual Survey of Manufacturers, Value of Product Shipments".[5] Total furniture shipments includes wood, upholstered and metal household furniture (SIC 2511, 25120, 2514), wood TV, radio and sewing machine cabinets (SIC 25170) and household furniture not elsewhere classified (SIC 25190). Is excludes mattresses and bedsprings (SIC 2515). The data are available from 1968 to 1977.

Relative Price Variable

The data representing the level of prices of floor coverings consumers face is the consumer price index (CPI) for floor coverings. The consumer price index is a statistical measure of price changes of consumer goods and services. It measures the changes in price which effects the cost of living. The CPI is a weighted aggregate index number with fixed annual rates. It is measured by repricing costs of fixed goods and services bought by consumers at regular time intervals. Except for weight revisions the quantity of goods and services is kept constant. The CPI is a consistant statistical measure of floor covering prices.

The demand for carpeting is negatively related to price. However, the price of other goods (durables and non-durables) play a significant role in determining the real effect price has on carpet sales. If the price of carpeting increases but decreases relative to other goods, the effect on carpet demand is positive. Therefore, the CPI for floor coverings is divided (deflated) by the implicit price deflator for personal consumption expenditures. This ratio is the price consumers pay for floor covering relative to the cost of all consumption expenditures. The relative price of carpeting is negatively related to the demand for carpeting.

The consumer price index for floor coverings is collected monthly by the Bureau of Labor Statistics and published in "CPI Detailed Report". The data are available from 1947 to 1977. The implicit price deflator for personal consumption expenditures is collected quarterly by the U.S. Department of Commerce, Bureau of Economic Analysis and published in the "National Income and Product Accounts of the U.S.". The data are available from 1947 to 1977.

Residential Retail Equation: Statistical Results

The statistical results of the retail equation are good. The model explains 97 percent of the variance in retail floor covering sales, with an average forecasting error of 5.0 percent. The Durbin-Watson statistic, a test for autocorrelation, is in the ambiguous range. However, upon examining the residuals of the model and applying various residential trend tests, the residuals are randomly distributed. The most logical variables are statistically significant and their regression coefficients are reasonable. The absolute value of the relative price coefficient is elastic and significant. The elasticity coefficients for the derived demand variables (household furniture shipments and the capital stock of housing) are positive and significant. The only surprise is an inelastic coefficient for the income variable. The quarterly model's forecasting ability is good on an annual basis but performs poorly on a quarterly basis. The reasons for the poor quarterly performance is the result of variable seasonality factors beyond the usual seasonality adjustments.

The Best Equation

The best equation for forecasting retail floor covering sales is:

$$\text{Log(FCRS72)} = -8.97 - \underset{(-2.28)}{1.47}\text{Log(PC1)} + \underset{(2.16)}{.32}\text{Log(DISCINC72)}$$
$$+ \underset{(4.11)}{.55}\text{Log(SHIPS\textbackslash 1)} + \underset{(4.55)}{3.0}\text{Log(KQHUSTS\textbackslash 3)}$$

t-statistic in parenthesis

FCRS72=Real retail floor covering sales, seasonally adjusted.
PC1=Relative retail price of floor coverings.
DISCINC72=Real discretionary income.
SHIPS\1=Real household furniture shipments, seasonally adjusted, lagged 1 quarter.
KQHUSTS\3=Number of existing housing stock, lagged 3 quarters.
Time interval=1969 to 1977
$\bar{R}^2$=.97
Durbin-Watson=1.49
Standard Error of the Regression=.050

Table 12 lists the values of the endogenous and exogenous variables used in the model. The equations are in log form in order to interpret the coefficients in percent changes and/or elasticities. Equation results with alternative variables tested are presented in Appendix II.

Statistical Interpretation

The Endogenous Variable

The values for retail sales of floor covering stores are seasonally adjusted and in constant dollars. The seasonal adjustment program is the X-11 varient of the

TABLE 12

RESIDENTIAL RETAIL EQUATION
ENDOGENOUS AND EXOGENOUS VARIABLES

	Real Residential Retail Floor Covering Sales Millions of Dollars	Relative Retail Price of Floor Coverings	Real Discretionar Income Billions of
1969:1	419.732	1.197	270.63
:2	409.470	1.183	280.99
:3	391.934	1.173	262.01
:4	393.840	1.164	261.86
1970:1	379.302	1.149	261.21
:2	374.413	1.141	264.32
:3	413.309	1.131	252.99
:4	444.173	1.120	250.02
1971:1	443.516	1.116	258.68
:2	440.742	1.105	263.97
:3	431.069	1.096	264.99
:4	453.105	1.089	277.05
1972:1	533.690	1.074	278.14
:2	537.355	1.071	284.36
:3	551.970	1.063	281.08
:4	626.142	1.053	285.09
1973:1	671.381	1.044	321.21
:2	685.933	1.030	299.57
:3	680.599	1.024	288.35
:4	711.867	1.007	292.16
1974:1	779.549	.993	292.05
:2	841.959	1.000	288.96
:3	766.998	1.028	287.27
:4	632.326	1.041	256.81
1975:1	632.948	1.037	262.08
:2	620.344	1.028	271.21
:3	633.996	1.022	270.06
:4	715.622	1.021	214.92
1976:1	670.151	1.029	295.43
:2	707.184	1.030	299.80
:3	760.551	1.026	297.49
:4	735.921	1.018	311.63
1977:1	757.073	1.006	322.48
:2	756.788	1.002	335.72
:3	785.497	.995	323.21
:4	856.877	.994	333.01

tail ings	Real Discretionary Income Billions of Dollars	Real Household Furniture Shipments Billions of Dollars	Capital Stock of Housing Millions of Units
	270.630	3.863	66.8
	280.999	3.987	67.1
	262.014	3.910	67.4
	261.867	3.770	67.6
	261.218	3.751	67.8
	264.327	3.831	68.0
	252.998	3.940	68.2
	250.027	4.038	68.5
	258.686	4.067	68.8
	263.972	3.918	69.1
	264.995	4.221	69.5
	277.059	4.427	69.9
	278.149	4.779	70.3
	284.364	4.695	70.7
	281.085	5.042	71.2
	285.095	5.099	71.6
	321.217	5.455	72.1
	299.570	5.407	72.5
	288.355	4.983	72.9
	292.160	5.324	73.3
	292.056	5.198	73.6
	288.963	4.912	73.8
	287.270	4.747	74.1
	256.815	4.129	74.2
	262.081	3.753	74.4
	271.219	3.882	74.5
	270.068	4.257	74.6
	214.924	4.451	74.8
	295.434	4.778	75.0
	299.804	4.453	75.2
	297.492	4.513	75.4
	311.638	4.372	75.7
	322.485	4.589	76.0
	335.723	4.553	76.3
	323.214	4.681	76.6
	333.011	4.766	77.0

Census Method II.[7] The stable seasonality test[8] concludes seasonal patterns are persistant in the endogenous variable. Furthermore, the effects of inflation on retail sales were eliminated by deflating retail sales by the consumer price index for floor covering stores. Table 13 lists the seasonally unadjusted values, seasonal adjusted values and seasonal factors of retail sales. Table 14 lists retail sales in constant dollar terms and its consumer price index deflator.

The Exogenous Variables

Relative Price

The elasticity of retail floor covering sales to price is -1.5. The elastic coefficient for relative price reflects retail floor covering sales sensitivity to changes in its relative price.[9] This is not surprising. Historically, consumer's purchasing decisions for durable goods are significantly influenced by price movements. Throughout the regression time interval, the absolute price of floor coverings has been steadily increasing. Its relative price may reflect consumer's expectations for further absolute price increases or the possible erosion of the comparative advantage of floor covering prices relative to prices of other consumer durables.

Discretionary Income

The elasticity of retail floor covering sales to discretionary income is .32.[10] The inelastic coefficient reflects retail floor covering sales insensitivity to

TABLE 13

RETAIL SALES OF FLOOR COVERINGS
Millions of Dollars

	Seasonally Unadjusted	Seasonally Adjusted	Seasonal Factors
1969:1	414	436	95.0
:2	435	426	102.1
:3	400	409	97.8
:4	433	413	104.8
1970:1	378	397	95.2
:2	404	393	102.8
:3	421	434	97.0
:4	490	468	104.7
1971:1	448	471	95.2
:2	485	468	103.6
:3	444	459	96.7
:4	503	482	104.3
1972:1	538	567	94.9
:2	598	572	104.5
:3	570	589	96.8
:4	693	667	103.8
1973:1	677	718	94.3
:2	774	738	104.8
:3	723	739	97.7
:4	807	780	103.5
1974:1	812	868	93.5
:2	1017	971	104.7
:3	923	935	98.7
:4	832	801	103.8
1975:1	750	811	92.5
:2	833	799	104.3
:3	863	866	99.7
:4	984	943	104.3
1976:1	826	901	91.7
:2	998	962	103.7
:3	1047	1044	100.3
:4	1067	1016	105.0
1977:1	956	1051	91.0
:2	1096	1061	103.3
:3	1113	1107	100.6
:4	1286	1220	105.4

TABLE 14

RETAIL SALES OF FLOOR COVERINGS
Millions of Constant Dollars

	Constant Dollars Seasonally Adjusted	CPI For Floor Coverings
1969:1	420	1.038
:2	410	1.040
:3	392	1.044
:4	394	1.049
1970:1	379	1.047
:2	374	1.050
:3	413	1.050
:4	444	1.054
1971:1	444	1.061
:2	441	1.062
:3	431	1.065
:4	453	1.065
1972:1	534	1.062
:2	537	1.065
:3	552	1.066
:4	626	1.066
1973:1	671	1.070
:2	686	1.076
:3	681	1.087
:4	712	1.096
1974:1	780	1.114
:2	842	1.154
:3	767	1.220
:4	632	1.267
1975:1	633	1.281
:2	620	1.288
:3	664	1.304
:4	716	1.319
1976:1	670	1.344
:2	707	1.361
:3	761	1.373
:4	736	1.381
1977:1	757	1.388
:2	757	1.402
:3	785	1.409
:4	857	1.424

changes in the level of discretionary income. This result is surprising[11] and can be justified by focusing on the increasing importance of the replacement market. For the carpet industry the replacement market is a key factor for carpets continued growth. However, among postponable purchases replacement carpeting has low priority. Furthermore, as the rate of increase of discretionary income declines,[12] consumers are able to buy less durable goods. This is especially acute for the replacement segment of the market. Therefore, the slower growth rate in retail floor covering sales might be caused by the slower rate of increase in consumer's discretionary income. This could explain the low elasticity coefficient for discretionary income.

Wholesale Household Furniture Shipments

The elasticity for the complimentary effect between household furniture shipments is positive but low. The elasticity coefficient is .55. Aesthetics is an important factor in determining floor covering sales. The positive sign appropriately reflects the consumer's desire to "totally" furnish his household.[13] However, the low elasticity coefficient might reflect the drain on consumer's discretionary income after furniture purchases. As a result, consumers may not be able to match floor covering purchases with household furniture purchases. In addition, a one quarter lag between wholesale furniture shipments and retail floor covering sales is appropriate due to: (a) a general lag between purchases or (b) a lag between wholesale shipments and retail sales.

Capital Stock of Housing

The elasticity of the capital stock of housing with regard to retail floor covering sales is positive and high. The elasticity coefficient is 3.0. The percentage change in the capital stock of housing reflects the stock of additional floor space available. The high elasticity coefficient implies consumers are likely to purchase carpeting when additional floor space is available. However, the best correlation occurs with the percentage change in the stock of housing leading floor covering sales by three quarters. This implies consumers might initially postpone carpet purchases, most likely after completing other household furniture purchases. However, the percentage change in the capital stock of housing includes new housing units initially covered by contract carpeting. As a result, the elasticity coefficient might be biased downward.

Testing the Validity of the Retail Model

There are many methods of determining how good the model is as a predictive device for floor covering sales. The following pages will focus upon the most common methods.

Goodness of Fit Measure

The goodness of fit measure relates to the model's ability to account for historical derivations over time of floor covering sales. The $\overline{R}^2$, the coefficient of determination, measures the goodness of fit. In this model the $\overline{R}^2$ is .97 or 97 percent of the variation in the dependent variable is explained by the exogenous variables.

Statistical Significance of the Regression Coefficients

Statistical significance of the regression coefficients as measured by the t-statistic determine whether the coefficients for the exogenous variable are truly significant or simply occur by chance. Each exogenous variable in our model is statistically significant at the 5 percent level.[14] Therefore, their subsequent coefficients are statistically acceptable.

Comparison of Actual vs. Fitted Values

Comparison of actual vs. fitted values of our model over the time period estimated reveals the degree of divergence (residual) between the two series. Furthermore, it reveals the models ability to anticipate turning points associated with cyclical movements. Chart II exhibits actual and fitted values for the retail sales model. The fitted values closely mirror the upward and downward movement of the actual values. Especially encouraging is the model's ability to catch the significant decline in retail floor covering sales during the 1974-1975 recession. However, this model fails to catch many quarter to quarter movements beyond 1975. The deviation is attributed to variable factors which are not statistically measurable. These factors will be discussed below.

Test for Autocorrelation

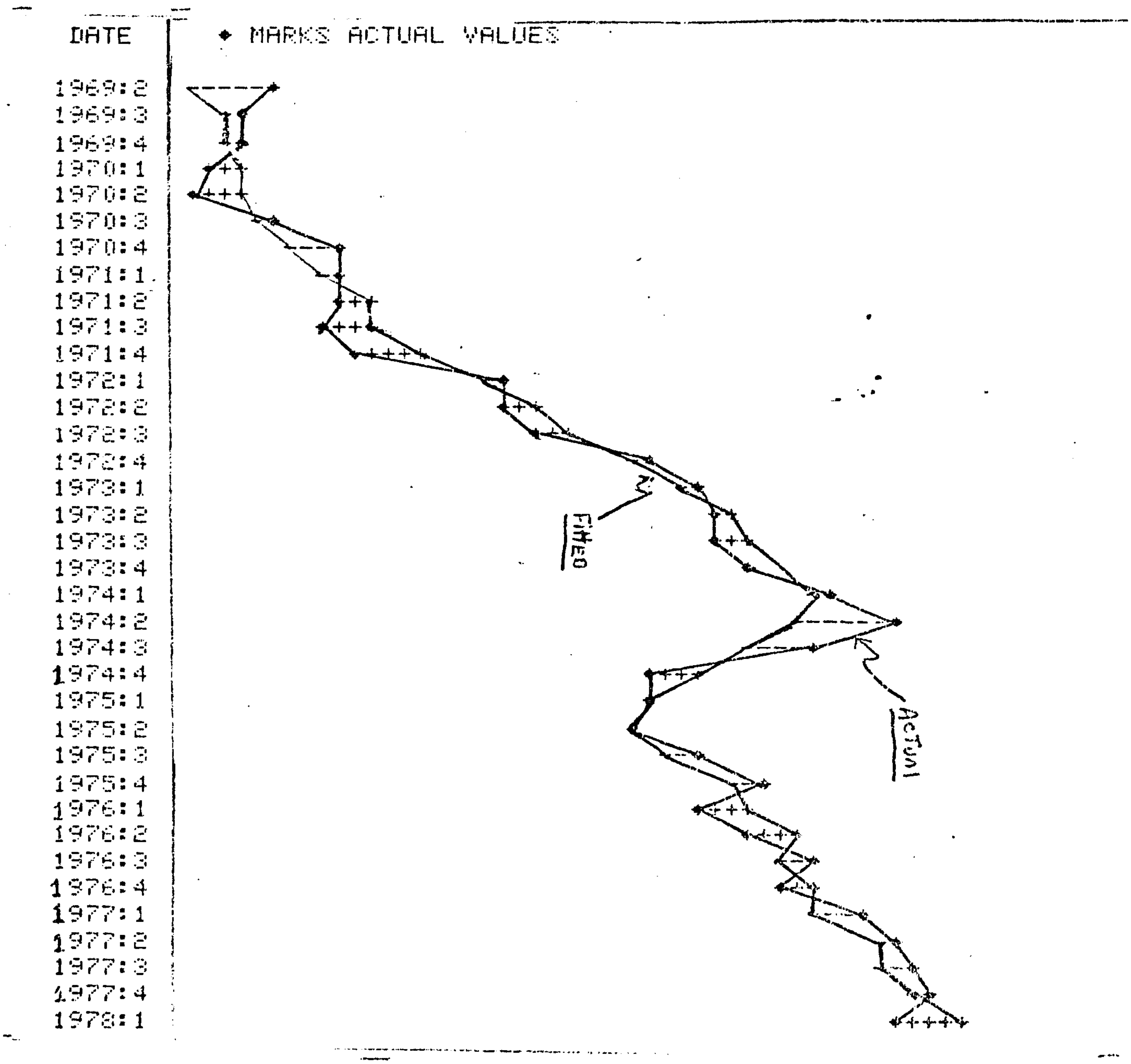
The Durbin-Watson statistic tests for the presence of autocorrelation. The Durbin-Watson statistic for the retail equation is 1.49. With five parameters and 36 observations the upper and lower critical bounds are 1.16 and 1.74 respectively.[15] Therefore, the results of the Durbin-Watson test is in the ambiguous range. However, upon examining the residuals of the regression (Chart II), no visible trend in the residuals are apparent. Furthermore, by ranking the order of the residuals by size, i.e., assign a rank to each residual depending on its size and correlating the vector of ranks with a time trend will determine if the residuals have any trend in them. If the residuals have any trend, their rank order will either be highly positively or negatively related to the time trend. The correlation coefficient (called the Spearman rank correlation coefficient) is low (.013).[16] The residuals are approximately normally distributed. Therefore, positive autocorrelation is not apparent in the retail equation.

Stability of the Regression Coefficients-Chow Test

The Chow test performs an F-test on the stability of the regression coefficients by dividing the regression interval into two subintervals. Regressions are run on each of the two subintervals and the entire interval.

CHART II

RESIDENTIAL RETAIL EQUATION
Actual vs. Fitted Values



Residual sums of squares are calculated for each regression and compared using the F ratio. The F ratio is constructed as follows:

$$F=\frac{(RSS_0-RSS_1-RSS_2)/K}{(RSS_1+RSS_2)/T-2K}$$

The null and alternative hypothesis are:

$H_0=RSS_0-RSS_1-RSS_2=0$

$H_1=RSS_0-RSS_1-RSS_2\neq 0$

RSS_0=Residual sum of squares for the whole interval.
RSS_1=Residual sum of squares of one subinterval.
RSS_2=Residual sum of squares of the second subinterval.
K=Number of parameters.
T=Number of observations.

If the model changes significantly over time the residual sum of squares for the whole interval will be large in comparison to the residual sum of squares for the other two subintervals. This will result in a high calculated F value and lead to the rejection of the null hypothesis. A low calculated F value results in the acceptance of the null hypothesis and confirms the estimated model's stability.

The Chow test on the retail sales equation is performed twice:[17] (a) the first interval 1969:1 to 1973:2 and the second interval 1973:4 to 1977:4 and (b) the first interval 1969:1 to 1974:4 and the second interval 1975:1 to 1977:4. The calculated F value for the first Chow test equals 2.156. The calculated F value falls within the critical bounds[18] at the 5 percent level of significance.

The calculated value for the second Chow test equals 0.730 which easily falls within the critical bounds at the 5 percent level of significance. Therefore, these two tests confirm the estimated model's stability over the entire regression interval.[19]

Backcasting

Backcasting is a method where the most recent data is withheld in estimating the model. The truncated version of the model is then used to forecast the missing periods. This truncated version of the model reveals the model's forecasting accuracy. The truncated version of the model, regressed from 1969 to 1976 is as follows:

$$\underset{}{Log(FCRS72)} = -8.92 - \underset{(-2.18)}{1.44Log(PC1)} + \underset{(1.5)}{.33Log(DISCINC72)}$$

$$+ \underset{(3.70)}{.57Log(SHIPS\backslash 1)} + \underset{(4.40)}{2.97Log(KQHUSTS\backslash 3)}$$

t-statistics in parenthesis

$\bar{R}^2 = .96$
Durbin-Watson=1.5
Standard Error of the Regression=.051

Table 15 compares the percent changes between the actual and fitted values of the truncated model. Quarterly, the model significantly overestimates the first two quarters and underestimates the latter two quarters. Upon analyzing the forecast period, the reason for the inaccuracies become apparent. The model's overestimation is the result of the severe weather (beyond the normal seasonal factors) during the first half of 1977. This derailed expected

TABLE 15

RESIDENTIAL RETAIL FLOOR COVERING SALES
Millions of Constant Dollars
TRUNCATED MODEL
ACTUAL vs. FITTED VALUES

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	757.1	757.8	785.5	856.9	3157.3
Fitted	771.2	815.7	818.2	850.0	3255.1
Percent Error*	-1.9	-7.6	-4.2	0.8	-3.1

$$\text{*Percent Error} = \frac{\text{Actual} - \text{Fitted}}{\text{Actual}}$$

retail floor covering sales drastically. The model's underestimation is the result of pent up demand during the second half of 1977. This resulted in an underestimation of floor covering sales for the second half of 1977. Except for the second quarter, the percent errors of the estimated model are less than the standard error of the regression (5.1 percent).

When the results of the quarterly model is aggregated to produce an annual estimate for 1977, the model's accuracy improves. The model forecasts a 13 percent increase in floor covering sales. Actual floor covering sales were 10 percent. The annual percent error is 3.1, substantially less than the 5.1 percent standard error of the regression. Therefore, on an annual basis the quarterly model's forecasting accuracy is good.

Contract Carpet Equation: Variables Tested

The variables tested in the contract carpet sales equations similarly conform to the traditional framework of demand analysis. Commercial and residential demand for contract carpeting is determined by the level of corporate profits, the relative price of retail carpeting and demand derived from other factors not associated with income or price.

The Endogenous Variable

Contract Carpet Sales

Data on total U.S. contract carpet sales from government or private sources presently do not exist. Furthermore, most companies engaged in the contract carpeting market are reluctant to divulge its sales data. Fortunately, Bigelow-Sanford, a subsidiary of the Sperry and Hutchinson Company, agreed to supply data on its contract carpet sales.[20] The data are available in square yards on a semiannual basis. Table 16 lists Bigelow-Sanford's contract square yard sales between 1969 and 1977. In order to upgrade this data to reflect total industry's contract carpet sales, the following computations were necessary:

(1) Using quarterly percentage shares of Bigelow-Sanford's total carpet sales, semiannual contract carpet data were transformed into quarterly figures.

(2) Applying the quarterly percentage growth over its previous quarter of Bigelow-Sanford contract carpet's percentage share of its total carpet sales, total industry quarterly contract carpet's percentage share of total industry carpet sales were calculated.[21]

(3) Total industry's contract carpet sales were calculated by multiplying total industry contract carpet's percentage share of total industry carpet sales by total industry wholesale carpet sales.

TABLE 16

BIGELOW-SANFORD WOVEN AND TUFTED
CONTRACT SQUARE YARD BILLINGS
Millions of Square Yards
1969-1977

1969	Spring	5198
	Fall	5365
1970	Spring	5145
	Fall	5340
1971	Spring	5033
	Fall	5761
1972	Spring	5524
	Fall	5717
1973	Spring	6357
	Fall	6690
1974	Spring	6773
	Fall	6185
1975	Spring	5466
	Fall	5513
1976	Spring	5623
	Fall	6080
1977	Spring	6209
	Fall	6615

Table 17 lists the quarterly estimates of total square yards of contract carpet shipments for both Bigel Sanford and the total industry.

The Exogenous Variables

Corporate Profits Variable

The level of corporate profits reflects industr ability to finance its expenditures. The level of corpo profits is critical under the assumption of imperfect ca tal markets. Corporate purchasing patterns are similar individual consumer purchasing patterns. As corporate p rise, commercial establishments will be more able and li to expand its expenditures. When corporate profits fall, commercial establishments will reduce its expenditures. Furthermore, commercial establishments set forth spendin guidelines on its expenditures. When corporate profits low, low priority expenditures are postponed. Carpetin primarily used in commercial establishments for aestheti purposes, are low priority purchases. As a result, cont commercial carpet sales are very sensitive to changes in corporate profits.

The variable which reflects corporate ability to finance its expenditures is real corporate profits befor taxes. Corporate profits after taxes distorts the true picture of a corporation's financial well being. Capita gains and losses of the previous year are taxed or writt off in the present year. Therefore, corporate's true profits are biased upward during cyclical downswings

TABLE 17

BIGELOW-SANFORD AND TOTAL INDUSTRY
CONTRACT CARPET SHIPMENTS
Millions of Square Yards

	Bigelow-Sanford	Total Indus
1969:1	2,394	52,536
:2	2,804	54,002
:3	2,524	55,235
:4	2,841	57,909
1970:1	2,395	56,060
:2	2,750	59,251
:3	2,611	58,705
:4	2,729	61,490
1971:1	2,339	52,940
:2	2,694	58,283
:3	2,596	61,402
:4	3,165	66,595
1972:1	2,468	69,999
:2	3,056	77,606
:3	2,576	77,392
:4	3,141	80,493
1973:1	3,069	82,390
:2	3,288	87,588
:3	3,168	85,694
:4	3,522	86,814
1974:1	3,302	81,509
:2	3,471	87,446
:3	3,093	85,272
:4	3,092	72,050
1975:1	2,572	63,797
:2	2,894	77,314
:3	2,566	76,092
:4	2,947	75,206
1976:1	2,551	77,978
:2	3,072	82,551
:3	2,766	84,586
:4	3,314	84,904
1977:1	2,960	85,665
:2	3,249	94,761
:3	3,170	90,542
:4	3,445	95,090

and biased downward during cyclical upswings.[22] Corporate profits before taxes excluding inventory valuation adjustments is calculated by Data Resources, Inc. as follows:

ZB72=RE/PIFIXNR+DIV/PC+TCGF/PGF+TCGSL/PGSL

ZB72=Corporate profits before tax excluding inventory valuation adjustments.
RE=Undistributed corporate profits.
PIFIXNR=Implicit price deflator, gross private nonresidential investment.
DIV=Dividends.
PC=Implicit price deflator, personal consumption expenditures.
TCGF=Federal government corporate profits tax accounts.
PGF=Implicit price deflator, federal government purchases of goods and services.
TCGSL=State and local government corporate profits tax accruals.
PGSL=Implicit price deflator, state and local government purchases of goods and services.

Corporate profits before tax excluding inventory evaluation adjustments is calculated by Data Resources, Inc. based on U.S. Department of Commerce data. The data are collected on a quarterly basis by the U.S. Department of Commerce, Bureau of Economic Analysis and published in the "National Income and Product Accounts of the U.S." The data are available on a quarterly basis from 1947 to 1977.

Derived Demand Variable

Derived demand variables explain the demand for commercial and nonresidential contract carpet sales not related to corporate profits or relative price. The derived demand for contract carpet sales is reflected in new available commercial and residential floor space.[23]

A positive relationship exists between the flow of new available floor space and the demand for contract carpeting. Due to data limitations new available commercial floor space is measurable only in a flow concept. For comparative purposes, new available residential floor space is also measured in a flow concept.

The flow of new available commercial floor space is measured by real gross investment in private non-residential structures. This includes investment in private commercial building, private industrial buildings and private non-profit institutions.

The flow of new available contract residential floor space is measured by investment in residential structures. However, this variable includes investment in all single and multi-family structures, including non-contracted residential structures. Therefore, its coefficient might be biased downward.

The flow of new total available floor space is measured by investment in total structures. This measure is the sum of investment in residential and nonresidential structures. Its coefficient may also be biased downward because non-contracted residential structures are also included.

Each derived demand variable will be tested in order to determine which flow concept most closely correlates with contract carpet sales.

Investment in residential structures and total structures are calculated by Data Resources, Inc. based on data collected by the U.S. Department of Commerce and published in "National Income and Products Account of the U.S." The data are available from 1947 to 1977. Data for gross investment in nonresidential structures are collected on a quarterly basis by the U.S. Department of Commerce, Bureau of Economic Analysis and published in "National Income and Product Accounts of the U.S." The data are available from 1947 to 1977.

Relative Consumer Price

The data representing the level of prices of soft floor coverings contract distributors face is the consumer price index[24] for soft floor coverings. In actuality, the prices which contract consumer's face lie between wholesale and retail prices. Seventy-five percent of contract carpeting is bought either trough distributors or retailors, although twenty-five percent is bought directly from the manufacturer.[25] However, contract carpet buyers are by definition consumers. The CPI for soft floor covering is therefore, a consistant statistical measure of the level of carpet prices contract consumer's face. However, as in the residential retail supply, the relative[26] consumer price of carpeting is the appropriate price variable affecting contract carpet sales. Therefore, the CPI for soft floor coverings is deflated by the implicit price deflator for personal consumption expenditures. The relative price of soft floor coverings is negatively related to the demand for contract carpeting. The source for CPI data is found in the residential retail equation.

Contract Carpet Equation: Statistical Results

The statistical results of the contract carpet equation model are good. The model explains 95 percent of the variance in contract soft floor covering sales, with an average forecasting error of 4.1 percent. The Durbin-Watson statistic at 1.32 is in the ambiguous range. However, after examining the residuals of the model and applying various residual trend tests, the residuals are randomly distributed. The fitted values of the model closely follow the actual values. The most logical variables are statistically significant and their regression coefficients are reasonable. The results of the contract carpet equation are similar to the results of the residential retail equation. The absolute value of the relative price coefficient is elastic and significant. The elasticity coefficient for the derived demand variable (investment in total structures) is positive and significant. The value of the corporate profits coefficient is significant but inelastic. The quarterly model's forecasting ability is excellent on an annual basis and good on a quarterly basis.

The Best Equation

The best equation for contract carpet sales is:

$$\text{Log(CSQYDSA)} = 7.81 - \underset{(-14.96)}{1.61}\text{Log(PC11)} + \underset{(4.6)}{.30}\text{Log(ZB72)} + \underset{(6.6)}{.44}\text{Log(IC72\textbackslash 2)}$$

t-statistics are in parenthesis

CSQYDSA=Contract carpet shipments, millions of square yards, seasonally adjusted.
PC11=Relative retail price of carpeting.
ZB72=Real corporate profit begore taxes.
IC72\2=Real investment in total structures, lagged two quarters.

Time interval=1969 to 1977
$\bar{R}^2=.95$
Durbin-Watson=1.32
Standard Error of the Regression=.041

Table 18 lists the values of the endogenous and exogenous variables used in the model. Table 19 lists the values of the two alternative derived demand variables. The equation is in log terms in order to interpret the coefficients in percent changes and/or elasticities. Equation results of alternative variables tested are presented in Appendix II.

Statistical Interpretation

The Endogenous Variable

The values for contract soft floor covering sales are in millions of square yards and are seasonally adjusted. The seasonal adjustment program is the X-11 variant of the Census Method II.[27] The stable seasonality test[28] concludes seasonal patterns are present in the endogenous

TABLE 18

CONTRACT CARPET EQUATION
ENDOGENOUS AND EXOGENOUS VARIABLES

	Commercial Carpet Shipments, Millions of Square Yards	Relative Retail Price of Carpeting	Real Corporate Before Ta[illegible] Billions [illegible]
1969:1	53,981	1.191	10[illegible]
:2	53,640	1.174	10[illegible]
:3	55,456	1.163	9[illegible]
:4	56,654	1.152	9[illegible]
1970:1	57,578	1.130	8[illegible]
:2	58,693	1.119	8[illegible]
:3	58,825	1.106	8[illegible]
:4	60,472	1.092	7[illegible]
1971:1	54,469	1.077	8[illegible]
:2	57,425	1.063	8[illegible]
:3	61,293	1.053	8[illegible]
:4	65,991	1.044	8[illegible]
1972:1	72,246	1.027	9[illegible]
:2	75,965	1.021	9[illegible]
:3	76,845	1.012	9[illegible]
:4	80,493	1.002	10[illegible]
1973:1	85,310	0.990	11[illegible]
:2	85,191	0.979	11[illegible]
:3	84,651	0.974	10[illegible]
:4	87,557	0.957	10[illegible]
1974:1	84,565	0.940	10[illegible]
:2	84,600	0.948	10[illegible]
:3	84,080	0.964	11[illegible]
:4	72,963	0.965	10[illegible]
1975:1	66,320	0.956	8[illegible]
:2	74,553	0.946	8[illegible]
:3	74,925	0.935	10[illegible]
:4	76,329	0.934	10[illegible]
1976:1	81,206	0.939	11[illegible]
:2	79,380	0.940	11[illegible]
:3	83,376	0.936	11[illegible]
:4	86,156	0.926	11[illegible]
1977:1	89,276	0.913	11[illegible]
:2	91,040	0.909	12[illegible]
:3	89,261	0.901	12[illegible]
:4	96,552	0.898	12[illegible]

3

EQUATION
OUS VARIABLES

Relative Retail Price of Carpeting	Real Corporate Profit Before Tax Billions of Dollars	Real Investment in Total Structures Millions of Dollars
1.191	106.3	87.7
1.174	103.0	87.3
1.163	95.8	86.9
1.152	92.9	83.4
1.130	82.9	82.3
1.119	80.7	80.6
1.106	81.6	81.4
1.092	75.1	84.8
1.077	83.4	87.7
1.063	85.8	92.2
1.053	87.7	95.4
1.044	89.2	96.3
1.027	91.2	102.1
1.021	92.9	102.8
1.012	96.5	103.0
1.002	104.1	105.9
0.990	112.5	107.6
0.979	113.2	106.3
0.974	107.3	103.3
0.957	107.8	98.6
0.940	109.1	93.1
0.948	109.9	89.8
0.964	117.3	84.0
0.965	101.1	78.9
0.956	80.2	73.0
0.946	86.0	72.7
0.935	103.1	75.6
0.934	103.8	78.5
0.939	114.2	82.8
0.940	117.8	84.3
0.936	116.0	84.1
0.926	111.7	89.4
0.913	117.2	90.7
0.909	123.0	96.9
0.901	122.7	98.4
0.898	120.7	100.1

TABLE 19

DERIVED DEMAND VARIABLES

	Real Investment in Residential Structures Millions of Dollars	Real Investment in Nonresidential Structures Millions of Dollars
1969:1	44.3	43.4
:2	43.7	43.6
:3	42.1	44.8
:4	39.2	44.2
1970:1	39.3	43.0
:2	37.4	43.2
:3	38.6	42.8
:4	42.5	42.3
1971:1	45.5	42.2
:2	50.3	41.9
:3	53.6	41,8
:4	55.3	41.0
1972:1	59.9	42.2
:2	60.5	42.3
:3	60.6	42.4
:4	62.7	43.2
1973:1	63.3	44.3
:2	60.8	45.5
:3	57.0	46.3
:4	52.9	45.7
1974:1	48.3	44.8
:2	45.6	44.2
:3	42.9	41.1
:4	38.8	40.1
1975:1	35.4	37.6
:2	36.1	36.6
:3	38.6	37.0
:4	41.3	37.2
1976:1	44.5	38.3
:2	45.8	38.5
:3	45.8	38.3
:4	51.1	38.3
1977:1	52.4	38.3
:2	56.9	40.0
:3	57.6	40.8
:4	59.1	41.0

variable. Table 20 lists the seasonal unadjusted values, seasonal adjusted values and seasonal factors of contract carpet sales in square yards.

The Exogenous Variables

Relative Price

The elasticity coefficient for the relative price of soft floor covering is -1.6. The elastic coefficient for relative price reflects contract sales sensitivity to changes in its relative price. It is predominantly the result of soft floor coverings' new status as a competitive floor covering for new commercial floor space.

Hard floor covering is the predominant floor covering of commercial floor space because of its durability, its easy maintenance costs and its overall low cost. It has generally accounted for nearly two-thirds of this market. Soft floor coverings' improved durability and maintenance combined with its overall aesthetic appeal has enabled soft floor covering to compete with hard floor coverings in the commercial market. However, it is the decline in the price of soft floor coverings relative to hard floor coverings which has enables soft floor coverings to increase its penetration of the commercial market.[29] Therefore, more new commercial floor space is initially covered by contract soft floor coverings.

TABLE 20

CONTRACT CARPET SHIPMENTS
Millions of Square Yards

	Seasonally Unadjusted	Seasonally Adjusted	Seasonal Factors
1969:1	52,536	53,981	97.3
:2	54,002	53,640	100.7
:3	55,235	55,456	99,6
:4	57,909	56,654	102.2
1970:1	56,060	57,578	97.4
:2	59,251	58,693	101.0
:3	58,705	58,825	99.8
:4	61,490	60,472	101.7
1971:1	52,940	54,469	97.2
:2	58,283	57,425	101.5
:3	61,402	61,293	100.2
:4	66,595	65,991	100.9
1972:1	69,999	72,246	96.9
:2	77,606	75,964	102.2
:3	77,392	76,845	100.7
:4	80,498	80,493	100.0
1973:1	82,390	85,310	96.6
:2	87,588	85,191	102.8
:3	85,694	84,651	101.2
:4	86,814	87,557	99.2
1974:1	81,509	84,565	96.4
:2	87,446	84,600	103.4
:3	85,272	84,080	101.4
:4	72,050	72,963	98.7
1975:1	63,797	66,320	96.2
:2	77,314	74,553	103.7
:3	76,092	74,925	101.6
:4	75,206	76,329	98.5
1976:1	77,978	81,206	96.0
:2	82,551	79,380	104.0
:3	84,586	83,376	101.5
:4	84,904	86,156	98.5
1977:1	85,665	89,276	96.0
:2	94,761	91,040	104.1
:3	90,542	89,261	101.4
:4	95,090	96,552	98.5

Corporate Profits

The elasticity coefficient for corporate profits is .30.[30] The low elasticity coefficient reflects contract carpet sales' insensitivity to changes in the level of corporate profits. This result is also surprising. However, the low elasticity coefficient can be explained by the decline in the rate of increase of corporate profits.[31] Commercial soft floor covering is more expensive than commercial hard floor coverings. Its primary advantage is its overall aesthetic appeal.[32] As a result commercial establishments view soft floor covering as low priority purchases. As the rate of increase of corporate profits decline, commercial establishments are less able to finance low priority purchases. In addition, purchases of soft floor covering for replacement purposes are even less frequent. This has contributed to an overall slowing in growth for contract carpeting.

Investment in Total Structures[33]

The elasticity coefficient for investment in total structures is .44. The percentage change in total private structures monitors the movement of new commercial and residential floor space available. Every one percent increase in expenditures in new residential and commercial structures results in a .4 percent increase in total contract carpet purchases. The inelastic coefficient implies only a small percentage of new private commercial and residential floor space is initially covered with contract carpeting.[34] The best correlation occurs when the percentage change in investment in total structures leads contract carpet sales by two quarters. This implies, on average for all structures, a two quarter lag between initial construction and contract carpet purchases.

Testing the Validity of the Contract Model

The same criteria for testing the validity of a model established in the retail floor covering model will be used to test the validity of the contract model.

Goodness of Fit Measure

In this model the $\bar{R}^2$, the coefficient of determination, is .95. In other words, 95 percent of the movement in contract carpet sales is explained by the exogenous variables.

Statistical Significance of the Regression Coefficients

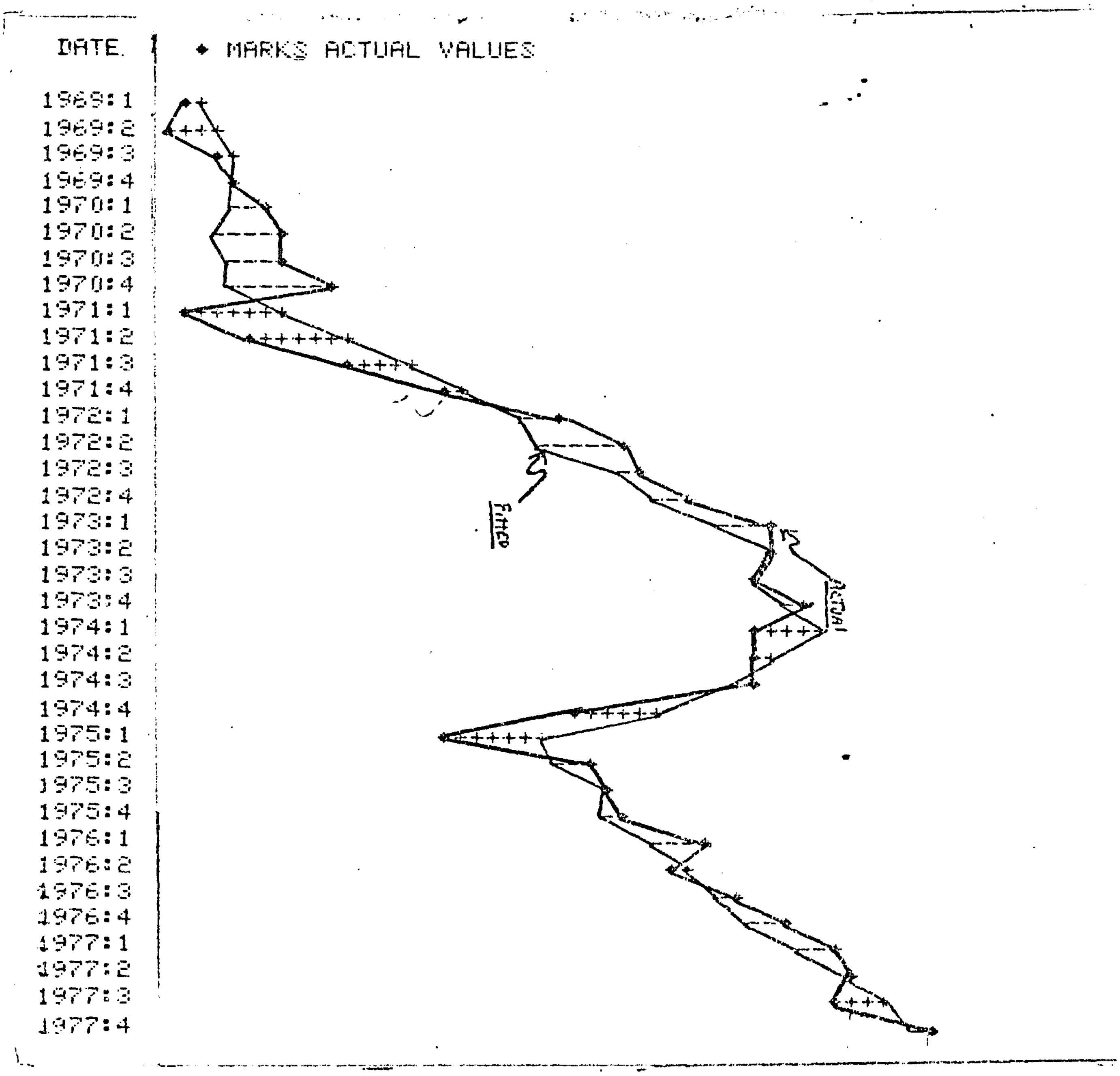
Each variable in the model is statistically significant as measured by the t-statistic at the 5 percent level of significance.[35] This implies the coefficients for the exogenous variables are significant determinants of contract carpet sales and don't occur by chance.

Comparison of Actual vs. Fitted Values

Chart III exhibits the actual and fitted values of the contract carpet equation. The fitted sales values closely reflect the movements of actual contract carpet sales values. The model's ability to anticipate turning

CHART III

CONTRACT CARPET EQUATION
Actual vs. Fitted Values



points, expecially in 1974, is very good. The model's estimation of quarter to quarter movements is more accurate than the retail carpet equation.

Test for Autocorrelation[36]

The Durbin-Watson statistic for the contract carpet equation is 1.32. With four parameters and 36 observations the upper and lower critical bounds are 1.24 and 1.73 respectively. Therefore, the results are inconclusive. However, the residuals of the model do not exhibit any apparent trend. Furthermore, the Spearman rank correlation coefficient is low (.020), and we can conclude the residuals are independently distributed.[37] Therefore, positive autocorrelation is not apparent in the contract carpet equation.

Stability of the Regression Coefficients-Chow Test[38]

The Chow test on the contract carpet equation is performed twice:[39] (a) the first interval 1969:1 to 1973:2 and the second interval 1975:1 to 1977:4 and (b) the first interval 1969:1 to 1974:4 and 1975:1 to 1977:4. The calculated F values for the first Chow test equals 1.53.[40] The calculated F value falls within the critical bounds at the 5 percent level of significance. The calculated value for the second Chow test is .91 which easily falls within the critical bounds. Therefore, these tests confirm the stability of the estimated contract equation over the regression interval.[41]

Backcasting

The truncated version of the model, regressed from 1969:1 to 1976:4, is as follows:

$$\underset{}{\mathrm{Log}(CSQYDSA)=7.79}\underset{(-14.0)}{-1.61\mathrm{Log}(PC11)}$$

$$\underset{(4.2)}{+.30\mathrm{Log}(ZB72)}\underset{(6.3)}{+.45\mathrm{Log}(IC72\backslash 2)}$$

t-statistics are in parenthesis

$\bar{R}^2=.94$
Durbin-Watson=1.3
Standard Error of the Regression=.043

Table 21 compares the actual and fitted values of the truncated model for 1977. The model's forecasting accuracy on a quarter to quarter basis is good. The model underestimates the first, second and fourth quarter and overestimates the third quarter. The percent error for each quarter is either equal or significantly less than the 4.3 percent standard error of the regression.[42]

On an annual basis, the quarterly model's accuracy is excellent. The model forecasts an annual increase of 11 percent. The annual percentage error at .1 percent is nearly perfect and is significantly less than the 4.3 percent standard error of the regression.

Wholesale Carpet Equation:
Variables Tested

The variables tested in the wholesale carpet equation similarily conform to the traditional framework of demand analysis. Wholesale demand is determined by the level of consumer purchasing power, i.e. an income variable,

TABLE 21

CONTRACT CARPET SALES
Millions of Square Yards
Truncated Model
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	89,275	91,040	89,261	96,552	366,128
Fitted	86,556	90,890	92,749	95,678	365,873
Percent Error*	3.1	0.2	-3.8	0.9	0.1

*Percent Error= $\frac{\text{Actual--Fitted}}{\text{Actual}}$

the relative wholesale price of soft floor coverings and demand derived by other factors not associated with income or price.

The Endogenous Variable

Wholesale Carpet Sales

Data on soft floor coverings are based on a survey of approximately 300 manufacturers accounting for 90 percent of the total U.S. output of soft floor coverings. The data for wholesale carpet shipments (sales) are collected on a quarterly basis by the U.S. Department of Commerce, Bureau of the Census and published in a Current Industrial Report entitled "Carpet and Rugs". The data are seasonally unadjusted and are in millions of square yards. The data are available from 1968 to 1977.

Although the universe for this sample is the 1972 Census of Manufacturers, approximately 50 additional companies which came into business from 1972 to the present were added to the survey. Quarterly numbers include estimates for 10 percent of small carpet manufacturers which were not surveyed. Furthermore, quarterly numbers include estimates for respondents whose reports were not received in time. The overall general estimation level rarely exceeds 20 percent and may be subject to the usual survey errors such as collection, reporting coding response and operational errors.

The Exogenous Variables

Income Variable

Consumer purchasing power concurrently reflect the ability of retailers, distributors and consumers to purchase carpeting. Consumer demand for residential carpeting and distributor demand for contract carpeting are the initial catalyst which evenutally determine wholesale carpet shipments. Total carpet demand includes residential, residential contract and commercial contract segments of the market. The level of consumer and distributor purchasing power is positively related to wholesale demand. Furthermore, due to imperfect capital markets wholesale carpet shipments is sensitive to changes in total consumer purchasing power.

A variable which reflects the level of consumer purchasing power is real disposable personal income. It is a proxy for the general health of the economy. However, disposable personal income measures the level of income people have for spending on all items. As a result, reservations raised by the residential retail market is appropriate by the wholesale market. Furthermore, the contract market as part of the total wholesale market might upwardly bias the personal income variable.

Another measure for the level of total purchasing power is the level of national income. National income includes corporate profits and proprietor income as well as compensation of employees. National income measures the level of total purchasing power concurrently for both the residential retail and contract carpet markets. However, employee compensation does not exclude personal taxes.

This may result in a downward bias of the national income variable. Furthermore, the initial reservation established by the personal disposable income variable is apparent for the national income variable.

Both variables will be tested in order to determine which variable most closely correlates with wholesale carpet shipments. The source for disposable personal income data is found in the residential retail section. National income data are collected quarterly by the U.S. Department of Commerce, Bureau of Economic Analysis and published in the "National Income and Product Accounts of the U.S.". The data are available from 1947 to 1977.

Derived Demand Variables

Derived demand variables explain the demand for wholesale carpet sales not related to income or price. As in both the residential retail and contract carpet markets, the derived demand for wholesale carpet sales is reflected in the amount of new floor space available to be covered. Furthermore, as in the residential retail market, a complimentary relationship exists between carpeting and furniture shipments. For the wholesale market new additional floor space includes both new available commercial and residential floor space. The positive relationship between total new floor space available and wholesale carpet shipments is measured in a flow concept. The flow of new additional floor space is measured by real investment in total structures. This measure is the sum of real investment in private residential and private nonresidential structures.

A complimentary relationship between floor covering sales and household furniture shipments has been established in the residential retail section. Over 60 percent of the wholesale market is derived from the residential market. Subsequently, a complimentary relationship between wholesale carpet shipments and household furniture shipments exists. However, the furniture shipment variable does not include commercial furniture. As a result, the coefficient for the household furniture shipments variable may be biased upward.

Each derived demand variable will be tested in order to determine which most closely correlates with wholesale carpet shipments. The source for data on total investment in structures is found in the contract carpet section. The source for data on household furniture is found in the residential retail section.

Relative Price Variable

The data representing the level of prices of floor coverings retailer's face is the wholesale price index (WPI) for floor coverings. The WPI is a consistant statistical measure for prices retailer's face. The WPI measures the average change in the price of commodities in the primary markets of the U.S. Prices used in the WPI apply to the first significant transaction which occurs in the U.S. The

WPI is calculated by averaging together price changes for the various commodities with weights which represent their importance in the total net selling value. Weights are revised periodically when data from the industrial census are available.

Wholesale demand for carpeting is negatively related to the wholesale price of carpeting. However, it is the relative wholesale price of soft floor coverings which is more appropriately related to the demand for soft floor coverings. Therefore, the WPI for floor coverings is deflated by the wholesale price index for all commodities. This ratio represents the wholesale price of carpeting retailer's face relative to wholesale prices for all commodities.

The wholesale price index for floor coverings and the wholesale price index for all commodities are collected monthly by the Bureau of Labor Statistics and published in "Wholesale Prices and Price Indicies". The data are available from 1947 to 1977.

Wholesale Carpet Equation: Statistical Results

The statistical results of the wholesale carpet model(s)[43] are good. The model explains 97 percent of the variance in wholesale carpet sales with an average forecasting error of 2.8 percent. The Durbin-Watson statistic is within the critical upper bounds. The fitted values of the model closely follow the actual values. The most logical variables are statistically significant and their regression coefficients reasonable. The results of the wholesale carpet equation are different than the results of the two previous equations. The absolute value of the relative price coefficient is slightly lower than unity. The elasticity coefficients for the derived demand variables (household furniture shipments and investment in total structures) are positive and significant. The value of the real disposable personal income variable is approximately unity.

The Best Equation

The best equation[44] for wholesale carpet sales is:

$$\text{Log(QSQYD)} = 3.0 + 1.1\,\text{Log(Yd72)} + .21\,\text{Log(IC72)} + .65\,\text{Log(SHIPS)}$$
$$(14.3) \qquad\qquad (3.0) \qquad\qquad (8.1)$$

QSQYD=Wholesale carpet shipments, millions of square yards, seasonally adjusted.
Yd72=Real disposable personal income.
IC72=Real investment in total structures.
SHIPS=Real household furniture shipments.
Time interval=1969 to 1977
$\bar{R}^2$=.97
Durbin-Watson=1.75
Standard Error of the Regression=.028

Table 22 lists the values of the endogenous and exogenous variables used in the model. The equations are in log form in order to interpret the coefficients in percent changes and/or elasticities. Equation results with alternative variables tested are presented in Appendix II.

Statistical Interpretation

<u>The Endogenous Variable</u>

The values for wholesale carpet shipments are in millions of square yards and are seasonally adjusted. The

TABLE 22

WHOLESALE CARPET EQUATION
ENDOGENOUS AND EXOGENOUS VARIABLES

	Wholesale Carpet Shipments, Millions of Square Yards	Real Disposable Personal Income	Real Investment in Total Structu
1969:1	167.5	701.8	87.7
1969:2	162.7	707.2	87.3
1969:3	168.9	718.8	86.9
1969:4	175.7	723.0	83.4
1970:1	168.4	727.4	82.3
1970:2	167.9	742.6	80.6
1970:3	172.0	750.1	81.4
1970:4	178.9	745.6	84.8
1971:1	181.4	761.4	87.7
1971:2	187.1	769.9	92.2
1971:3	193.2	769.9	95.4
1971:4	200.3	775.9	96.3
1972:1	226.8	783.7	102.1
1972:2	233.6	790.7	102.8
1972:3	235.4	803.7	103.0
1972:4	247.2	827.1	105.9
1973:1	256.8	845.1	107.6
1973:2	251.7	852.7	106.3
1973:3	254.2	858.2	103.3
1973:4	263.5	862.1	98.6
1974:1	254.2	846.7	93.1
1974:2	250.5	843.1	89.8
1974:3	232.5	843.0	84.0
1974:4	202.0	835.1	78.9
1975:1	184.2	829.8	73.0
1975:2	204.5	874.1	72.7
1975:3	219.6	863.1	75.6
1975:4	224.6	871.7	78.5
1976:1	237.3	881.8	82.8
1976:2	229.8	886.3	84.3
1976:3	232.0	891.5	84.1
1976:4	240.6	900.9	89.4
1977:1	247.2	904.8	90.7
1977:2	250.0	918.6	96.9
1977:3	252.9	931.9	98.4
1977:4	274.9	949.6	100.1

BLES

isposable al Income	Real Investment in Total Structures	Real Household Furniture Shipments Billions of Dollars	Relative Wholesale Price of Carpeting
1.8	87.7	3.86	0.974
7.2	87.3	3.98	0.947
8.8	86.9	3.91	0.935
3.0	83.4	3.77	0.922
7.4	82.3	3.75	0.910
2.6	80.6	3.83	0.901
0.1	81.4	3.94	0.898
5.6	84.8	4.04	0.893
1.4	87.7	4.07	0.889
9.9	92.2	3.92	0.864
9.9	95.4	4.22	0.841
5.9	96.3	4.43	0.832
3.7	102.1	4.78	0.833
0.7	102.8	4.69	0.828
3.7	103.0	5.04	0.821
7.1	105.9	5.09	0.816
5.1	107.6	5.46	0.804
2.7	106.3	5.41	0.794
8.2	103.3	4.98	0.771
2.1	98.6	5.32	0.760
6.7	93.1	5.20	0.742
3.1	89.8	4.91	0.753
3.0	84.0	4.75	0.746
5.1	78.9	4.13	0.730
9.8	73.0	3.75	0.724
4.1	72.7	3.89	0.709
3.1	75.6	4.26	0.690
1.7	78.5	4.45	0.681
1.8	82.8	4.78	0.703
6.3	84.3	4.45	0.700
1.5	84.1	4.57	0.698
0.9	89.4	4.37	0.692
4.8	90.7	4.89	0.693
8.6	96.9	4.40	0.677
1.9	98.4	4.70	0.677
9.6	100.1	4.71	0.679

seasonally adjustment program is the X-11 variant of the Census Method II.[45] The stable seasonality test[46] concludes seasonal patterns are present in the endogenous variable. Table 23 lists the seasonal unadjusted values, seasonal adjusted values and seasonal factors of wholesale carpet shipments in square yards.

The Exogenous Variables

Real Disposable Personal Income[47]

The elasticity of wholesale carpet sales to real disposabable personal income is approximately unity.[48] The unitary elastic coefficient reflects wholesale carpet sales relative indifference toward changes in real disposable income. Between 1960 and 1977 real personal disposable income grew at a constant rate.[49] Furthermore, wholesale carpet demand is an aggregate of residential retail and contract demand for carpeting.[50] The unitary elastic coefficient confirms both consumer and commercial establishments' perception of carpet purchases as low priority among postponable goods. This status is clearly appropriate for the replacement segment of the market, which for both the residential and contract market is an important determinant for carpeting's continued growth. This may be reflected in the overall slowing in growth for the wholesale carpet market during the 1970s.

Wholesale Household Furniture Shipments

The elasticity coefficient for the complimenatry relationship between household furniture shipments and

TABLE 23

WHOLESALE CARPET SHIPMENTS
Millions of Square Yards

	Seasonally Unadjusted	Seasonally Adjusted	Seasonal Factors
1969:1	161,650	167,519	96.5
1969:2	166,109	162,666	102.1
1969:3	169,382	168,945	100.3
1969:4	177,636	175,734	101.1
1970:1	162,494	168,418	96.5
1970:2	171,743	167,925	102.3
1970:3	172,460	172,038	100.2
1970:4	180,587	178,872	101.0
1971:1	174,603	181,420	96.2
1971:2	192,227	187,136	102.7
1971:3	194,015	193,242	100.4
1971:4	201,417	200,344	100.5
1972:1	217,591	226,837	95.9
1972:2	241,163	233,599	103.2
1972:3	237,326	235,417	100.8
1972:4	246,926	247,238	99.9
1973:1	245,574	256,774	95.6
1973:2	261,066	251,652	103.7
1973:3	257,417	254,192	101.3
1973:4	261,332	263,461	99.2
1974:1	242,803	254,194	95.5
1974:2	260,411	250,460	104.0
1974:3	236,278	232,488	101.6
1974:4	199,641	201,951	98.9
1975:1	175,653	184,192	95.4
1975:2	212,868	204,524	104.1
1975:3	223,801	219,650	101.9
1975:4	221,715	224,635	98.7
1976:1	226,024	237,341	95.2
1976:2	239,279	229,797	104.1
1976:3	236,603	231,965	102.0
1976:4	237,428	240,622	98.7
1977:1	235,213	247,166	95.2
1977:2	260,263	249,883	104.2
1977:3	258,029	252,864	102.0
1977:4	271,067	274,881	98.6

wholesale carpet sales is .65. This result is similar, although slightly higher, to the results found for the residential retail equation. The slight difference may be attributed to a possible upward bias in this equation because household furniture shipments does not include commercial furniture. It's significance confirms the consumer's desire to "totally" furnish his household. The inelastic coefficient substantiates the competitive nature among home furnishing purchases for a slice of consumer's disposable income. However, on a wholesale level no lag exists between carpet shipments and furniture shipments.

Investment in Total Structures

The elasticity coefficient for investment in total structures is .21. This implies a .2 percent increase in wholesale carpet sales for every one percent increase in investment in total structures (residential and nonresidential). The low elasticity coefficient suggests only a certain percentage of total new housing is initially covered by carpeting. This result is slightly lower than the results found by the contract carpet equation (.44). The difference may be attributed to a possible upward bias in this equation because the contract market does not include residential structures which are initially covered by residential retail carpeting.

Alternative Best Equation

Both real disposable personal income and the relative wholesale price of carpeting cannot be presented in the same equation. The correlation coefficient between these two variables is -.96. Multicollinearity would result since it would be difficult to disentangle the relative influence of each variable.

In order to look at the relationship between relative wholesale price and wholesale carpet sales, relative price is substituted for real disposable personal income. The coefficients for the other two variables do not change significantly. The result of this equation is as follows:

$$\text{Log(QSQYD)} = 9.4 \underset{(-14.0)}{-.80\text{Log(WPI11)}} \underset{(5.0)}{+.39\text{Log(IC72)}} \underset{(8.0)}{+.65\text{Log(SHIPS)}}$$

t-statistics are in parenthesis

WPI11=Relative wholesale price of carpeting.
$\bar{R}^2$=.97
Durbin-Watson=1.9
Standard Error of the Regression=.028

Table 22 also lists the values for the relative wholesale price of carpeting. Equation results of alternative variables are presented in Appendix II.

The elasticity of wholesale carpet shipments to price is -.8. This elasticity coefficient is lower than the elasticity coefficients found by the residential retail and contract carpet equations.[51]

The low elasticity coefficient for wholesale price may be explained by focusing on the definition of price elasticity and by comparing the growth between the WPI and CPI for carpeting. The price elasticity concept explains a consumer's ability to substitute one consumer good for another in response to price changes. However, a carpet retailer, by definition, has little maneuvering room in which to substitute out of carpeting, i.e., hard floor covering in place of soft floor covering. The only major response to higher prices is an inventory adjustment. Furthermore, consumer prices for carpeting rose faster than wholesale prices for carpeting.[52] Retailers are able to buy in bulk from manufacturers at lower prices. Although these low prices are usually passed on to the consumer, other costs faced by retailers result in larger markups.[53] Retailers, therefore, are not as sensitive as consumers to carpet price changes. This may explain the lower coefficient for the relative wholesale price for carpeting.

Testing the Validity of the Model[54]

The same criteria for testing the validity of a model established in the residential retail equation will be used in order to test the validity of the wholesale carpet model.

Goodness of Fit Measure

In this model the $\bar{R}^2$, the coefficient of determination is .97. In other words, 97 percent of the movement in wholesale carpet sales is explained by the exogenous variables.

Statistical Significance of the Regression Coefficients

Each variable in the model is statistically significant as measured by the t-statistic at the 5 percent level of significance. This implies the coefficients for the exogenous variables are significant and do not occur by chance.

Comparison of Actual vs. Fitted Values

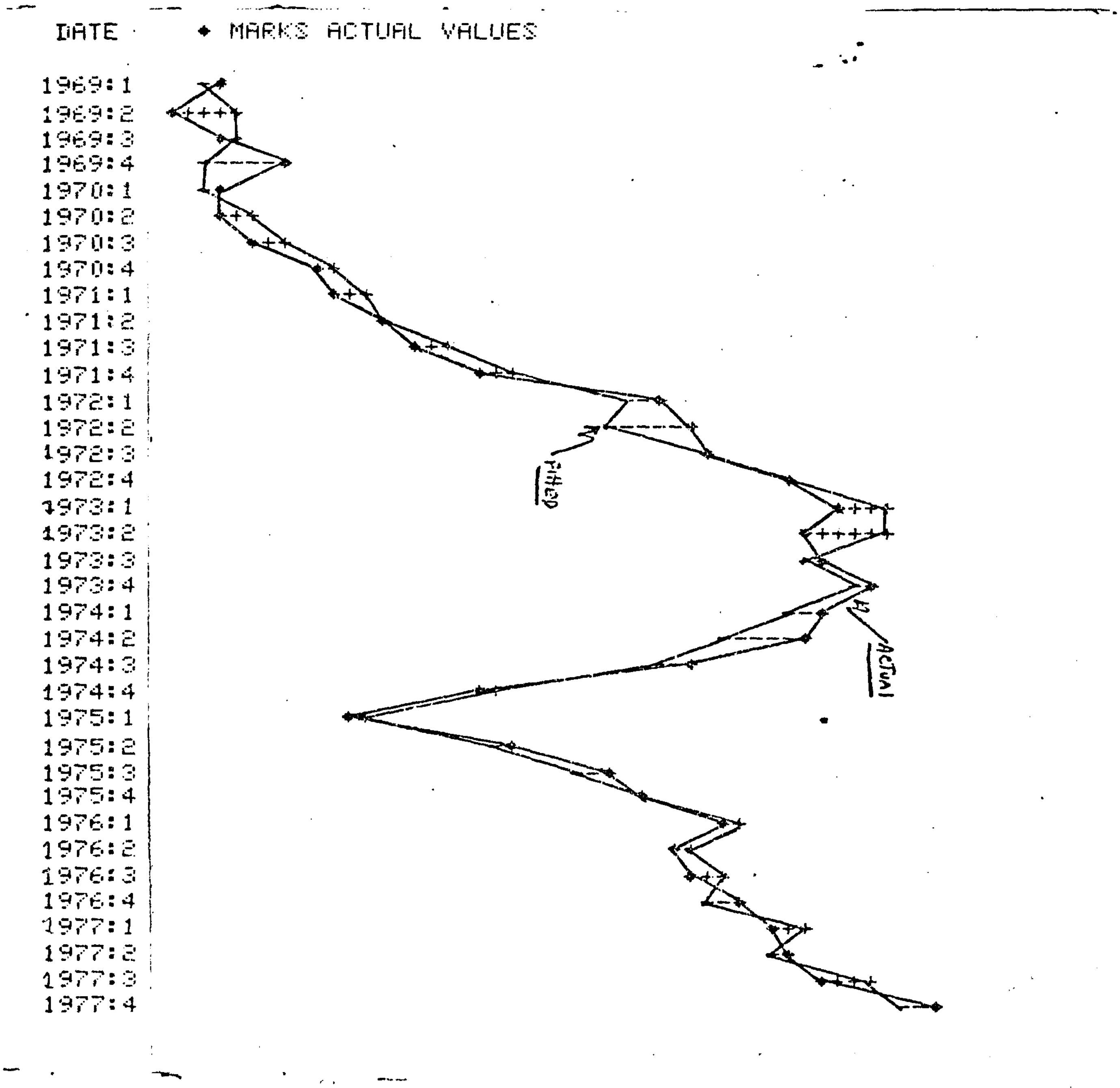
Chart IV exhibits the actual and fitted values of the wholesale carpet equation. The fitted values are very close to the actual values, especially between 1974 and 1977. The model is nearly perfect in anticipating the 1974 downturn. Although the model significantly misses a few quarterly movements, the model is generally accurate in its estimation of quarter to quarter movements.

Test for Autocorrelation[55]

The Durbin-Watson statistic for the wholesale carpet equation is 1.75. With four parameters and 36 observations the upper and lower critical bounds are 1.24 and 1.73 respectively. The estimated Durbin-Watson statistic is within the upper bound, and we reject the null hypothesis that positive autocorrelation exists. This is confirmed by observing the residuals (Chart IV). No difinitive trend for the residuals is apparent. Furthermore,

CHART IV

WHOLESAL CARPET EQUATION
Actual vs. Fitted Values



the Spearman rank correlation coefficient[56] is low (.057) and we can conclude the residuals are independently distributed. Therefore, positive autocorrelation is not apparent in the wholesale carpet equation.

Stability of the Regression Coefficients-Chow Test[57]

The Chow test on the wholesale carpet equation is performed on the same two time intervals as in the residential retail and contract carpet equations. The calculated F value for the first Chow test (1969:1-1973:2 and 1973:3-1977:4) and the second Chow test (1969:1-1974:4 and 1975:1-1977:4) equal 1.836 and .445 respectively. The calculated F values falls within the critical bounds.[58] We accept the null hypothesis and conclude that a 95 percent level of confidence exists for the estimated wholesale carpet equations stability over the regression interval.

Backcasting

The truncated version of the wholesale carpet model, regressed from 1969 to 1976 is as follows:

$$\underset{}{Log(QSQYD)}=2.9+1.1\underset{(9.1)}{Log(Yd72)}+.21\underset{(2.1)}{Log(IC72)}$$

$$+.66\underset{(5.9)}{Log(SHIPS)}$$

t-statistics are in parenthesis

$\bar{R}^2=.97$
Durbin-Watson=1.54
Standard Error of the Regression=.028

Table 24 compares the actual and fitted values of the truncated model for 1977. The model's forecasting accuracy on a quarter to quarter basis is good. The model overestimates the first and third quarters and underestimates the second and fourth quarters. The model's largest miss is the fourth quarter. For the first, second and fourth quarters, the percent error is less than the 2.8 percent standard error of the regression. The third quarter's percent error, however, is slightly greater (3.8 percent) than the equation's standard error. On an annual basis, the quarterly model's accuracy is excellent. The model forecasts an annual increase of 10.0 percent for 1977. Actual wholesale carpet sales increased 9.2 percent. The annual percent error is .8 percent, significantly less than the 2.8 percent standard error of the regression.

TABLE 24

WHOLESALE CARPET SHIPMENTS
Millions of Square Yards
Truncated Model
Actual vs. Fitted

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	247.2	249.9	252.9	275.9	1025.9
Fitted	254.5	246.9	262.6	269.7	1033.7
Percent Error*	2.2	1.2	3.8	2.2	.8

$$\text{*Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

NOTES

[1] Since wholesale hard floor covering sales does not exceed 13 percent of total floor covering sales this data is an excellent proxy for retail carpet sales.

[2] The Conference Board, Discretionary Spending, 1966, Technical Paper Number 17.

[3] The equations used in calculating the capital stock of housing are:

(a) $KQHUSTS1_t=(1-.00567)^{.25}xKQHUSTS_{t-1}$
$+(.96xHUSTS_{t-1})\ 4$

(b) $KQHUSTS2\&_t=(1-.00819)^{.25}xKQHUSTS\&_{t-1}$
$+(.95xHUSTS2\&_{t-1})\ 4$

(c) $KQHUSTS_t=KQHUSTS1_t+KQHUSTS2\&_t$

KQHUSTS1=Capital stock of single family housing.
KQHUSTS2&=Capital stock of multi-family housing.
HUSTS1=Single family housing starts.
HUSTS2&=Multi-family housing starts.
t=Time period.

[4] Value of product shipments at the wholesale level.

[5] Only annual furniture shipments are published in the "Annual Survey of Manufacturers".

[6] The constant dollar value for retail floor covering sales is a proxy for quantity of sales. Therefore, the various coefficients are interpreted as elasticities.

[7] U.S. Department of Commerce, Bureau of the Census, The X-11 Variant of the Census Method II Seasonal Adjustment Program, 1967, Technical Paper Number 15.

8
Multiplicative Seasonal Adjustment Stable Seasonality Test:

	Sum of Squares	Degrees of Freedom	Mean Square	F
Between Quarters	852.914	3	284.305	24.448
Residual	476.782	41	11.629	
Total	1329.696	44		

Stable seasonality present at the 1 percent level.

9
The elasticity coefficient for relative price might be biased downward because negative errors of measurement in the absolute price of carpeting will overestimate real retail floor covering sales at the same time underestimate the relative price of floor coverings. Since real discretionary income is positively correlated to the relative price of floor covering, the elasticity coefficient for real discretionary income will also be biased downward.

10
Ibid.

11
The elasticity coefficient for income in Reynold's study (page 17) is much higher. However, he estimates the wholesale market for carpeting and uses real personal disposable income as his exogenous variable.

12
Between 1969 and 1977 real discretionary income rose 22 percent, an annual compound growth rate of 2.5 percent. Between 1960 and 1968 real discretionary income rose 31 percent, with an average annual compound growth rate of 3.4 percent.

13
A recent unpublished study by the Sperry and Hutchinson Company concluded nearly 34 percent complimented Bigelow carpet purchases with household furniture purchases.

14
The minimum value of the t-distribution at the 5 percent level with 33 degrees of freedom is approximately 1.697.

15
When the Durbin-Watson statistic is below the lower critical bounds significant positive autocorrelation exists. When the Durbin-Watson statistic is above the upper bounds significant negative autocorrelation exists.

16 The Spearman rank correlation is defined as:

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

d=Difference between the ranks of the error term and the time trend.
n=Number of observations.

The null and alternative hypothesis are:

H_0=Errors are independent and are not significantly different from zero.
H_1=Errors are not independent and are significantly different from zero.

When n>20 the sampling distribution approximates normality. Therefore, the normal area table can be used to find probabilities. The results are as follows:

$$Var(r_s) = \sigma r^2 = \frac{1}{n-1}$$

n=36
r_s=.013

$$\sigma r^2 = \frac{1}{35}$$

$$\sigma r^2 = \frac{1}{5.9}$$

Therefore, $Z = \frac{r_s}{\sigma r} = \frac{.013}{\frac{1}{5.9}} = .077$

This means r_s is .077 standard deviations away from zero which is not significantly different from zero. Therefore, we accept the null hypothesis that the errors are independent over time.

17 These two intervals were chosen in order to test the models stability before and after the 1974 recession.

18 The critical bound at the 5 percent level of significance for F(5.26) is 2.59.

19 In other words, these two tests conclude that a 95 percent confidence level exists on the estimated model's stability throughout the regression time interval.

20 The emphasis of the analysis is on corporate's decision to purchase contract carpeting. Contract carpet sales for Bigelow-Sanford is predominantly sales to commercial establishments. Residential contract carpeting will be primarily analyzed through the derived demand variable (construction variable).

21
By general consensus of carpet manufacturers, I am using as my base 1968=30 percent as the percentage share of contract carpet sales of total carpet sales. Also, I an assuming the movement of Bigeow-Sanford's contract carpet sales reflects the movement of total industry's contract carpet sales.

22
The best measure for corporate profits would be one which separates out operating profit from total corporate profits. However, due to data limitations operating profits could not be calculated.

23
Recently, as part of the total construction package new residential structures are initially covered by contract carpeting.

24
For a more detailed explanation of the consumer price index, its source and availability, see page 40.

25
Industry Comment, Carpet Industry, Arthur D. Little, 1971.

26
Relative to other durable and non-durable goods.

27
U.S. Department of Commerce, Bureau of the Census, The X-11 Variant of the Census Method II, Seasonal Adjustment Program, 1967, Technical Paper Number 15.

28
Multiplicative Seasonal Adjustment Stable Seasonality Test:

	Sum of Squares	Degrees of Freedom	Mean Square	F
Between Quarters	272.485	3	90.828	17.092
Residuals	191.312	36	5.314	
Total	463.796	39		

Stable seasonality present at the 1 percent level.

29 Between 1963 and 1977 soft floor covering prices increased by 19 percent while hard floor covering prices increased 30 percent for vinyl and 47 percent for tile. Floor Coverings, T51, Predicasts, Inc., 1978, pp. 12, 27. Although data on commercial soft floor coverings and hard floor coverings do not exist, a consensus among carpet manufacturers agree that soft floor covering has increased its penetration of the commercial market.

30 The absolute value of the relative price of carpeting and real corporate profits are positively correlat[ed]. If the coefficient for price is underestimated due to errors of measurement, the coefficient for real corporate profits is also underestimated.

31 Between 1958 and 1967 corporate profits grow at at 4.6 percent compound annual growth rate. Between 1968 and 1977 corporate profits grew at a 1.3 percent compound annual growth rate.

32 Although more durable and easily cleaned carpeting has made soft floor coverings more competitive with hard floor coverings (see p. 67).

33 Due to the high correlation (.98) between residential and nonresidential investment both variables could not be entered in the same equation. When either residential or nonresidential investment is entered individually no significant changes occur in the other coefficients. The elasticity coefficients for residential investment and nonresidential investments is .30 and .77. Table 19 lists the values of these two variables. Appendix II lists the results of these alternative equations.

34 Twenty-five percent of new floor space in tract homes in 1967 were covered with contract carpeting. (Robert Kirk, The Carpeting Industry, Present Status and Future Prospects, p. 73).

35 The minimum value of the t-distribution at the five percent level with 33 degrees of freedom is approximately 1.697.

[36] For a more detailed explanation of the Spearman rank test see page 50.

[37] $r_s = .020 \quad Var(r_s) = \sigma r^2 = \frac{1}{35} \quad \sigma r = \frac{1}{5.9}$

Therefore, $z = \frac{r_s}{\sigma r} = \frac{.020}{\frac{1}{5.9}} = .118$

This means r_s is .118 standard deviations away from zero which is not significantly different from zero. Therefore, we accept the null hypothesis that the errors are independent over time.

[38] For a more detailed explanation of the Chow test see pages 50,51.

[39] These two intervals were chosen in order to test the estimated model's stability before and after the 1974 recession.

[40] The critical bounds at the five percent level of significance for f(4.28) is approximately 2.71.

[41] In other words, these two tests conclude that a 95 percent level of confidence exists on the model's stability throughout the regression time interval.

[42] 1977's severe weather a significant factor in retail carpet sales did not significantly upset contract carpet sales.

[43] Two different equations are presented whose statistical results are nearly identical.

[44] An alternative best equation is presented on page 85.

[45] U.S. Department of Commerce, Bureau of the Census, The X-11 Variant of the Census Method II Seasonal Adjustment Program, 1967, Technical Paper, No. 15.

46 Stable Seasonality Adjustment Stable Seasonality Test:

	Sum of Squares	Degrees of Freedom	Mean Square	F
Between Quarters	268.944	3	89.648	22.141
Residual	129.568	32	4.049	
Total	398.513	35		

Stable seasonality present at the 1 percent level.

47 The statistical results for the real national income variable is presented in Appendix II.

48 The coefficient for real personal disposable income is higher than the coefficients for discretionary income and corporate profits by the residential retail and contract carpet equations respectively because: (a) personal disposable income does not account for the contract commercial market and (b) the relative price of wholesale carpeting is not presented in this equation.

49 Between 1960 and 1968 real disposable personal income increased by an average of 1.4 percent. Between 1969 and 1977 it increased by an average of 1.3 percent.

50 For my model they do not add up since residential retail demand is proxied by total floor covering sales and contract carpet sales is an estimate.

51 The elasticity coefficients for the other two equations are approximately -1.5.

52 Between 1969 and 1977 the CPI for carpeting rose by 35 percent, and the WPI rose by 21 percent.

53 Between 1969 and 1977 carpet retailer markups rose from 40 percent to 46 percent.

54 The tests for the best alternative equation will be presented in Appendix III.

55 For a more detailed explanation of the Spearman rank test see page 50.

[56] $r_s = .057$

$$var(r_s) = \sigma r^2 = \frac{1}{35}$$

$$\sigma r = \frac{1}{5.9}$$

Therefore, $z = \frac{r_s}{\sigma r} = \frac{.057}{\frac{1}{5.9}} = .33$

r_s is only .33 standard deviations away from zero which is not significantly different from zero. Therefore, we can accept the null hypothesis that the errors are independently distributed over time.

[57] For a more detailed explanation of the Chow test see pages 50, 51.

[58] The critical bounds at the 5 percent level of significance for f(4.28) is 2.71.

CHAPTER III

Forecasting Carpet Industry Sales With Trend Analysis

The use of trend analysis in forecasting carpet industry sales falls short of the necessary accuracy needed in order to accurately forecast cyclical changes in industry sales. Trend equations explain a smaller percentage of sales variation, have higher standard errors and show substantially more positive autocorrelation than equations using economic exogenous variables. For all three markets, i.e., retail, contract and wholesale simple trend analysis does not capture the cyclical variations which are now common in this industry. Simple trend analysis will forecast well (as in the contract model for 1977) only when the industry is growing at or near its trend rate. Any cyclical movement in the industry results in large residual errors for these models. Therefore, during cyclical upturns the model will underestimate the actual values and during cyclical downturns the model will overestimate the actual values. When each trend model is adjusted for the apparent declining trend in industry sales (the addition of times squared in each equation) it only improves the forecasting accuracy of the residential retail trend equation. However, such models will not be able to accurately forecast any future cyclical upturns because of the declining growth factor in the model.

Residential Retail Equation

The statistical results of regressing time on residential floor covering sales are:

$$\text{Log(FCRS72)}=3.93376+.02285(\text{TIME})$$
$$(12.3)$$

Time interval=1969 to 1977
$\overline{R}^2$=.81
Durbin-Watson=.34
Standard Error of the Regression=.116

In this model the $\overline{R}^2$ is .81 or 81 percent of the variation of retail floor covering sales is explained as trend. This equation shows that between 1969 and 1977 retail floor covering sales has grown at a quarterly compounded growth rate of 2.3 percent. The Durbin-Watson statistic suggests significant positive autocorrelation in this regression. Furthermore, upon examining the actual and fitted values (Chart V) it is obvious the residuals are not randomly distributed. The fitted values have significantly overestimated or underestimated cyclical fluctuations and will be unable to capture future cyclical variations from trend. However, the residuals are substantially less in the last few quarters as residential retail sales growth is beginning to reach its trend growth rate.

In order to see how well a simple trend equation estimates residential retail floor covering sales the statistical results of a truncated version of the model from 1969 to 1976 are:

$$\text{Log(FCRS72)}=3.77+.0245(\text{TIME})$$
$$(10.72)$$

$\overline{R}^2$=.79
Durbin-Watson=.35
Standard Error of the Regression=.119

CHART V

RESIDENTIAL RETAIL EQUATION
Trend Analysis
Actual vs. Fitted Values

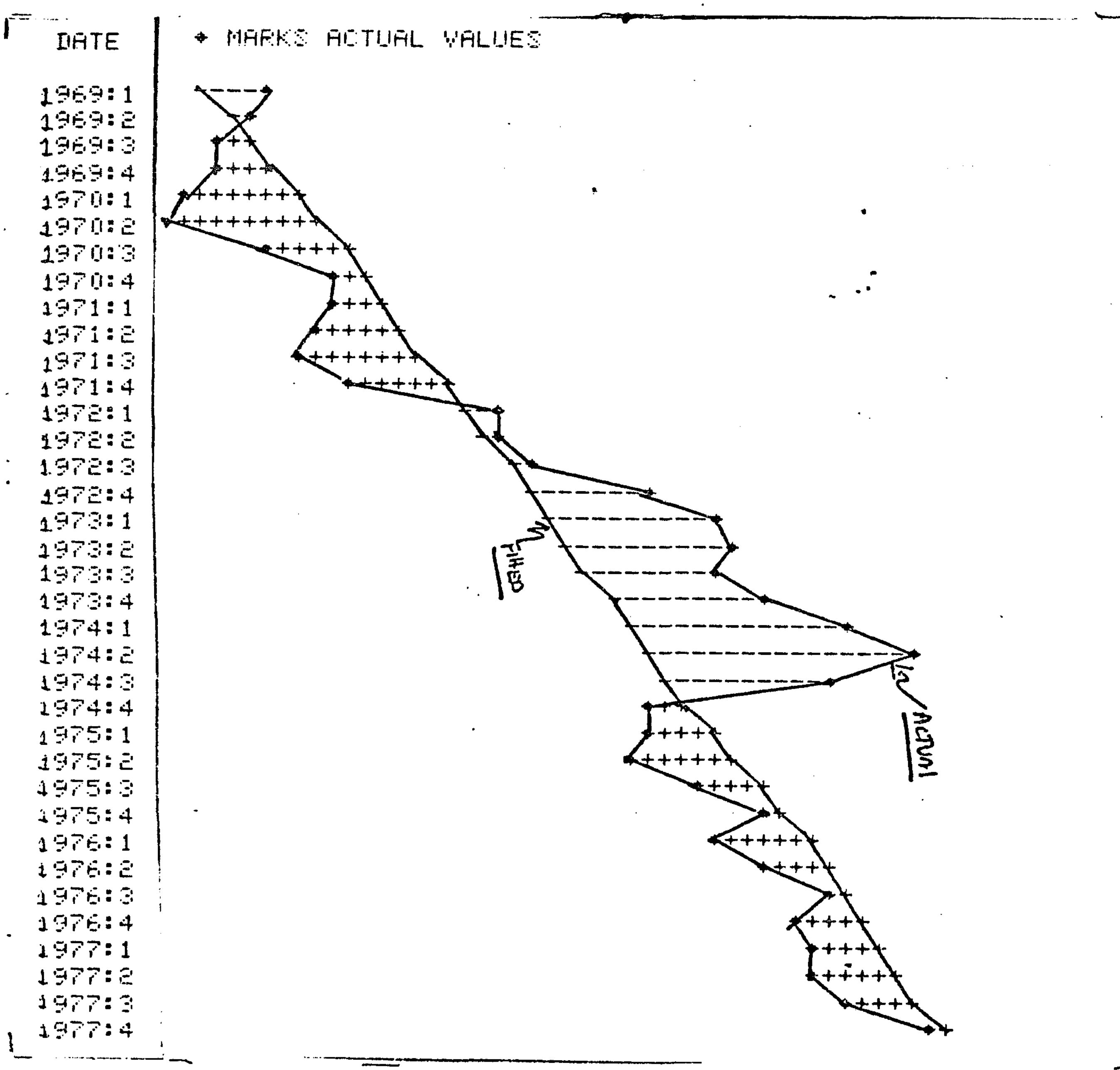


Table 25 compares the percent error between actual and fitted values for 1977 of the quarterly trend model. Quarterly, the model substantially overestimates the actual value in each quarter. When the results of the quarterly model is aggregated to produce an annual estimate for 1977, the model also substantially overestimates the actual value. The model's forecast errors are either near or over the standard error of the regression. This model's forecast for 1977 is not as accurate as the best fitting equation for retail floor covering sales (Table 15) using economic exogenous variables.

In order to determine if retail floor covering sales are either increasing or decreasing over time, time squared is added to the above equation. The statistical results are as follows:

$$\underset{}{\text{Log(FCRS72)}} = -1.02 + \underset{(2.98)}{.116}(\text{TIME}) - \underset{(-2.37)}{.0004}(\text{TIME})^2$$

$\bar{R}^2 = .85$
Durbin-Watson=.43
Standard Error of the Regression=.106

When time squared is added to the trend equation it explains only 4 percent of the variance in residential retail floor covering sales. The coefficient for time squared shows the growth of floor covering sales declining by a .04 percent compound quarterly rate. The Durbin-Watson statistic continues to confirm significant positive autocorrelation. Furthermore, upon examining the actual and fitted values (Chart VI) it is obvious the residuals are still not randomly

TABLE 25

RESIDENTIAL RETAIL FLOOR COVERING SALES*
Trend Analysis
Actual vs. Fitted Values

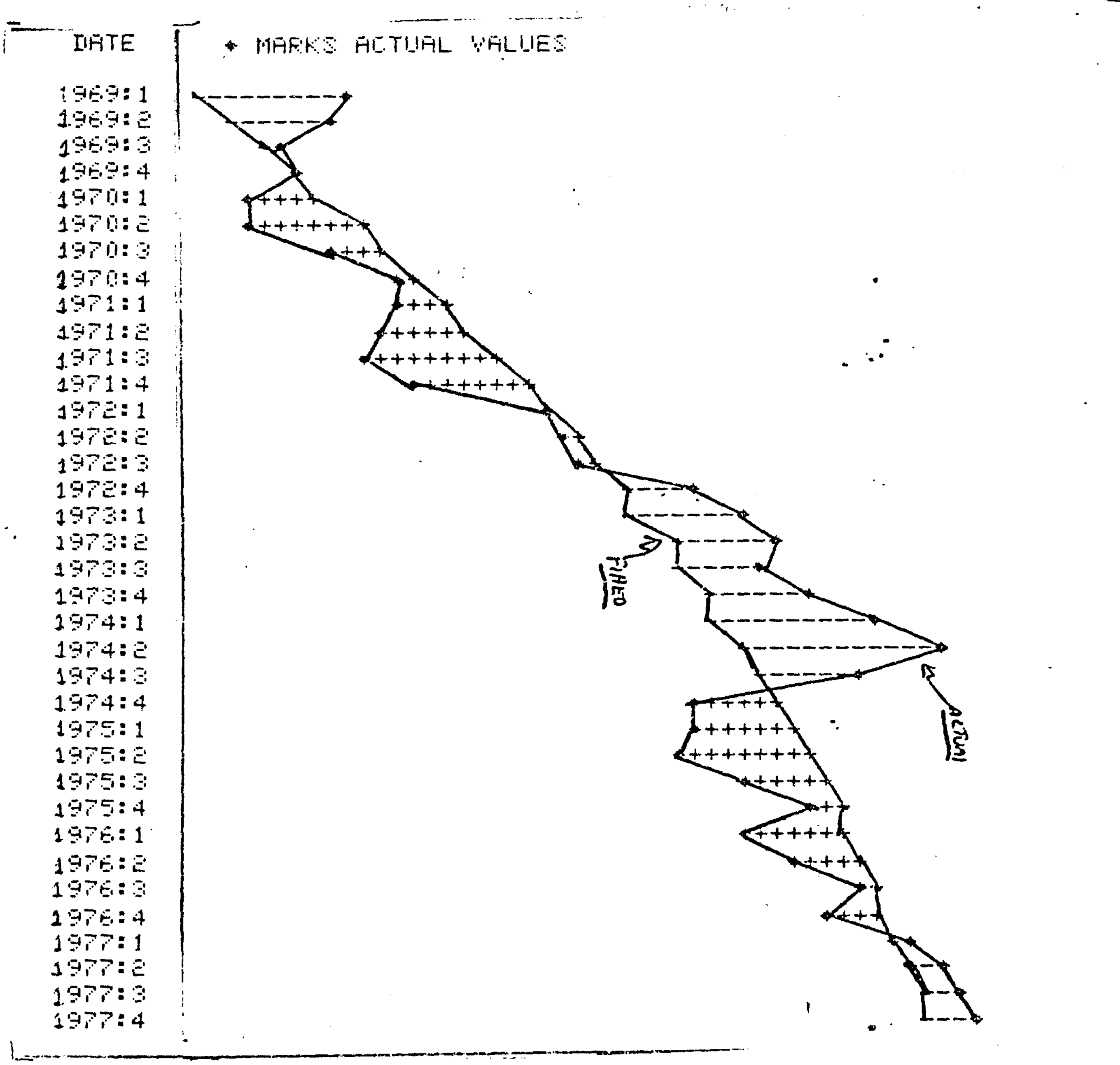
	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	757.1	757.8	785.5	856.9	3157.3
Fitted	840.2	861.0	882.4	904.3	3487.9
Percent Error**	-11.0	-12.1	-12.4	-5.5	-10.5

*Truncated Model

$$**\text{Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

CHART VI

RESIDENTIAL RETAIL EQUATION
Trend Analysis with Time Squared
Actual vs. Fitted Values



distributed. The residuals are still overestimating or underestimating cyclical fluctuations in residential retail floor covering sales. The residuals are increasing in the last few quarters as the declining trend factor is not capturing residential retail floor covering's improved growth for 1977.

In order to see how well the above model forecasts residential retail floor covering sales the statistical results of a truncated version of this model from 1969 to 1976 are:

$$\text{Log(FCRS72)}=-3.345+.162(\text{TIME})-.0007(\text{TIME})^2$$
$$(3.0) \qquad (-2.59)$$

$\bar{R}^2=.82$
Durbin-Watson=.44
Standard Error of the Regression=.109

Table 26 compares the percent error between actual and fitted values for 1977 for this model. Quarterly, the model underestimates the actual values in each quarter, with the errors becoming progressively larger. When the results of the quarterly model are aggregated to produce an annual estimate for 1977, the model also substantially underestimates the actual value. Except for the fourth quarter, however, the model's percent error are within the high (11 percent) standard error of the regression. Although this model's forecast for 1977 is good it is not as accurate as the best fitting equation for residential retail floor covering sales using economic exogenous variables (Table 15). This model will forecast well as long as retail floor coverings

TABLE 26

RESIDENTIAL RETAIL FLOOR COVERING SALES*
Trend Analysis with Time Squared
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	757.1	757.8	785.5	856.4	3137.3
Fitted	743.1	744.8	745.4	745.0	2978.3
Percent Error**	1.8	6.0	5.0	13.1	5.7

*Truncated Model

$$**\text{Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

grow at a declining trend rate. However, this model will not be able to capture the substantial cyclical variations which are now readily apparent by retail floor covering sales.

Contract Carpet Equation

The statistical results of regressing time on contract carpet sales are:

$$\text{Log(CSQYDSA)}=2.72+.015(\text{TIME})$$
$$(9.5)$$

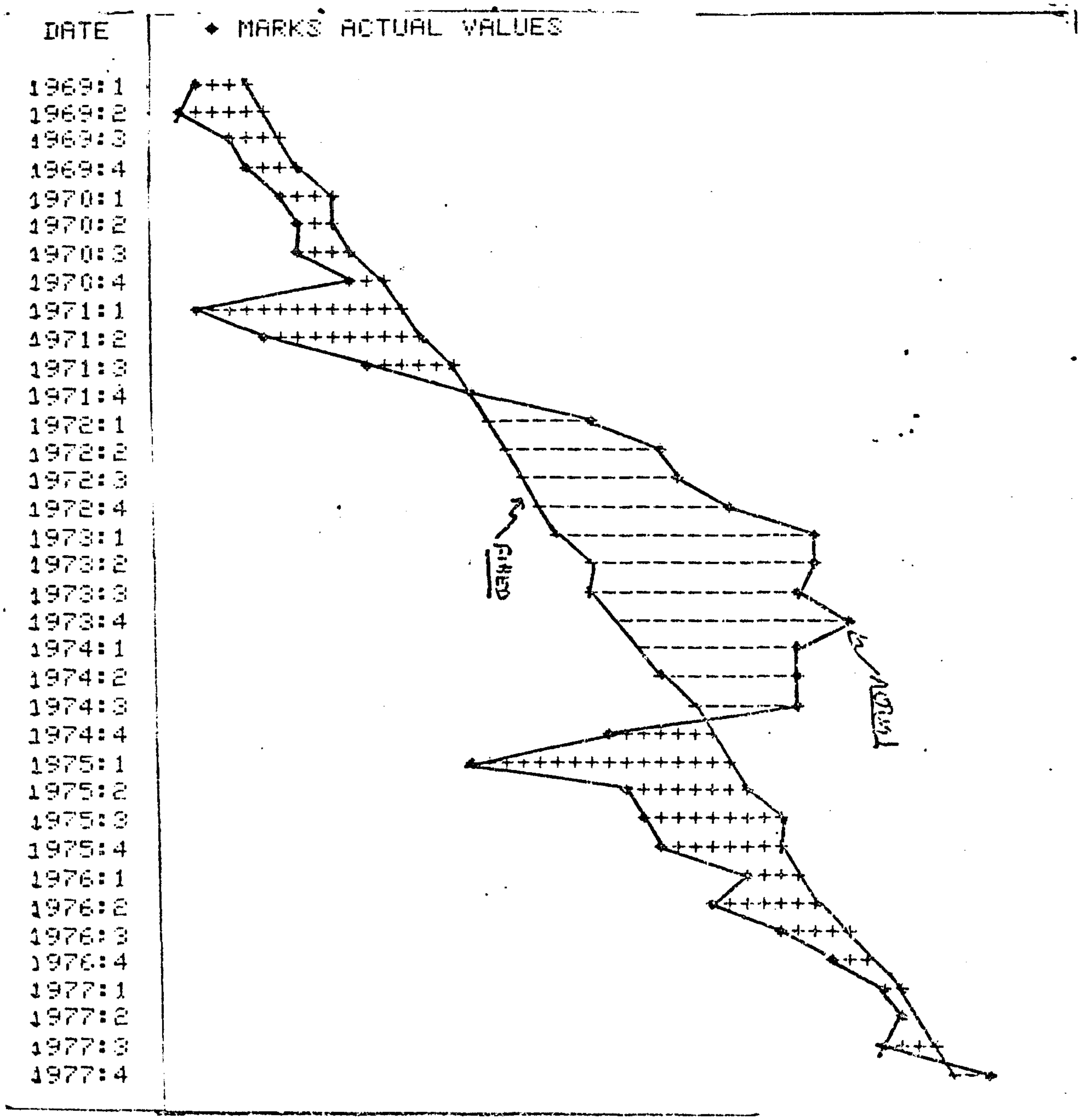
$\bar{R}^2$=.72
Durbin-Watson=.30
Standard Error of the Regression=.10

In this model the $\bar{R}^2$ is .72 or 72 percent of the variation in contract carpet sales is explained as trend. This equation shows that between 1969 and 1977 contract carpet sales has grown at a quarterly compounded growth rate of 1.5 percent. The Durbin-Watson statistic suggests significant positive autocorrelation in this regression. Furthermore, upon examining the actual and fitted values (Chart VII) it is obvious the residuals are not randomly distributed. As in the retail trend equation, the residuals show the estimated model is significantly overestimating or underestimating cyclical fluctuations. For 1977 the growth in contract carpet sales is beginning to near its trend growth rate. As a result, the residuals in the four quarters of 1977 are substantially less.

In order to see how well a simple trend equation estimates contract carpet sales, the statistical results of a truncated version of the model from 1969 to 1976 are:

CHART VII

CONTRACT CARPET EQUATION
Trend Analysis
Actual vs. Fitted Values



$$\text{Log(CSQYDSA)}=2.7+\underset{(7.8)}{.015}\text{(TIME)}$$

$\bar{R}^2$=.65
Durbin-Watson=.28
Standard Error of the Regression=.10

Table 27 compares the percent error between actual and fitted values for 1977 of the quarterly trend model. Quarterly, the model overestimates the first and third quarters and underestimates the second and fourth quarters. When the results of the quarterly model are aggregated to produce an annual estimate for 1977, the model overestimates the actual value. This model's percent error is well within the standard error of the regression (10 percent). Although this model's forecast for 1977 is good, it is not as accurate as the best fitting equation for contract carpet sales using economic exogenous variables (Table 21).

In order to determine if contract carpet sales are either increasing or decreasing over time, time squared is added to the above equation. The statistical results are as follows:

$$\text{Log(CSQYDSA)}=-1.9+\underset{(3.1)}{.109}\text{(TIME)}-\underset{(-2.7)}{.0004}\text{(TIME)}^2$$

$\bar{R}^2$=.77
Durbin-Watson=.35
Standard Error of the Regression=.099

When time squared is added to the trend equation for contract carpet sales, it explains only 6 percent more of the variance in contract carpet sales. The coefficient for time squared also shows the growth of contract carpet sales declining by a .04 percent compound quarterly rate.

TABLE 27

CONTRACT CARPET SALES*
Trend Analysis
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	89.3	91.0	89.3	96.6	366.1
Fitted	90.2	91.6	92.9	94.3	369.0
Percent Error**	-1.0	-0.6	-4.1	-2.3	-0.8

*Truncated Model

$$\text{**Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

The Durbin-Watson statistic continues to confirm significant positive autocorrelation. Upon examining the actual and fitted values (Chart VIII) it is obvious the residuals are still overestimating or underestimating cyclical variations in contract carpet sales. Furthermore, this model significantly underestimates all four quarters in 1977 as the declining trend factor is not capturing contract carpet sales improved growth for 1977.

In order to see how well the above model forecasts contract carpet sales, the statistical results of a truncated version of this model from 1969 to 1976 are:

$$\text{Log(CSQYDSA)} = -5.35 + \underset{(4.1)}{.17}(\text{TIME}) - \underset{(-3.7)}{.0007}(\text{TIME})^2$$

$\bar{R}^2 = .75$
Durbin-Watson=.43
Standard Error of the Regression=.086

Table 28 compares the percent error between the actual and fitted values for 1977 for this model. Quarterly, the model significantly underestimates the actual values in each quarter, with the error growing progressively larger. When the results of the quarterly model is aggregated to produce an annual estimate for 1977, the model also substantially underestimates the actual value. For every quarter the model's percent error is well above the standard error of the regression (8.6 percent). This model's forecasting accuracy is not as accurate as the best fitting equation for contract carpet sales using economic exogenous variables (Table 21).

CHART VIII

CONTRACT CARPET EQUATION
Trend Analysis with Time Squared
Actual vs. Fitted Values

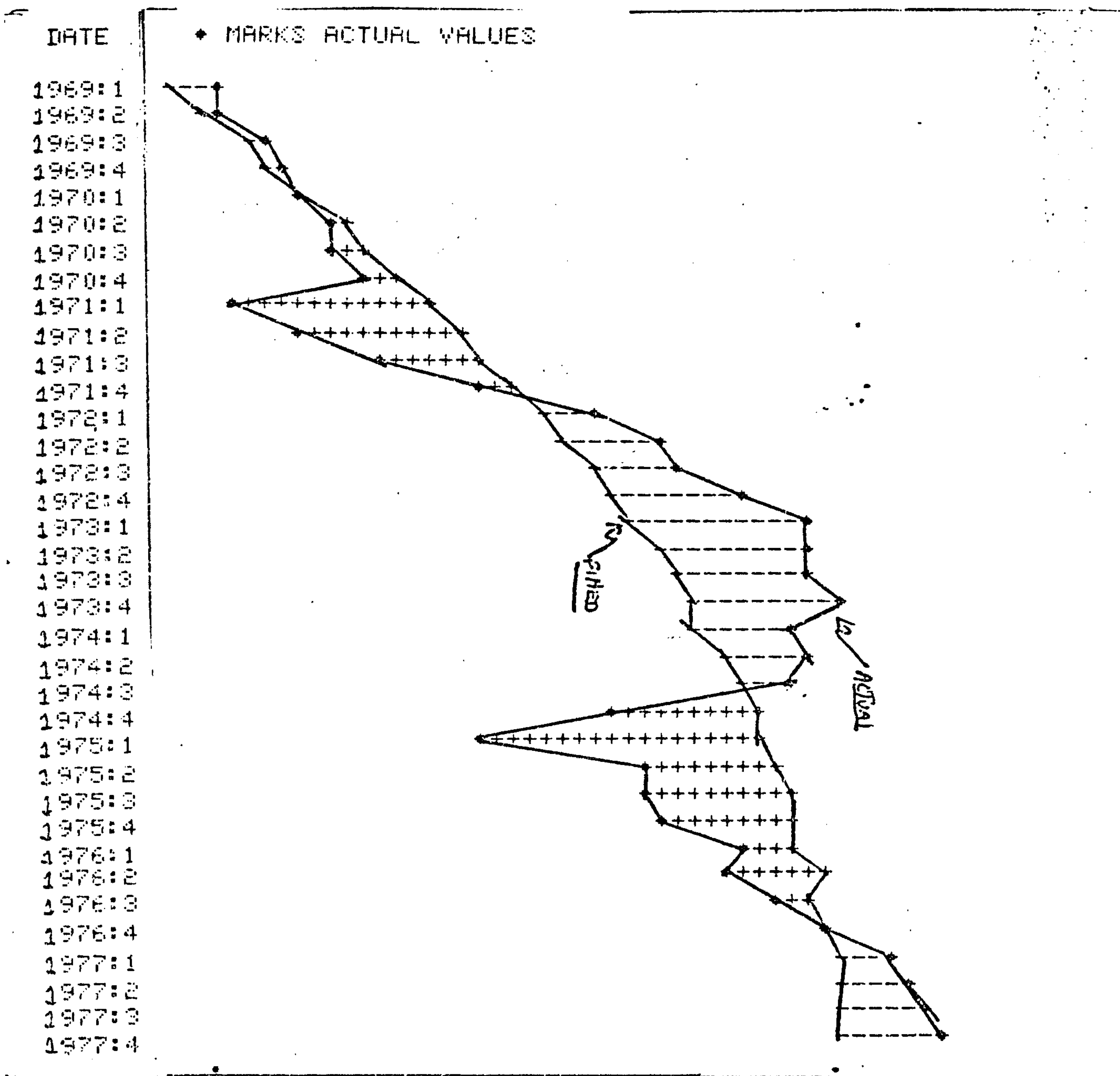


TABLE 28

CONTRACT CARPET SALES*
Trend Analysis with Time Squared
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	89.3	91.0	89.3	96.6	366.1
Fitted	78.5	77.7	76.8	75.7	308.7
Percent Error**	12.1	14.7	14.0	10.5	15.7

*Truncated Model

$$**\text{Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

Wholesale Carpet Equation

The statistical results of regressing time on wholesale carpet sales are:

$$\text{Log(QSQYD)}=4.1+.012\underset{(6.7)}{\text{(TIME)}}$$

$\bar{R}^2$=.55
Durbin-Watson=.23
Standard Error of the Regression=.108

In this model the $\bar{R}^2$ is .55 or 55 percent of the variation in wholesale carpet sales is explained as trend. This equation shows that between 1969 and 1977 wholesale carpet sales has grown at a quarterly compounded growth rate of 1.2 percent. The Durbin-Watson statistic suggests significant positive autocorrelation in this regression. Furthermore, upon examining the actual and fitted values (Chart IX) it is obvious the residuals are not randomly distributed. The residuals also show this model is significantly overestimating or underestimating cyclical fluctuations. However, wholesale carpet sales is also beginning to near its trend growth rate. As a result, the residuals in this model are substantially less for the four quarters of 1977.

In order to see how well a simple trend equation estimates wholesale carpet sales, the statistical results of a truncated version of the model from 1969 to 1976 are:

$$\text{Log(QSQYD)}=4.1+.012\underset{(5.4)}{\text{(TIME)}}$$

$\bar{R}^2$=.47
Durbin-Watson=.22
Standard Error of the Regression=.115

CHART IX

WHOLESALE CARPET EQUATION
Trend Analysis
Actual vs. Fitted Values

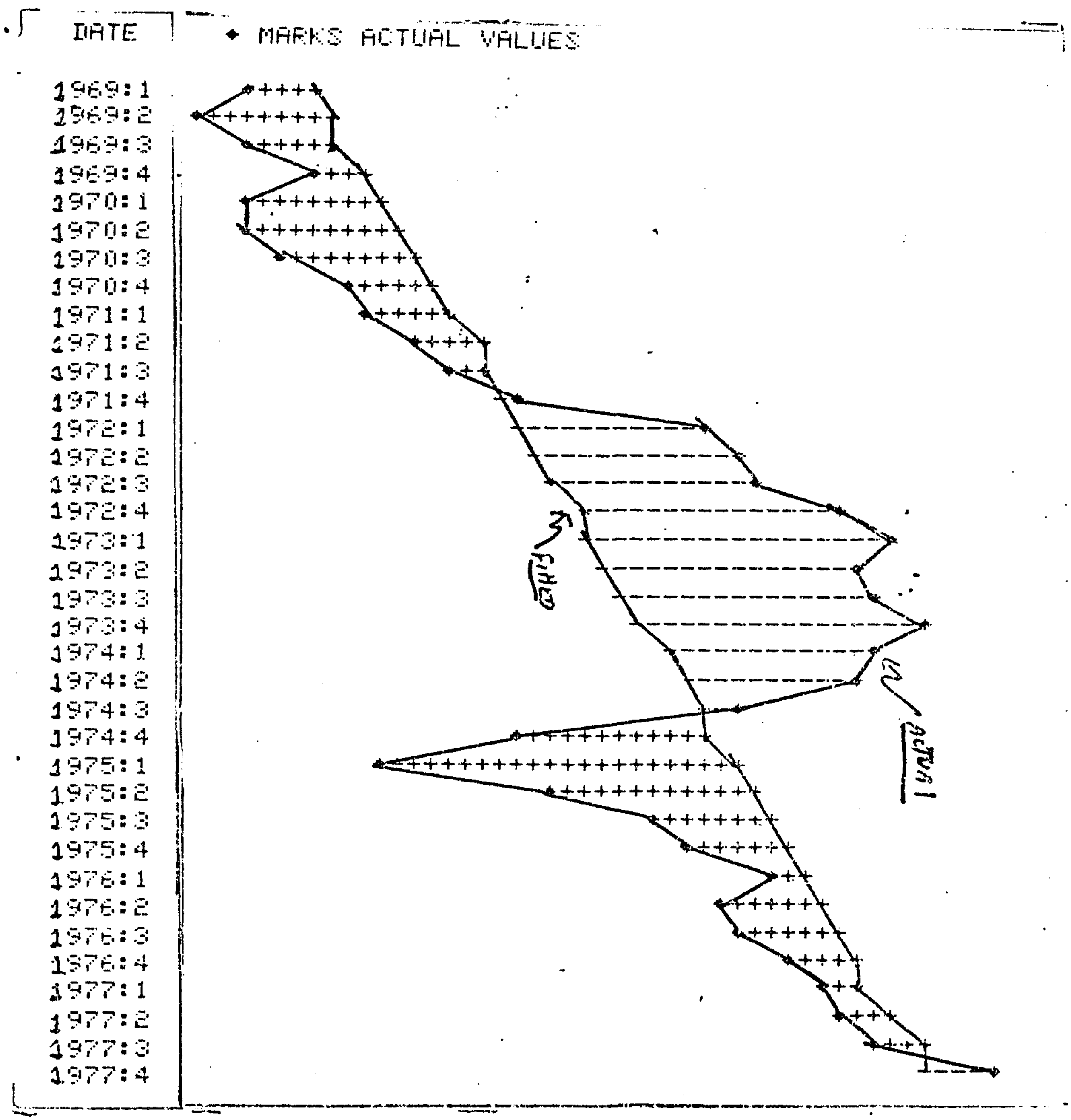


Table 29 compares the percent error between actual and fitted values for 1977 of the quarterly trend model. Quarterly, the model significantly overestimates the first three quarters and underestimates the last quarter. When the results of the quarterly model is aggregated to produce an annual estimate for 1977, the model overestimates the actual value. This model's percent error is well within the standard error of the regression (11.5 percent). However, its forecasting accuracy falls far short of the best fitting equation for wholesale carpet sales using economic exogenous variables (Table 24). Furthermore, the residuals become much larger when wholesale carpet sales deviate from trend during cyclical periods.

In order to determine if wholesale carpet sales are either increasing or decreasing over time, time squared is added to the above equation. The statistical results are as follows:

$$\text{Log(QSQYD)} = -1.5 + \underset{(3.3)}{.12}(\text{TIME}) - \underset{(-3.0)}{.0005}(\text{TIME})^2$$

$\bar{R}^2 = .65$
Durbin-Watson=.29
Standard Error of the Regression=.097

When time squared is added to the trend equation for wholesale carpet sales, it explaines nearly 10 percent more variance in wholesale carpet sales. The coefficient for time squared shows the growth of quarterly wholesale carpet sales declining by a .05 percent compound quarterly rate. The Durbin-Watson statistic continues to confirm significant

TABLE 29

WHOLESALE CARPET SALES*
Trend Analysis
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	247.2	249.9	252.9	275.9	1025.9
Fitted	255.4	258.4	261.5	264.6	1040.0
Percent Error**	-3.3	-3.4	-3.4	3.7	-1.5

*Truncated Model

$$\text{**Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

positive autocorrelation. Upon examining the actual and fitted values (Chart X) it is obvious the residuals are still not randomly distributed. The residuals are still overestimating or underestimating cyclical variations in wholesale carpet sales. Furthermore, this model significantly underestimates all four quarters in 1977 as the declining trend factor is not capturing the improved growth for wholesale carpet sales in 1977.

In order to see how well the above model forecasts wholesale carpet sales, the statistical results of a truncated version of this model from 1969 to 1976 are:

$$\text{Log(QSQYD)}=-5.7+\underset{(4.5)}{.20}(\text{TIME})-\underset{(4.3)}{.0009}(\text{TIME})^2$$

$\bar{R}^2=.67$
Durbin-Watson=.37
Standard Error of the Regression=.091

Table 30 compares the percent error between the actual and fitted values for 1977 for this model. Quarterly, the model significantly underestimates the actual values in each quarter, with the errors growing progressively larger. When the results of the quarterly model is aggregated to produce an annual estimate for 1977, the model also substantially underestimates the actual value. For every quarter, the model's percent error is well above the standard error of the regression (9.1 percent). This model's forecasting accuracy is not as accurate as the best fitting equation for wholesale carpet sales using economic exogenous variables (Table 24).

CHART X

WHOLESALE CARPET EQUATION
Trend Analysis with Time Squared
Actual vs. Fitted Values

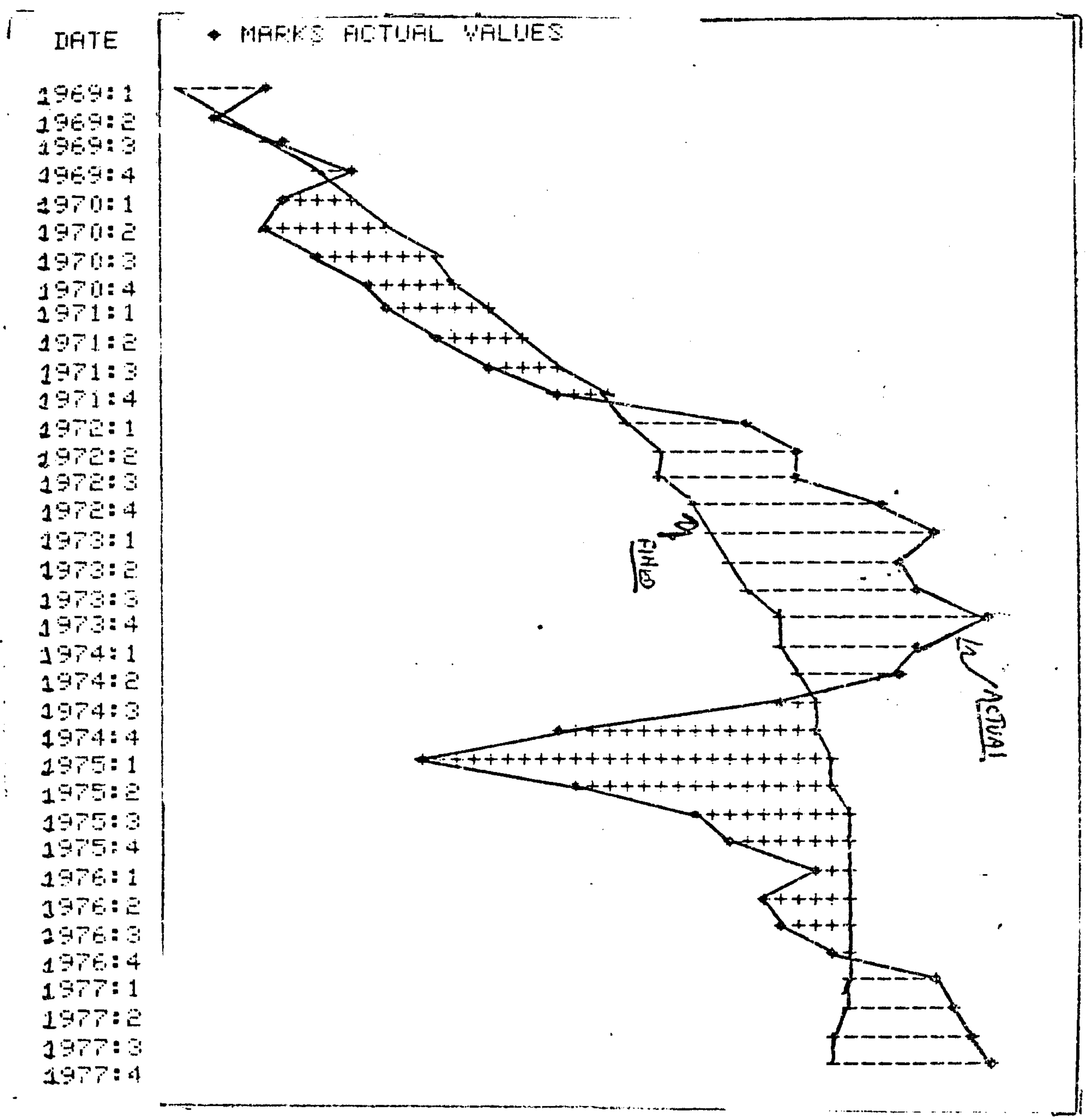


TABLE 30

WHOLESALE CARPET SALES*
Trend Analysis with Time Squared
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	247.2	249.9	252.9	275.9	1025.9
Fitted	215.5	211.5	207.1	202.5	836.6
Percent Error**	12.8	15.4	18.1	26.3	18.4

*Truncated Model

$$\text{**Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

CHAPTER IV

Summary and Conclusions

Summary

As set forth in the introduction, this study attempts to improve the technology for forecasting carpet industry sales. Numerous equations were estimated in order to derive the best forecast estimates for the three main segments of the carpet industry: retail, contract and wholesale. Each best equation underwent numerous statistical tests in order to verify each equation's stability and forecasting accuracy. Each segment of the carpet industry conforms to the traditional framework of demand analysis. The best equations revealed interesting if, at times, surprising revelations. In addition, trend analysis was applied to each market for comparison purposes. The forecast results of the best equations using economic exogenous variables are more accurate than the forecast results using trend analysis.

The best equation for residential retail carpet sales shows strong correlation with its relative price, discretionary income and two derived demand variables, i.e., capital stock of housing and household furniture sales. The negative elastic coefficient for relative price reveals consumer sensitivity to relative price movements. The positive but inelastic coefficient for discretionary income is surprising. However, the inelastic coefficient is directly related to the significantly slower growth in discretionary income and the importance of self-financing due to imperfect capital markets. These factors demonstrate carpeting's position, especially the replacement market, as low priority purchases among durable goods. The two derived demand variables reveal a very strong desire to initially cover additional available floor space coupled with the desire to totally furnish ones household.

The best equation for contract carpet sales shows strong correlation with its relative price, corporate profits and a derived demand variable, i.e., total investment in structures. The conclusions associated with the negative elastic coefficient for its relative price and the positive inelastic coefficient for corporate profits are similar to the residential retail carpet sales equation. The negative elastic coefficient for relative price reveals commercial establishments' sensitivity to relative price movements. The inelastic coefficient for corporate profits is also directly related to the slow growth in corporate profits, imperfect capital markets in the corporate sector and carpeting's low priority among commercial establishment expenditures. The derived demand variable also reveals a strong desire to cover new residential and nonresidential floor space with contract carpeting.

The best equation for wholesale carpet sales shows strong correlation with disposable income, relative price and two derived demand variables, i.e., total investment in structures and household furniture shipments. The conclusions drawn from the wholesale demand equation are slightly different than the two previous equations. Imperfect capital markets is also an important factor for the wholesale market. The unitary elastic coefficient for personal disposable income reveals wholesaler's relative indifference toward changes in personal disposable income. The unitary elastic coefficient is higher than the inelastic coefficients for the residential retail and contract carpet sales equation due to the relatively constant growth in real personal disposable income. As the growth in income remains constant over time, carpet purchases over this same interval reflect carpet buyers' relative indifference toward income changes. Subsequently, it reflects carpet buyers' decision to place a low priority on wholesale carpet purchases.

The conclusions drawn from the low negative price elasticity differ than those in the previous equations. It reflects retailers and wholesale distributor's inability to substitute out of carpeting other than inventory adjustments. Furthermore, it reflects lower wholesale price increases relative to consumer price increases for carpeting. Therefore, retailers and wholesale distributors are not as sensitive to wholesale carpet price changes.

The two derived demand variables confirm the desire to "totally" furnish ones household and a desire to cover new residential and nonresidential floor space with either residential or contract carpeting. These results are similar to the previous equations.

Contributions

Accurate forecasting of the carpet industry is a significant contribution to this industry. The carpet model enables us to understand the relationship between consumer demand for carpeting and external cyclical and trend factors. The income and price elasticities reflect both short (business cycle) and long run variations in income and price. The estimated forecast equations emphasize the low priority attached to carpeting as a durable good. Carpeting's low priority status is especially apparent during periods of slow income growth. This is more obvious when the focus is on the replacement market for carpeting.

For durable goods external cyclical and trend factors are important determinants of demand. An important cyclical variable in the carpet model is income. Real discretionary income, real corporate profits and real disposable personal income are the income proxies for the retail, contract and wholesale markets respectively. Due to imperfect capital markets, self-financing plays an important role for carpet purchases in all three markets. However, it is the growth in income which is significantly affected by external cyclical factors. Over the estimated time interval, the growth in real discretionary income and real corporate profits has slowed such that it has significantly slowed industry growth. Although the growth in real personal disposable income has been constant, its impact on wholesale carpet purchases has remained relatively unchanged. Furthermore, even as the growth in income picks up, carpeting's low priority is a drag on carpet sales recovery. For example, by the middle of 1977 wholesale carpet sales finally reached its pre-recession level (1974).

This is especially relevant for the replacement market. The carpet industry must generate increased sales in the replacement segment of the market in order to experience sustained growth. However, this has not happened as the growth in income has slacked. This is an important factor in the slow growth of carpet sales in the last decade. Consequently, carpet sales[1] must understand the significant correlation between healthy income growth and a sustained growth for carpet sales in all markets.

Carpet sales are also affected by the cyclicality of the housing market. New housing reflect the availability of new floor space. New housing is directly related to credit availability, which, historically, is directly related to the cyclicality of the economy. As short term rates on Treasury bills increase, disintermediation occurs as funds from savings and loan associations are transferred to higher yielding Treasury bills.[2] As a result, the market for initial carpeting is significantly affected by the cyclicality of the housing market. Furthermore, this study points out that only a percentage of new available floor space is initially covered by carpeting. Consequently, carpet dealers must understand the relevant relationship between the cyclicality of the housing market with its potential and carpet sales.

The trend factor in carpet sales is apparent through its price, i.e., absolute and relative price level. The absolute price of carpeting has been steadily increasing mainly as a result of higher energy costs for its energy based synthetic fibers. This has had a negative impact on the growth of carpet sales. However, due to the high degree of competition among the major carpet producers, the price[3] of carpeting relative to other durables has actually been declining. This has had a significant positive affect on the growth of carpet sales. Unfortunately, for the carpet industry a low relative price means low profitability. The contribution of accurate forecasting of the carpet industry and low profitability is discussed below.

Accurate forecasting of the carpet industry can improve the industry's profitability at all levels. Carpet industry's low relative price is a significant cause for the industry's low profitability. This is a result of stiff competition among the major carpet manufacturers. This trend variable is built into the various equations. However, it is the cyclical components affecting the demand for carpeting which can be manipulated by the industry to increase its profitability. The cyclical components, i.e., income and the housing market is built into the model. During cyclical downturns, i.e., when income growth and new housing slackens, carpet dealers can limit their inventory levels and cut down on losses from future demand declines. Furthermore, they can try to capture the largest possible share of the market by appealing to all segments of the consumer market through increased carpet offerings. This model has accounted for the cyclical factors. As a result, the industry can be forewarned of demand declines (or, for that matter, demand increases) and, in turn, adjust production and selling strategy in order to improve its profitability.

Future Research

The scope of this study is limited through necessity and desire. Because of data limitations from both government and private trade association[4] sources, various segments of the industry could not be throughly analyzed. Future research requires more and better data accumulation from both sources. Furthermore, this study does not tackle other interesting topics relating to the carpet industry due to the large amount of research required. These areas include analysis of specific end markets, the supply side of fiber materials and an annual long run model of the industry. This study has established the foundation for analysis of these areas of the carpet industry.

Both government and private trade associations limit their collection of data on the carpet industry. Both sources find data collection in many areas of the industry to be both highly complex and extremely expensive. Data are lacking in such important areas as retail carpet sales,[5] contract market data,[6] retail inventory data, replacement demand data and specific end market data. Explicit data on retail carpet sales, both in square yards and dollar value, could substantially improve sales forecasting for this market.

This will enable the forecast for the residential retail market to deal exclusively with retail carpet sales by excluding hard floor covering from the data. Due to its high expense and enormous data collection problems neither source is able or willing to collect data on retail carpet sales. However, this should not underlie the importance of this data.

In addition, data on retail inventory and replacement demand could substantially improve industry forecasts. Retail inventory data could improve the wholesale demand forecast. The extent of carpet inventory at the retail level is an important leading indicator of future retail demand for wholesale carpets. Data on replacement demand in all markets will enable forecastors to isolate replacement carpet demand from initial carpet demand. Furthermore, a series on both carpet depreciation and stock adjustment could be constructed. Unfortunately, government sources have no intentions of collecting these data. The Carpet and Rug Institute (CRI) had at one point considered collecting retail inventory data. However, the apparatus for it and replacement demand data, are too expensive to set up and monitor. CRI felt both sampling problems and collection problems would also make such series highly inaccurate.

The most promising new source of data is for the contract carpet market. At the present time, CRI is seriously considering an intensive effort to collect data on contract carpet sales. Actual contract carpet sales data would eliminate the need to construct the estimated series used in this study. As a result forecasts for this market should be more accurate. Furthermore, data on specific end markets in the contract segment of the industry will enable researchers to conduct studies for these important market segments in the industry. However, this project is only at the planning stage. The type of data to be collected, e.g., dollar value, square yards, specific end markets has not yet been determined.

Although continuous data on carpetings' specific end markets are presently not available, considerable interest by many groups within the industry might induce either private or trade associations to collect this data. This would encourage forecastors to predict sales growth for various segments within each carpet market. It would be of interest to those whose carpet sales are intended for specific end uses. The framework for demand forecasting specific end markets has been established in this study. The demand for carpeting for each end market theoretically conform with traditional analysis of demand, with more specific derived demand variables[7] as economic exogenous variables in each equation. Furthermore, a better understanding of the components of carpet uses[8] would enhance the overall understanding of the carpet industry.

An additional topic not discussed in this study is the supply side of fiber materials. Although research on the relationship between fiber supply and carpet manufacturing is continuously updated by fiber manufacturers, traditional demand analysis has not been applied directly. A full understanding of the demand for carpet yarn is especially useful in explaining the eventual wholesale price of carpeting. It would be particularly useful in simultaneously estimating carpet demand in all markets.

The most logical compliment to a quarterly short run forecasting model of the carpet industry is an annual long run forecasting model. An annual model could conceptionally conform with traditional demand analysis whose basic framework has been established in this study. This model would be of interest to carpet dealers who are involved in long range planning. A better understanding of the factors determining carpet demand in the long run would enable planners to plan or adjust long range strategies. Furthermore, a long run view of potential carpet sales could influence corporate (wholesale and retail) decisions for expansion or contraction. However, construction of a long run carpet model for all markets also involves numerous data problems, ranging from discontinuities in existing data for some markets to nonexistant data for others. This should not, however, discourage future efforts to tackle this problem.

NOTES

1 Wholesalers, distributors and retailers.

2 Although in 1978, the effects of disintermediation was medigated through Savings and Loans bank certificates pegged to Treasury bill rates.

3 Prices at the wholesale and retail level.

4 The two trade associations which collect data on a continuous basis are the Carpet and Rug Institute based in Dalton, Georgia and the National Association of Floor Covering Distributors based in Chicago, Illinois. Both associations collect similar data. The main difference is the former collects data from manufacturers and the latter collects data from distributors.

5 In this study data on retail floor covering sales is the proxy for retail carpet sales.

6 In this study data on contract carpet sales were estimated.

7 Manufacturers and sellers of carpeting for office or single and multi-family homes would be very interested in carpeting's relationship with office construction and single and multi-family construction respectively.

8 The final use of the carpet, e.g., in an office building or a dining room.

APPENDIX I

The Structural Model Using Two Stage Least Squares

The structural model using two stage least squares for the carpet industry consists of three sets of simultaneous equations, i.e., one set of equations for the retail market, one set of equations for the contract market and one set of equations for the wholesale market.[1] The demand for each market is determined by a two equation simultaneous model. Each set of simultaneous equations satisfy the identification restrictions.

The structural model for the carpet industry is as follows:

Residential Retail Equations[2]

(1) DRS=f(I,Rc,Pc)

(2) Pc=f(DRS,Pw)

The endogenous and exogenous variable are as follows:

Endogenous Variables

DRS=Demand for retail floor coverings.

Pc=Consumer price for floor covering (included endogenous variable).

Exogenous Variables

I=Income

Rc=Residential construction (derived demand variable).

Pw=Wholesale price for floor coverings.

Contract Carpet Equations

(3) Dc=f(Cp,Nrc,Pc')

(4) Pc'=f(Dc,Pw)

The endogenous and exogenous variables are as follows:

Endogenous Variables

Dc=Demand for contract carpeting.

Pc'=Consumer price for contract carpeting (included endogenous variable).

Exogenous Variables

Cp=Corporate profits.

Nrc=Residential and/or nonresidential construction (derived demand variable).

Pw=Wholesale price for carpeting.

Wholesale Carpet Equations

(5) Dw=f(Yd,Tc,Pw)

(6) Pw=f(Dw,Pf)

The endogenous and exogenous variables are as follows:

Endogenous Variables

Dw=Demand for wholesale carpeting.

Pw=Wholesale price for carpeting (included endogenous variable).

Exogenous Variables

Yd=Income

Tc=Total construction variable (derived demand variable).

Pf=Prices of factors of production.

Each set of equations include an interaction of contemporaneous endogenous variables. Therefore, each series is a simultaneous system. The best method for estimating simultaneous equations is two stage least squares (TSLS). The objective in using TSLS as the estimating procedure is to eliminate from the exogenous variables the stocastic component associated with the error term. The principle of two stage least squares is to substitute for each included endogenous variable a linear combination of exogenous variables. Ordinary least squares (OLS) regression is then performed and an estimate of the included endogenous variable is assumed to be uncorrelated with the error term. The estimate of the included endogenous variable is then placed into the original equation and OLS regression is applied to the reformulated relation. This method eliminates the correlation between the error term and the exogenous variables in each set of equations.

Identification Restrictions

Each set of simultaneous equations satisfy both the order and rank conditions for identification. Each set of equations will be tested for identification in order to insure a unique set of coefficients for each equation. The methodology used for identification (both the rank and order conditions) are the same for each set of equations.

The endogenous and exogenous variables for the residential retail equations are composed in the following fashion:

	DRS	Pc	I	Rc	Pw
Equation (1)	a_1	a_2	a_3	a_4	o
Equation (2)	a_5	a_6	o	o	a_7

$$\underbrace{\begin{bmatrix} a_1 & a_2 \\ a_5 & a_6 \end{bmatrix}}_{\beta} \underbrace{\begin{bmatrix} a_3 & a_4 & o \\ o & o & a_7 \end{bmatrix}}_{\Gamma}$$

To satisfy the order condition the number of excluded exogenous variables in each equation must be as great as the number of endogenous variables less one.[3] If g equals the number of endogenous variables, then each equation must have at least one excluded exogenous variable. In equation (1) Pw is excluded and in equation (2) I and Rc are excluded. Therefore, the order condition for identification is satisfied.

To satisfy the rank condition, the rank (ρ) of $(A\Theta)=g-1$. $A=\beta\Gamma$ and is a g+k row (k=the number of exogenous variables) and a column for each restriction for each equation. In other words, for equation (1):

$$A = \underset{2x5}{[\beta\Gamma]} \qquad \Theta = \underset{5x1}{\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}}$$

and $A\Theta = \underset{2x1}{\begin{bmatrix} 0 \\ a_7 \end{bmatrix}}$ with the $\rho(A\Theta)=1=g-1$. Therefore, equation (1) is identified.

For equation (2):

$$A_2 = \underset{2x5}{[\beta\Gamma]} \qquad \Theta_2 = \underset{5x2}{\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}}$$

and $A_1'\theta_2' = \underset{2x2}{\begin{bmatrix} b_3 & b_4 \\ 0 & 0 \end{bmatrix}}$ with the $\rho(A_1'\theta_2')=1$ and equal to the number of endogenous variables minus one (no second order determinant exists since the determinant of $A_1'\theta_2'$ equals zero). Therefore, the rank order condition is satisfied and equation (4) is identified.

The endogenous and exogenous variables for the wholesale demand equations are composed in the following fashion:

$$\begin{array}{lcc} & \begin{matrix} Dw & Pw \end{matrix} & \begin{matrix} Yd & Tc & Pf \end{matrix} \\ \begin{matrix} \text{Equation (5)} \\ \text{Equation (6)} \end{matrix} & \underset{\beta''}{\begin{bmatrix} C_1 & C_2 \\ C_5 & C_6 \end{bmatrix}} & \underset{\Gamma''}{\begin{bmatrix} C_3 & C_4 & 0 \\ 0 & 0 & C_7 \end{bmatrix}} \end{array}$$

The exogenous variable excluded in equation (5) is Pf and the exogenous variable excluded in equation (6) are Yd and Tc. Therefore, equation (3) and (4) satisfy the order conditions for identification.

For equation (5):

$$A'' = \underset{2x5}{[\beta'' \Gamma'']} \qquad \theta'' = \underset{5x1}{\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}}$$

and $A''\theta'' = \underset{2x1}{\begin{bmatrix} 0 \\ C_7 \end{bmatrix}}$ with the $\rho(A''\theta'')=1$ and equal to the number of endogenous variables minus one. Therefore, the rank order condition is satisfied and equation (5) is identified.

For equation (6):

$$A_1'' = [\beta''\Gamma'']_{2x5} \quad \text{and} \quad A_1''\theta''_2 = \begin{bmatrix} c_3 & c_4 \\ 0 & 0 \end{bmatrix}_{2x2} \quad \theta''_2 = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}_{5x2}$$

with the $\rho(A''_2\theta''_2)=1$ and equal to the number of endogenous variables minus one (no second order determinant exists since the determinant of $A''_1\theta''_2$ equals zero). Therefore, the rank order condition is satisfied and equation (6) is identified.

Statistical Results Using Two Stage Least Squares

Residential Retail Equation

$$\text{Log(FCRS72)}=-4.2-2.3\underset{(-2.5)}{\text{Log(PC1)}}+.34\underset{(2.2)}{\text{Log(DISCINC72)}}$$

$$+4.3\underset{(2.8)}{\text{Log(SHIPS}\backslash 2)}+1.9\underset{(2.2)}{\text{Log(KQHUSTS}\backslash 3)}$$

FCRS72=Real retail sales, seasonally adjusted.
PC1=Relative retail price of floor coverings (included endogenous variable).
DISCINC72=Real discretionary income.
SHIPS\2=Real household furniture shipments, seasonally adjusted, lagged 2 quarters.
KQHUSTS\3=Number of existing housing stock, lagged 3 quarters.

Time interval=1969 to 1977
$\bar{R}^2$=.96
Durbin-Watson=1.3
Standard Error of the Regression=.053

For the residential retail equation two stage least squares estimation is similar to ordinary least squares estimation. The summary statistics are very similar with the same significant exogenous variables.[4] However, a higher price elasticity and a lower housing stock elasticity is apparent with this estimation procedure. In both models the fitted values (Chart IA) mirror the actual values in a similar fashion.

This model's forecasting accuracy is less reliable than the OLS model. Table 1A compares the actual and fitted values for 1977 of a truncated version of this model. Its percent error is higher both quarterly and annually. Except for the fourth quarter of 1977 its quarterly percent errors are all larger than the standard error of the regression. Furthermore, the annual estimate for 1977 is poor. The model forecasts a 17 percent increase actual sales increased 10 percent. Its annual percent error of 5.9 percent is also higher than the standard error of the regression (5.3 percent).

Contract Carpet Equation

$$\text{Log(CSQYDSA)} = 7.79 - \underset{(-14.53)}{1.59}\text{Log(PC11)} + \underset{(4.67)}{.31}\text{Log(ZB72)}$$

$$+ \underset{(6.63)}{.45}\text{Log(IC72\textbackslash 2)}$$

CSQYDSA=Contract carpet shipments, millions of square yards, seasonally adjusted.
PC11=Relative retail price of carpeting (included endogenous variable).
ZB72=Real corporate profits before taxes
IC72\2=Real investment in total structures, lagged 2 quarters.

Time interval=1969 to 1977
$\bar{R}^2$=.95
Durbin-Watson=1.32
Standard Error of the Regression=.041

For the contract carpet equation, two stage least

CHART IA

RESIDENTIAL RETAIL EQUATION
Two Staged Least Squares
Actual vs. Fitted Values

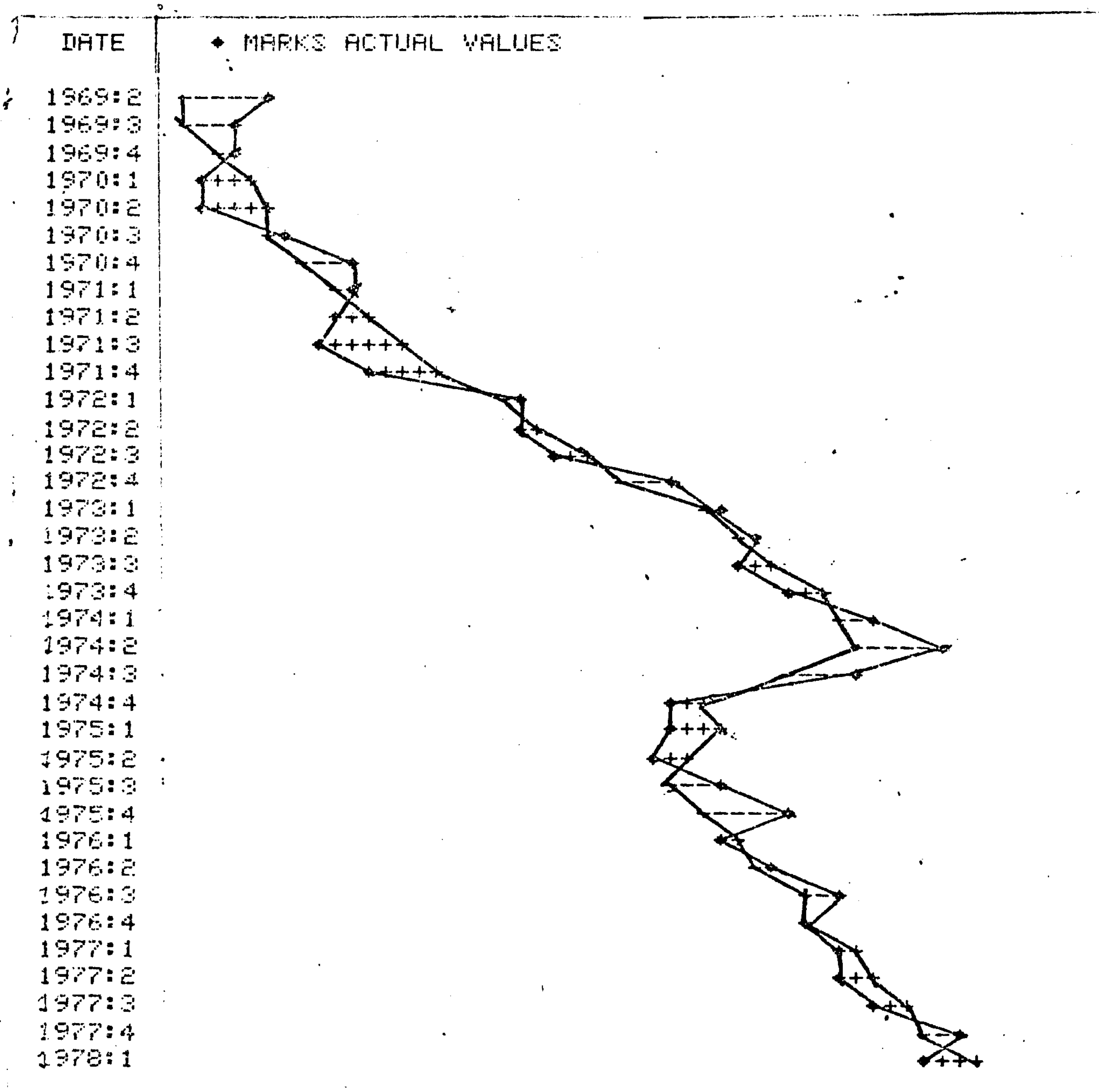


TABLE 1A

TWO STAGE LEAST SQUARES
RESIDENTIAL RETAIL FLOOR COVERING SALES
Millions of Constant Dollars
Truncated Model
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	757.1	757.8	785.5	856.9	3157.3
Fitted	811.8	829.6	844.8	866.0	3352.2
Percent Error*	-7.2	-9.5	-7.5	-1.1	-6.2

$$\text{*Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

square estimation is nearly identical to ordinary least square estimation. The summary statistics are similar and the coefficient attached to the same variables are nearly identical. In both models the fitted values (Chart IIA) closely mirror the actual values of contract carpet sales. Quarterly, the model's forecasting accuracy is as good as the model using ordinary least squares. Table 2A compares the actual vs. fitted values for 1977 of a truncated version of this model. The model's quarterly percent errors are significantly lower than the standard error of the regression (4.3 percent). The model's forecasting accuracy on an annual basis is excellent.

Wholesale Carpet Equation

$$\text{Log(QSQYD)} = 9.4 - \underset{(-13.8)}{.81}\text{Log(WPI11)} + \underset{(5.0)}{.39}\text{Log(IC72)} + \underset{(7.9)}{.65}\text{Log(SHIPS)}$$

Time interval=1969 to 1977
$\bar{R}^2$=.97
Durbin-Watson=1.9
Standard Error of the Regression=.028

QSQYD=Wholesale carpet shipments, millions of square yards, seasonally adjusted.
WPI11=Relative wholesale price of carpeting (included endogenous variable).
IC72=Real total investment in private structures.
SHIPS=Real household furniture shipments.

For the wholesale carpet equation, two stage least squares estimation is nearly identical to ordinary least squares estimation. The summary statistics are similar and the coefficients attached to the same variables[5] are nearly

CHART IIA

CONTRACT CARPET EQUATION
Two Staged Least Squares
Actual vs. Fitted Values

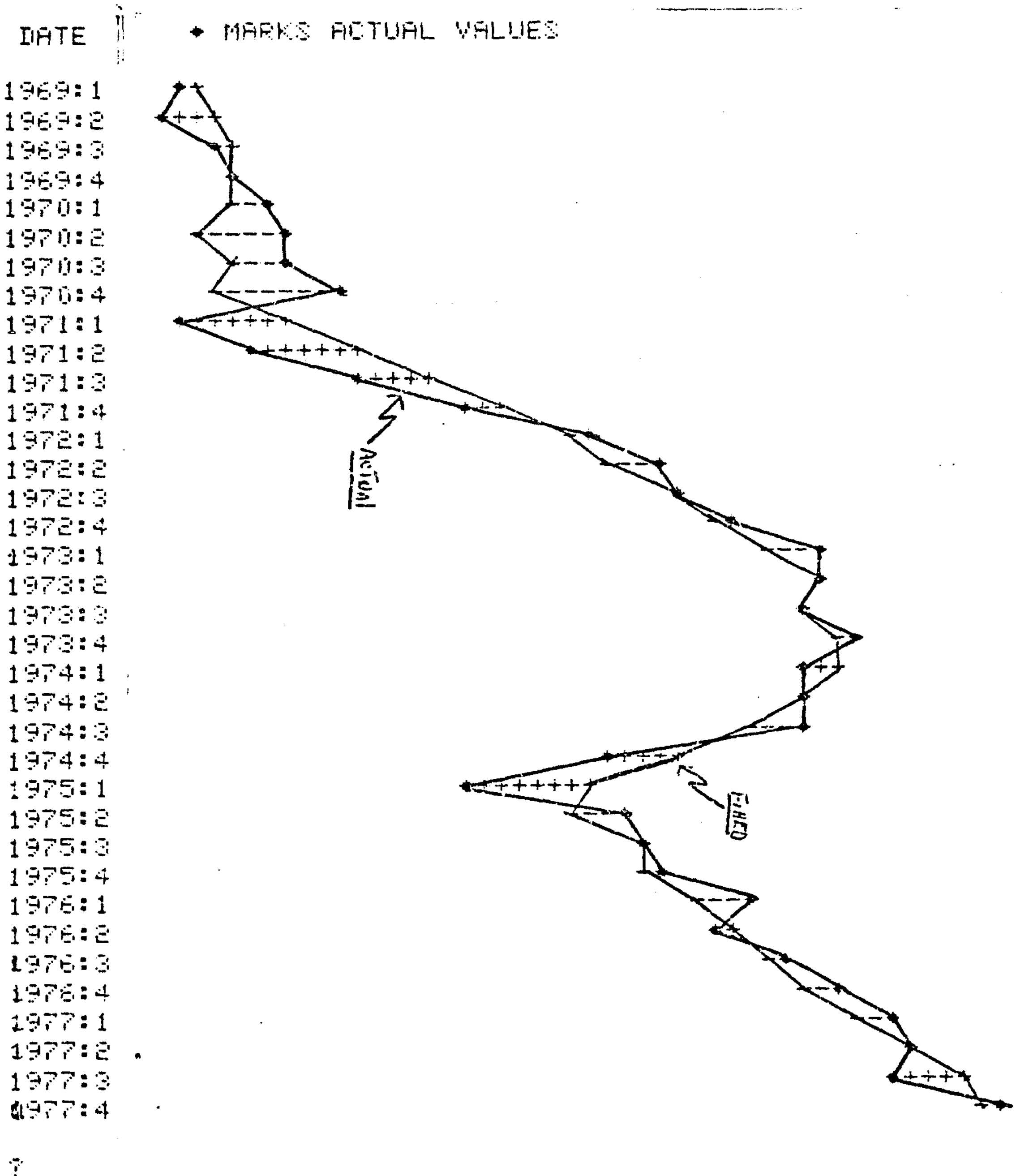


TABLE 2A

TWO STAGE LEAST SQUARES
CONTRACT CARPET SHIPMENTS
Millions of Square Yards
Truncated Model
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	89.3	91.0	89.3	96.6	366.1
Fitted	86.5	90.8	92.7	95.6	365.6
Percent Error*	3.2	0.2	-3.7	1.0	0.1

*Percent Error= $\frac{\text{Actual-Fitted}}{\text{Actual}}$

identical. In both models the fitted values (Chart IIIA) closely mirror the actual values of wholesale carpet sales. Quarterly, the model's forecasting accuracy is as good as the model using ordinary least squares. Table 3A compares the actual vs. fitted values for 1977 of a truncated version of this model. Except for the fourth quarter, the model's percent error is below the standard error of the regression (2.8 percent). The model's forecasting accuracy on an annual basis is excellent.

CHART IIIA

WHOLESALE CARPET EQUATION
Two Staged Least Squares
Actual vs. Fitted Values

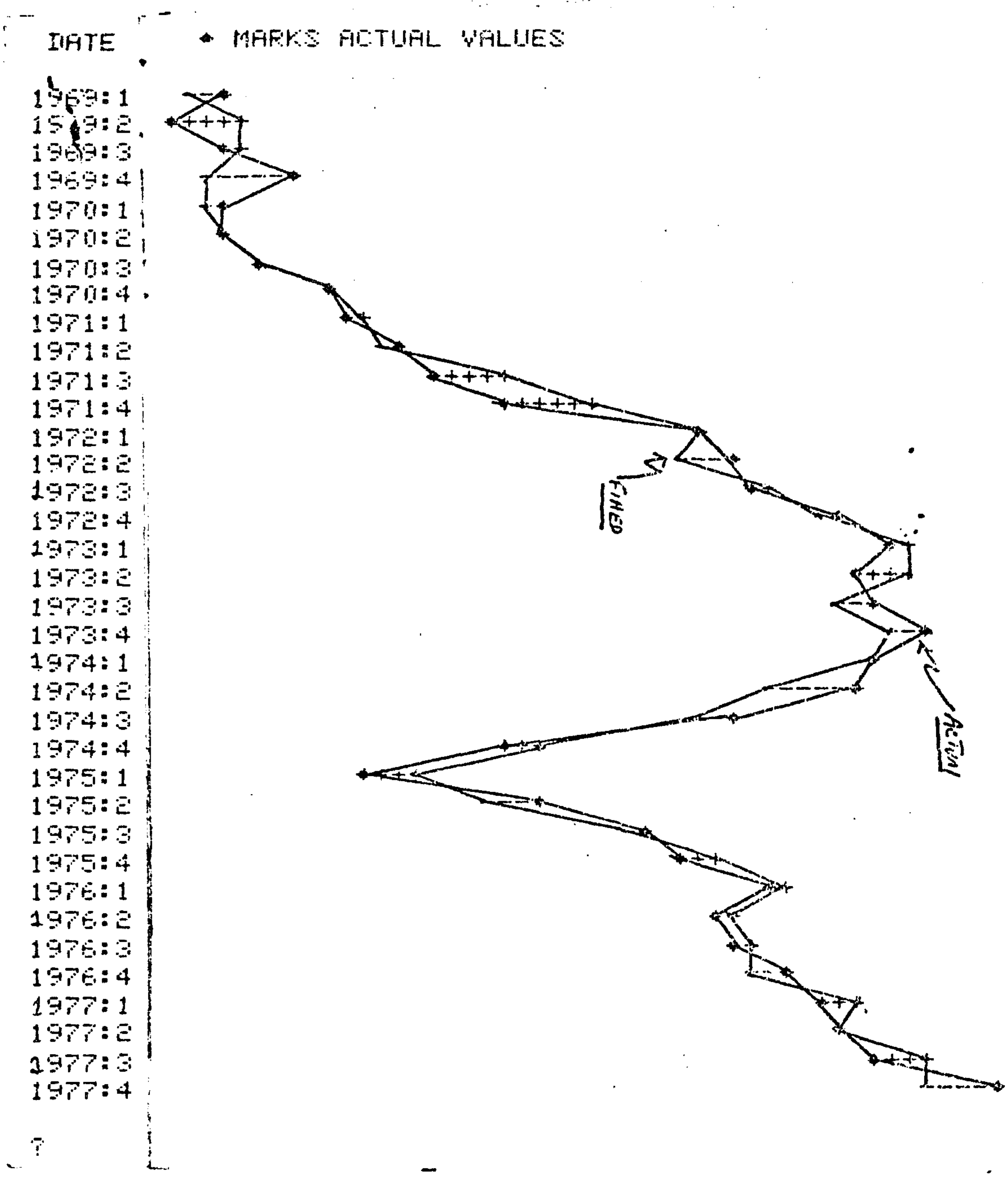


TABLE 3A

TWO STAGE LEAST SQUARES
WHOLESALE CARPET EQUATION
Millions of Square Yards
Truncated Model
Actual vs. Fitted Values

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	247.2	249.9	252.9	275.9	1025.9
Fitted	252.4	246.5	259.4	261.0	1019.3
Percent Error	-2.1	1.4	-2.6	5.4	0.6

*Percent Error= $\frac{\text{Actual-Fitted}}{\text{Actual}}$

APPENDIX II

Alternative Variables Tested

Residential Retail Equation

Ordinary Least Squares with Yd72*
(Best Equations)

Dependent Variable: FCRS72

Constant	FC1	Yd72	SHIPS\1	HUSTS\1	ICR72\1
1.3	-3.7 (-5.4)	.79 (1.8)			
-2.5	-2.4 (-3.3)	1.3 (2.9)	.39 (3.0)		
.59	-3.3 (-4.1)	.89 (1.7)		.02 (.31)	
.29	-3.2 (-4.0)	.91 (1.8)			.05 (.60)

t-statistics are in parenthesis

*All equations are in log form.

IX II

ables Tested

il Equation

ures with Yd72*
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72

	SHIPS\1	HUSTS\1	ICR72\1	$\bar{R}^2$	Durbin-Watson	Standard Error
3)				.93	.78	6.3
9)	.39 (3.0)			.95	.95	6.1
7)		.02 (.31)		.91	.63	8.0
3)			.05 (.60)	.92	.64	8.0

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Residential Retail Equation

Ordinary Least Squares with KQHUSTS*
(Best Equations)

Dependent Variable: FCRS72

Constant	FC1	DISCINC72	SHIPS\1	KQHUSTS	KQHUSTS\1
-2.8	-3.2	.48		1.6	
	(-5.3)	(2.8)		(2.1)	
-9.7	-1.4	.26	.47	3.3	
	(2.0)	(1.6)	(3.6)	(4.1)	
-9.5	-1.4	.29	.49		3.2
	(-2.1)	(1.9)	(3.8)		(4.3)
-9.4	-1.4	.31	.53		
	(-2.1)	(2.1)	(4.0)		

t-statistics are in parenthesis

*All equations are in log form.

tion

KQHUSTS*

IPS\1	KQHUSTS	KQHUSTS\1	KQHUSTS\2	$\bar{R}^2$	Durbin-Watson	Standard Error
	1.6 (2.1)			.95	.93	6.1
.47 3.6)	3.3 (4.1)			.96	1.4	5.2
.49 3.8)		3.2 (4.3)		.97	1.4	5.1
.53 4.0)			3.8 (4.5)	.97	1.5	5.0

Residential Retail Equation

Ordinary Least Squares with ICR72 and HUSTS*
(Best Equations)

Dependent Variable: FCRS72

Constant	PC1	DISCINC72	HUSTS	HUSTS\1	ICR72
2.7	-3.9 (-13.5)	.81 (3.6)			-.17 (-1.96)
3.0	-4.0 (-13.3)	.70 (3.1)			-.10 (-1.2)
2.3	-3.8 (-12.8)	.77 (3.7)	-.11 (-2.1)		
2.5	-3.9 (12.6)	.73 (3.3)		-.08 (-1.53)	

t-statistics are in parenthesis

*All equations are in log form.

l Retail Equation

res with ICR72 and HUSTS*
Equations)

72

IMC72	HUSTS	HUSTS\1	ICR72	$\bar{R}^2$	Durbin-Watson	Standard Error
81 (.6)			-.17 (-1.96)	.93	.88	7.0
70 (.1)			-.10 (-1.2)	.93	.77	7.0
77 (.7)	-.11 (-2.1)			.93	.84	7.0
73 (.3)		-.08 (-1.53)		.93	.84	7.0

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Contract Carpet Equation

Ordinary Least Squares with IC72*
(Best Equations)

Dependent Variable: CSQYDSA

Constant	FC11	ZB72	IC72	IC72\1	IC72\2	$\bar{R}^2$
8.2	-1.7 (-13.4)	.26 (3.4)	.40 (5.1)			.93
8.1	-1.7 (-14.6)	.25 (3.6)		.44 (6.0)		.94
7.8	-1.6 (-15.0)	.30 (4.6)			.44 (6.6)	.95

t-statistics are in parenthesis

*All equations are in log form

Contract Carpet Equation

dinary Least Squares with IC72*
(Best Equations)

iable: CSQYDSA

FC11	ZB72	IC72	IC72\1	IC72\2	$\bar{R}^2$	Durbin-Watson	Standard Error
-1.7 -13.4)	.26 (3.4)	.40 (5.1)			.93	1.0	5.0
-1.7 -14.6)	.25 (3.6)		.44 (6.0)		.94	1.4	0.4
-1.6 -15.0)	.30 (4.6)			.44 (6.6)	.95	1.3	0.4

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s are in log form

Contract Carpet Equation

Ordinary Least Squares with ICR72*
(Best Equations)

Dependent Variable: CSQYDSA

Constant	PC11	ZB72	ICR72	ICR72\1	ICR72\2	ICR72\3
9.0	-1.55 (-11.6)	.29 (3.4)	.22 (4.1)			
9.0	-1.56 (-13.0)	.25 (3.2)		.27 (5.3)		
8.9	-1.54 (-14.6)	.26 (3.9)			.30 (6.8)	
8.7	-1.50 (-14.4)	.30 (4.7)				.30 (4.0)

t-statistics are in parenthesis

*All equations are in log form.

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ares with ICR72*
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:

ICR72	ICR72\1	ICR72\2	ICR72\3	$\bar{R}^2$	Durbin-Watson	Standard Error
.22 (4.1)				.92	.88	5.0
	.27 (5.3)			.95	1.2	4.0
		.30 (6.8)		.95	1.4	4.0
			.30 (4.0)	.95	1.3	4.0

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Contract Carpet Equation

Ordinary Least Squares with ICNR72*
(Best Equations)

Dependent Variable: CSQYDSA

Constant	PC11	ZB72	ICNR72	ICNR72\1	ICNR72\2	$\bar{R}^2$
7.1	-2.0 (-13.3)	.27 (3.6)	.77 (5.1)			.93
7.2	-1.9 (-12.1)	.36 (4.5)		.64 (4.1)		.92
7.2	-1.7 (-11.4)	.43 (5.1)			.53 (3.3)	.91

t-statistics are in parenthesis

*All equations are in log form.

ract Carpet Equation

ast Squares with ICNR72*
est Equations)

CSQYDSA						
ZB72	ICNR72	ICNR72\1	ICNR72\2	$\bar{R}^2$	Durbin-Watson	Standard Error
.27 (3.6)	.77 (5.1)			.93	1.2	5.0
.36 (4.5)		.64 (4.1)		.92	.98	5.0
.43 (5.1)			.53 (3.3)	.91	.81	5.0

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n log form.

Wholesale Carpet Equation

Ordinary Least Squares with Yd72*
(Best Equations)

Dependent Variable: QSQYD

Constant	Yd72	WPI11	SHIPS	IC72	IC72\1	IC72\2
.89	1.5 (15.8)			.65 (8.6)		
2.9	1.1 (13.5)		.64 (7.3)		.21 (2.7)	
3.1	1.1 (13.7)		.68 (8.7)			.18 (2.6)
3.1	.83 (1.5)	-.51 (-1.2)		.76 (6.5)		
5.8	.61 (1.9)	-.37 (-1.6)	.64 (8.2)	.30 (3.4)		
4.5	.83 (2.7)	-.21 (-.9)	.64 (7.2)			
-12.0	3.7 (7.0)	1.6 (4.0)				

t-statistics are in parenthesis

*All equations are in log form.

e Carpet Equation

st Squares with Yd72*
t Equations)

SQYD

WPI11	SHIPS	IC72	IC72\1	IC72\2	$\bar{R}^2$	Durbin-Watson	Standard Error
		.65 (8.6)			.91	.59	4.8
	.64 (7.3)		.21 (2.7)		.96	2.0	2.9
	.68 (8.7)			.18 (2.6)	.96	1.8	2.9
-.51 (-1.2)		.76 (6.5)			.91	.67	4.8
-.37 (-1.6)	.64 (8.2)	.30 (3.4)			.97	1.9	2.7
-.21 (-.9)	.64 (7.2)				.97	2.1	2.9
1.6 (4.0)					.81	.53	7.0

renthesis

log form.

Wholesale Carpet Equation

Ordinary Least Squares with YN72*
(Best Equations)

Dependent Variable: QSQYD

Constant	YN72	WPI11	SHIPS	IC72	IC72\1	IC72\2
-4.9	2.5 (7.4)	.21 (1.1)				
1.8	1.4 (10.3)		.70 (6.7)	.001 (.017)		
5.6	.79 (3.5)	-.31 (-3.0)	.81 (10.1)			
4.5	.62 (1.6)	-.80 (-3.7)		.74 (6.1)		
7.4	.35 (1.5)	-.63 (-4.9)	.64 (7.9)	.31 (3.5)		
6.8	.47 (1.9)	-.56 (-4.0)	.65 (7.0)		.26 (2.5)	
6.0	.63 (2.8)	-.45 (-3.9)	.69 (8.1)			.18 (2.3)

t-statistics are in parenthesis

*All equations are in log form.

ale Carpet Equation

east Squares with YN72*
est Equations)

SQYD WPI11	SHIPS	IC72	IC72\1	IC72\2	$\bar{R}^2$	Durbin-Watson	Standard Error
.21 (1.1)					.82	.31	7.0
	.70 (6.7)	.001 (.017)			.95	1.4	3.6
-.31 (-3.0)	.81 (10.1)				.96	1.9	3.2
-.80 (-3.7)		.74 (6.1)			.91	.72	4.7
-.63 (-4.9)	.64 (7.9)	.31 (3.5)			.97	2.0	2.8
-.56 (-4.0)	.65 (7.0)		.26 (2.5)		.97	2.1	3.0
-.45 (-3.9)	.69 (8.1)			.18 (2.3)	.96	1.9	3.0

renthesis

.og form.

Wholesale Carpet Equation

Ordinary Least Squares with First Differences*

Dependent Variable: LDQSWYD

Constant	LDYd72	LDWPI12	LDSHIPS	LDIC72	$\bar{R}^2$	Durbi Watso
.00001	1.17 (2.49)		.33 (3.29)	.56 (3.41)	.61	1.7
-.001	1.60 (3.0)	.09 (.17)	.44 (3.91)		.46	2.0
-.0001	1.17 (2.45)	-.017 (-.04)	.33 (3.19)	.56 (3.35)	.60	1.7

t-statistics are in parenthesis

*The first difference form is as follows:

$$\text{Log}Y_t - \text{Log}Y_{t-1} = a + b(\text{Log}X_t - \text{Log}X_{t-1}) + e$$

Y_t=Dependent variable
X_t=Vector of independent variables
e=Error term

Wholesale Carpet Equation

Least Squares with First Differences*

riable: LDQSWYD

LDYd72	LDWPI12	LDSHIPS	LDIC72	$\bar{R}^2$	Durbin-Watson	Standard Error
1.17 (2.49)		.33 (3.29)	.56 (3.41)	.61	1.7	3.2
1.60 (3.0)	.09 (.17)	.44 (3.91)		.46	2.0	3.8
1.17 (2.45)	-.017 (-.04)	.33 (3.19)	.56 (3.35)	.60	1.7	3.3

; are in parenthesis

lifference form is as follows:

$LogY_{t-1} = a + b(LogX_t - LogX_{t-1}) + e$

endent variable
tor of independent variables
r term

APPENDIX III

Testing the Validity of the Alternative Best Wholesale Carpet Equation

The statistical results of the alternate wholesale carpet equation are very similar to the results found for the primary equation. The coefficients for investment in total structures and wholesale household furniture shipments are nearly identical for both equations. The $\bar{R}^2$ is also .97 and each variable is statistically significant at the 5 percent level. The fitted values and the residuals of both equations (Chart IVA) are very similar, with both models capturing the 1974 downturn.

The Durbin-Watson statistic is 1.95, clearly within the upper critical bound (1.73). This is confirmed by the apparent randomness of the residuals (Chart IVA). Also, the Spearman rank correlation coefficient is low (.026).[1] Therefore, autocorrelation is not present in this equation.

The calculated F values of the Chow test for the same two intervals are .955 and .453 respectively. At the 5 percent level of significance the calculated F values fall within the critical bounds. Therefore, we accept the null hypothesis and are 95 percent confident this estimated model is stable over the regression interval.

The truncated version of the alternative model (1969 to 1976) is as follows:

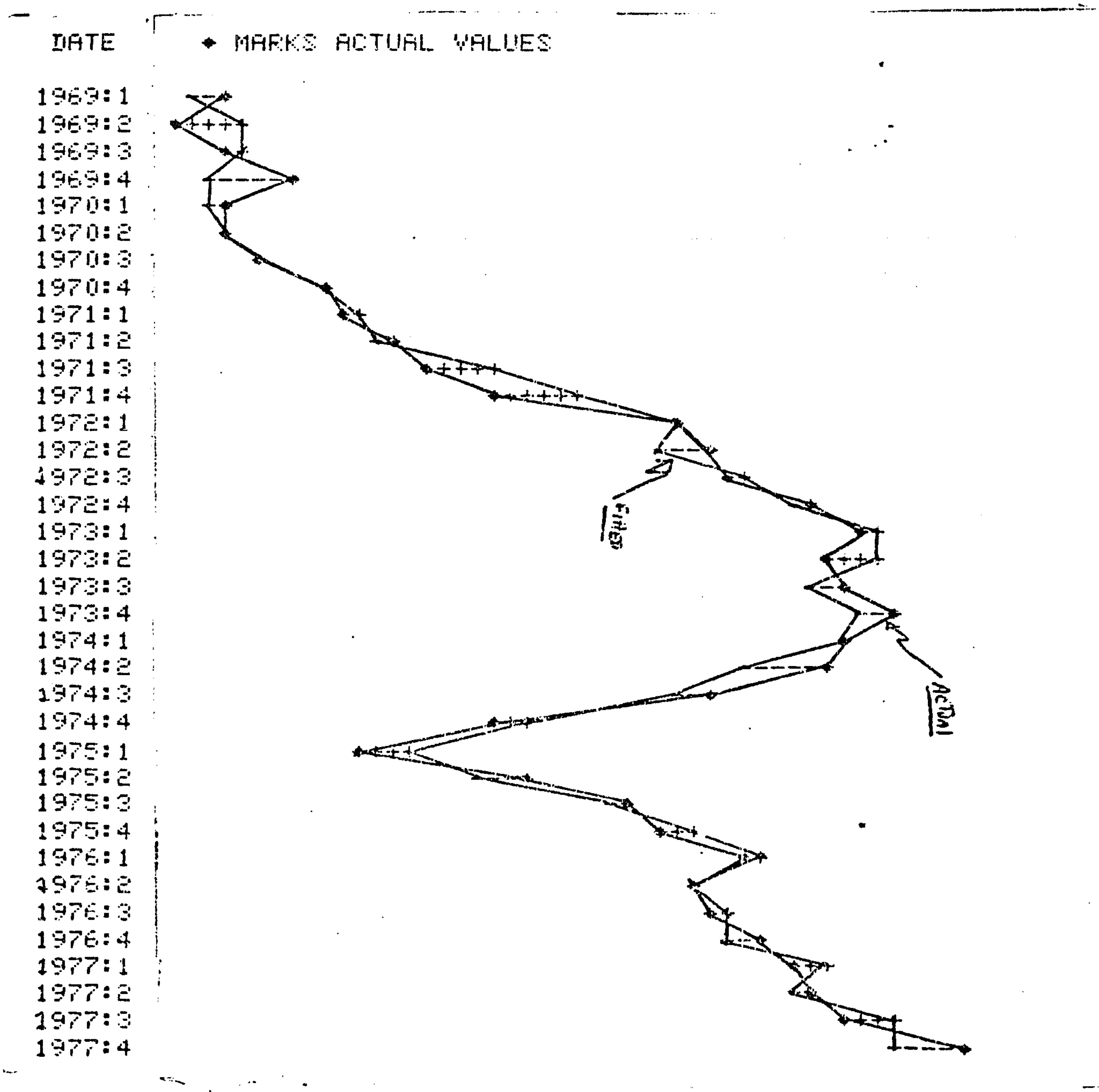
$$\underset{}{\text{Log(QSQYD)}} = 9.5 \underset{(-9.1)}{-.77\text{Log(WPI11)}}$$

$$\underset{(3.2)}{+.34\text{Log(I072)}} \underset{(6.5)}{+.70\text{Log(SHIPS)}}$$

t-statistics are in parenthesis

CHART IVA

WHOLESALE CARPET EQUATION
Alternative Equation
Actual vs. Fitted Values



$\bar{R}^2$=.97
Durbin-Watson=1.90
Standard Error of the Regression=.028

Table 4A compares the actual and fitted values for 1977. Quarterly, the models forecasting accuracy is good. This model also overestimates the first and third quarters and underestimates the second and fourth quarters. The largest miss is also in the fourth quarter. Except for the fourth quarter, the percent errors are less than the 2.8 percent standard error of the regression. Annually, the model's accuracy is excellent. The model underestimates wholesale carpet shipments for 1977. The annual percent error at .8 percent is significantly less than the 2.8 percent standard error of the regression.

Although the statistical results of both equations are nearly identical, I characterize the equation with income the "best" equation because, on average, its forecast percent errors are slightly less. I present both models because it is nearly impossible to choose the better one.

TABLE 4A

WHOLESALE CARPET SHIPMENTS
Millions of Square Yards
Truncated Model
Actual vs. Fitted
(Alternative Model)

	1977:1	1977:2	1977:3	1977:4	Total 1977
Actual	247.2	249.9	252.9	275.9	1025.9
Fitted	252.3	246.1	259.0	260.6	1018.0
Percent Error*	2.1	1.5	2.4	5.5	0.8

$$\text{*Percent Error} = \frac{\text{Actual-Fitted}}{\text{Actual}}$$

NOTES

[1]

$r_s = .026$

$Var(r_s) = \sigma r^2 = \frac{1}{35}$

$r = \frac{1}{5.9}$

Therefore, $Z = \frac{r_s}{\sigma r} = \frac{.026}{\frac{1}{5.9}} = .15$

r_s is only .15 standard deviations away from zero which is not significantly different than zero. Therefore, we accept the null hypothesis that the errors are independently distributed over time.

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GLOSSARY

CSQYDSA: Contract Carpet Shipments, Millions of Square Yards

DISCINC72: Discretionary Income, 1972 Dollars

FCRS72: Retail Floor Covering Sales, 1972 Dollars

HUSTS: Housing Starts, Private Including Farm

KQHUSTS: Capital Stock of Housing, Millions of Units

IC72: Investment in Total Structures, 1972 Dollars

ICN72: Investment in Residential Structures, 1972 Dollars

ICNR72: Investment in Nonresidential Structures, 1972 Dollars

PC1: Relative Retail Price of Floor Coverings

PC11: Relative Retail Price of Carpeting

QSQYD: Wholesale Carpet Shipments, Millions of Square Yards

SHIPS: Furniture Shipments, Wholesale, 1972 Dollars

TIME: Time Trend Variable

Yd72: Personal Disposable Income, 1972 Dollars

WPI11: Relative Wholesale Price of Carpeting

ZB72: Corporate Profits Before Tax Excluding IVA, 1972 Dollars

\: Lag Symbol