SMALL AREA ESTIMATES BASED ON CONCURRENT MEASURES VS. REGRESSION ESTIMATES: THE CASE OF ONE FAMILY HOUSE CONSTRUCTION

Jonah Otelsberg York College

Introduction

The purpose of the study reported in this paper was to develop models for new one-family house construction at the state and country level. Construction in general, and one-family houses in particular, have long been recognized as important leading indicators of economic activity. They are used in almost all econometric models concerned with predicting the state of the economy on a national level. However, many decision makers need data for smaller geographic units in order to be able to make and evaluate marketing decisions such as: forecasting future sales of their product, determining sales quotas, designing sales territories, and evaluating the sales organization's performance. It is the needs of middle management, involved with this kind of decisions, that the models developed are aimed to satisfy.

The information that is currently available as measure of one-family house construction activity comes mainly from the Bureau of the Census who produces three statistical series:

- building permits
- housing starts
- value put in place

The permit series provides annual reports by permit place six to eight months after the closing of the year.

The starts series provides estimates of starts by month for the four Census Regions.

The value put in place series provides monthly estimates by the four Census Regions.

Thus, monthly data is not available for geographical breakdowns smaller than the Census Regions, while data for smaller geographical entities are available on an annual level only, six months after the end of the period.

The aim of this study is to fill the void by providing means of obtaining estimates of one-family house construction activity for small areas to be available shortly after the closing of the period.

In addition to providing marketing management with means of obtaining monthly county estimates of one-family house starts, the methodology developed for the study may be applicable to obtaining periodic small area estimates for other time series.

Available Measures of One-Family House Construction

The Construction Division of the Bureau of the Census issues three measures of new construction of one-family houses:

- Permits issued within permit issuing jurisdictions
- Housing starts
- Value of construction put in place

We will now discuss each one of these measures with regard to:

- Timing of issue
- Geography covered
- Extent to which it is based on direct measurement

Permits. The permits series is issued annually six to nine months after the closing of the year. The report shows the number of permits issued within the year by each of the 14,000 permit issuing jurisdictions.[1] All jurisdictions report annually, a sample of about 3,000 permit places reports monthly. The construction which takes place outside the permit issuing jurisdiction, in what is known as non-permit areas, is not accounted for.[2]

Starts. The starts series is issued monthly about four weeks after the closing of the month to which it pertains. It provides starts for the nation and the four census regions.

The start series is derived using the permit series. From a sample of permits the period which elapses between the time a permit is being taken out and actual start of construction is estimated. This estimate is applied to estimates of permits issued and a figure representing "starts" in permit issuing jurisdictions is obtained.

Starts in non-permit issuing areas are estimated on the basis of an area sample.[3]

Put in Place. The put in place series represents the value of one-family house construction put in place in a given month. It is available about four weeks after the closing of the month of interest.

The geography for which an estimate is issued is the same as for starts -- national and four census regions.

The figures are based on a sample of builders who report to the Bureau of the Census on their monthly expenditures from start of construction to completion.[4]

Of the three measures the only one which provides a measure for local areas is the permit series. The permit series is also the only one which is based on direct measurement of construction activity. It is, therefore, the most appropriate measure of one-family house construction.

The drawback of the permit series is that it does not provide a measure of activity in non-permit areas.

Scope of the Study

The purpose of the study is to develop a method of obtaining estimates of one-family house construction for local areas, as measured by building permits, prior to availability of these measures from the Bureau of the Census.

Estimating methods were explored on two levels: state and county.

At the state level, an attempt was made to express one-family house building permits in terms of other variables. The criteria for selection of variables for consideration in the model were:

1. Assumed relationship to demand or supply, or both, of one-family house construction.
2. Availability of annual data on a state level for the period 1968-1973.
3. No change in definition of the series within the period of study.

Nineteen variables satisfying these criteria were selected for further analysis. The final regional and national estimating equations were obtained utilizing factor analysis and regression analysis.

On the conty level, the concern was to develop a model that would provide decision makers with monthly measures of one-family house construction at the time when they are needed for decision making. Since no data, on the variables used in the development of the state model, was available on the county level, the model is based on the one-family house permits series itself. In the model that emerged one-family house permits issued during a given month within a given county are obtained using direct reports received from permit issuing jurisdiction which issued at least fifty permits a year, and an estimate of permits issued in smaller permit places, which issued less than fifty permits annually.

Limitations

Not all jurisdiction in the United States require building permits to be taken out prior to construction. For these areas, no direct measurement of construction activity exists and they will not be included in the analysis. The activity of non-permit issuing areas is estimated to account for about 15% of the total number of one-family houses built within a year in the United States. Through the efforts of the Bureau of the Census, however, the importance of these areas is steadily diminishing, as new permit issuing jurisdictions are being established.

Methodology Employed in the Study

Now we turn to the methodology employed in developing estimating models for one-family house construction.

Hypotheses. The criterion measure in testing the hypotheses is the coefficient of determination which represents the proportion of total variance explained by the model. The coefficients of determination are defined below:

R_1^2 = coefficient of determination obtained using a sample of permit places.

R_2^2 = coefficient of determination obtained using variables measured directly in the period being estimated

R_3^2 = coefficient of determination obtained from equation using variables selected for inclusion via factor analysis.

R_4^2 = coefficient of determination obtained using lagged independent variables.

R_5^2 = coefficient of determination obtained using regional estimating equations.

In terms of these coefficients of determination the following hypotheses were postulated:

1. State estimates of the number of one-family house permits obtained using direct reporting from a sample of permit issuing places are superior to estimates using explanatory variables.

$$R_1^2 > R_2^2 , R_3^2$$

The estimates based on direct reporting from a sample of the largest permit places can be expressed by the equation:

$$Y_t = f(LPP_t)$$

Underlying this hypothesis is the assumption that a series is a best estimate of itself and that current measurement on it will be superior to estimates based on relationship with other variables.

2. State estimates obtained using explanatory variables for which direct measurement, for the period being estimated, are available, are superior to estimates obtained utilizing variables not directly measured during this period.

$$R_2^2 > R_3^2$$

The estimates obtained from direct measurement can be expressed by

$$Y_t = f(X_{ti})$$

If a variable is not directly measured in the period of interest it has to be estimated, thus adding estimating error to the already existing measurement error. Thus estimates of Y which are not based on estimates of other variables should be superior to those that are.

3. State estimates obtained utlizing regional estimating equations are superior to estimates obtained using national equations.

$$R_5^2 > R_2^2 , R_3^2 , R_4^2$$

The regional estimates can be expressed by the formula

$$Y_R = f(X_{Ri})$$

This hypothesis is based on the assumption that there exist regional differences in the relationship of one-family house permits to other variables. These differences are assumed to be significant enough to improve the quality of estimates, if they are introduced.

4. Estimates based on lagged independent variables are inferior to estimates based on concurrent measures of these variables.

$$R_2^2 > R_4^2$$

The formula to express the lagged relationship is

$$Y_t = F(X_{i(t-s)})$$

One-family house construction is a leading series and it is more likely to lead the explanatory variables than to follow them. Thus, the closer the measurement to the current period the better the estimates obtained.

In general the philosophy underlying these hypotheses is that the closer the measurement to the period being estimated, the better the estimate.

Thus, it is expected that R_1^2 will be larger than R_2^2 which in turn will be larger than R_3^2.

To test the hypotheses two types of models were developed.

- County Model
- State Model

County Model. The county model is based on the assumption that current county activity can be estimated on the basis of direct measurement of current activity in the largest permit issuing places and past activity in small permit places.

$$Y_c = f(LPP_c, SPP_c)$$

Where:

Y_c -- estimate of one-family house construction within a county.

LPP_c -- measured activity in Large Permit Places (places issuing fifty or more permits annually) within the county.

SPP_c -- estimate of activity in Small Permit Places (places issuing less than fifty permits annually) based on past activity of these places and rate of change in LPP_c from the base period into the current period.

The proposed model is based on the identity:

$$CP_{ij} = LPP_{ij} + SPP_{ij}$$

Where:

CP_{ij} -- Total number of permits issued in a county in month i, year j

LPP_{ij} -- Permits issued by Large Permit Places within the county in month i, year j

SPP_{ij} -- Permits issued in Small Permit Places within the county in month i, year j.

SPP_{ij} is a random variable whose distribution is dependent on the annual activity of all such places in base year j_o - SPP_{j_o} the seasonal index for month i, year j - I_{ij} and the rate of change between year (j) and (j_o) - SPP_j/SPP_{j_o}.

$$SPP_{ij} = (SPP_{j_o})(I_{ij})(SPP_{ij}/SPP_{ij_o})$$

Since no direct observations are made on the Small Permit Places during month (i) in year (j), the rate of change from the base year (j_o) to current year (j) cannot be obtained directly. In the model it is assumed that

$$\frac{SPP_j}{SPP_{j_o i}} = \frac{LPP_j}{LPP_{j_o i}}$$

which can be measured from the reports received from Large Permit Places.

Thus: $SPP_{ij} = (SPP_{j_o})(I_{ij})(LPP_j/LPP_{j_o}) + e_s$

$$CP_{ij} = LPP_{ij} + SPP_{ij} + e_c$$

Where:

e_s and e_c are error terms assumed to be normally distributed with means equal to zero and known variance

$$e \sim N(0, \sigma^2)$$

The county error -- e_c -- is composed of LPP measurement error, e_1, and SPP measurement and estimating error, e_s.

The LPP and SPP designation is not constant but changes as annual data becomes available from the Bureau of the Census. At this point the permit places are reclassified, if their annual activity changed -- to an extent justifying reclassification.

At the same time, the values of e_c, e_1, and e_s are empirically obtained by comparing county estimates to reports received by the Bureau of the Census.

$$e_c = (C_{j_a} - C_{j_b}) / 2$$

$$e_1 = (LPP_{j_a} - LPP_{j_b}) / 2$$

$$e_s = (SPP_{j_a} - SPP_{j_b}) / 2$$

Where:

The subscript "a" indicates the Bureau of Census and "b" indicates study

since

$$e = X - E(X)$$

$$e_c = C_j - E(C_j)$$

$$E(C_j) = (C_{j_a} + C_{j_b}) / 2$$

substituting

$$e_c = C_{j_a} - (C_{j_a} + C_{j_b}) / 2$$

$$2e_c = 2C_{j_a} - C_{j_a} - C_{j_b}$$

$$2e_c = C_{j_a} - C_{j_b}$$

$$e_c = (C_{j_a} - C_{j_b}) / 2$$

by the same reasoning

$$e_1 = (LPP_{j_a} - LPP_{j_b}) / 2$$

$$e_s = (SPP_{j_a} - SPP_{j_b}) / 2$$

The distribution of e_c, e_1, and e_s for the United States as a whole and SMSA and Non-SMSA was analyzed for basic characteristics using the Codebook program in Statistical Packages for Social Sciences. This program provides measures for the mean, median, mode, variance, kurtosis, skewness, range, minimum and maximum values in the distribution.

Theoretically, all those distributions, but especially e_1 should be normal with mean 0.[5]

The formula used as a basis for the county model is a form of a regression equation in which the coefficients are not based on regression analysis of the data, but on assumptions about behavior of the phenomena.

Design

For the purpose of the study the universe of all Permit Issuing Places was partitioned into LPP and SPP according to the definitions given above.

All places identified as SPP were contacted to assure that monthly data would be obtained from them by the tenth working day in the month following the month of interest. After the initial contact has been established a form is sent out to the place every month so that it could be received by the tenth working day with the data filled in. If the place issues 250 or more permits a year, every effort is made to obtain the data from it by phone or via a telegram, if not received by the fifth working day. If the place issues less than 250 permits a year and a report has not been received by the tenth working day of the following month, an estimate of the activity of the place is made based on the last six months for which reports were received and the seasonal indices for these months:

$$\widehat{LPP}_{ij} = \left(\frac{LPP_{i-k,\,j-l}}{I_{i-k,\,j-l}} \Big/ k \right) I_{ij}$$

$k = 1, 2....6,\ l = 0, 1$

The annual activity of Small Permit Places is summarized by county and the result stored in a computer. Each month an estimate of the SPP county activity is obtained by multiplying the annual figure for the base year by the seasonal index for the month and the rate of change from the base year.

$$\widehat{SPP}_{ij} = (SPP_{j_o})\ (I_{ij})\ (LPP_{ij}/LPP_{ij_o})$$

The I_{ij} and LPP_{ij}/LPP_{ij_0} are computed by SMSA and Non-SMSA within four Census Regions, Counties are uniquely designated as SMSA or Non-SMSA within the regions following the definition used by the government.

As soon as the Bureau of the Census data becomes available it is used to revise the classification of the permit places and to evaluate the estimating errors, as described in the previous section.

State Model

The development of the state model proceeded through the following stages:

1. Selection of variables to be included in analysis.
2. Factor analysis in order to identify the structure underlying the variables selected.
3. Regression analysis to obtain estimating equations.

In developing our model, we assume the demand for one-family houses to be a function of:

- size of population
- income
- availability and cost of alternate housing
- availability and cost of mortgage funds
- expectations of future supply

Supply of one-family houses is a function of:

- availability of resources
- alternate uses of resources
- availability of mortgage money
- expectations of future demand

While the demand and supply equations can be specified separately, it is impossible to obtain independent measurements on each; the only points that we are able to observe in reality are points at which supply and demand equal each other, since in the short run the market is always in equilibrium, and all of our observations are in the short run. Thus, in the short run, the observed values are a function of both demand and supply.

The variables were selected for inclusion in the analysis because they satisfied the following criteria:

- were defined as supply or demand determinants
- data for them was available on the state level
- the content of the series has not changed during the period for which data were collected.

The variables selected through application of these criteria are described below.

X_2 - Value of Mortgage Loans made for New House Construction by members of the Federal Home Loan Bank Board (FHLB).

- Represents the mortgage funds available to home buyers.
- Effects the supply of one-family houses - if mortgage funds are not expected to be available, builders cannot expect to sell the houses they built.
- Lags permits at the time it is being reported, but expectations about its availability influence builders decisions about future construction.

X_3 - Civilian Population - An estimate developed by the Population Division of the Bureau of the Census.

- Effects demand for housing - as population increases, with relation to the existing housing inventory, so does the demand for housing.

X_4 - Housing Inventory - Available only in decennial censi. Represents a measure of available housing stock.

- If inventory is greater than total demand, no supply of new housing is generated.
- If inventory is smaller than demand, no demand for new housing is generated.

X_5, X_6 - Interest return on FHLB Mortgage Loans.

- The price of mortgage money available.

- Available only on regional level.
- As the rate increases demand for mortgages, ergo housing, decreases.

X_7 - Number of households - Estimate made by the Population Division of the Bureau of the Census.

- As the number increases the demand for housing increases.

X_8 - Personal Income by Place of Residence - Estimates made utilizing various data available.

- As income increases the demand for housing increases.

X_9 - Contract Construction Income.

- A measure of construction industry activity.
- An increase may effect housing either way - if the return on other construction is higher than on housing - may decrease supply of housing; if profitability of housing construction is higher than in other construction - may increase supply of housing.

X_{10} - Number of FHA Insured Home Mortgages

X_{11} - Dollar Volume of FHA Insured Home Mortgages

- Measures of availability of mortgage funds; increase causes increase in housing.

X_{12} - Square Feet of New Non-Residential Construction Floor Area

- Measure of construction activity.
- Use of resources competes with housing.
- When there is a surplus of resources for non-residential construction, resources become available to housing construction.

X_{13} - Square Feet of New Residential Construction Floor Area

- Includes one-family and multi-family dwellings.

X_{14} - Number of FHA Insured Mortgages for New One-Family Houses

X_{15} - Dollar Volume of FHA Insured Mortgages for New One-Family Houses

- These two variables represent the availability of mortgage funds to purchasers of new one-family houses.

X_{16} - Number of Employees Employed by General Building Contractors

X_{17} - Taxable Payroll of General Building Contractors

- These variables measure construction activity, can effect housing either way.

X_{18} - Number of Employees Employed by Special Trade Contractors

X_{19} - Taxable Payroll of Special Trade Contractors

- Mostly a measure of housing construction activity - mostly but not exclusively used in housing.
- Change should effect housing in the same direction; i.e., increase will cause increase in housing, decrease will cause decrease in housing.

X_{20} - Number of New Housing Units Constructed in Apartment Buildings

- Represent supply of new housing units in apartment buildings. Both one-family houses and apartment buildings satisfy the total demand for housing.
- The extent to which they are substitutes is not clear. For some individuals, under given conditions, an apartment is not an alternative to a one-family house, for others it may represent a substitute.
- From the supply point of view, it does represent an alternative use of some resources used in construction of one-family houses.

If we identify the variables according to their redominant characteristics as demand or supply determinants, the following groupings emerge.

Demand Variables. Within the demand variables category included are socio-economic measures (X_3 - Civilian Population, X_7 - Number of Households, X_8 - Personal Income by Place of Residence), Measures of the existing housing inventory (X_4), measures of new construction of substitutes of one-family houses (X_{13} - Square Feet of New Residential Construction Floor Area X_{20} - Number of New Housing Units Constructed in Apartment Buildings).

The demographic variables (Civilian Population and Number of Households) are not measured directly between decennial censi, thus measures included in the analysis represent estimates developed by the Population Division of the Bureau of Census. The income measure represents estimates obtained using different formulae in individual states depending on the availability of data.

The new construction measures were obtained from F.W. Dodge Division of McGraw-Hill Information Systems Company by special permission and represent direct observations.

Supply Variables. Among supply variables are included measures of availability of mortgage funds (X_2 - Mortgage Loans Made for New Construction by Federal Home Loan Banks, X_{10} - Number of FHA Insured Home Mortgages, X_{11} - Dollar Volume of FHA Insured Mortgages, X_{14} - Number of FHA Insured Mortgages for One-Family Houses), measures of current level of construction activity (X_{12} - Square Feet of New Non-Residential Construction Floor Area, X_9 - Contract Construction Income, X_{16} - Number of Employees Employed by General Building Contractors, X_{17} - Taxable Payroll of General Building Contractors, X_{18} - Number of Employees Employed by Special Trade Contractors, X_{19} - Taxable Payroll of Special Trade Contractors, measures of cost of mortgages (X_5 - Interest Return on Federal Home Loan Banks Mortgage Loans Held - June, X_6 - Interest Return on Federal Home Loan Banks Mortgage Loans Held - December).

Unlike demand variables, all of the supply variables represent direct measurement of the phenomena.

Mortgage information is based on reports received from member banks. Employment in the construction industry is based on reports filed under the State Unemployment Insurance Program.

TABLE I
VARIABLES USED IN FACTOR AND REGRESSION ANALYSIS

VARIABLE	NAME	SOURCE
X_1	Number of New Privately Owned One-Family House Units Authorized in Permit Issuing Places	Construction Reports, C 40 Housing Authorized by Building Permits and Public Contracts.
X_2	Mortgage Loans Made for New Home Construction, FHLE, ($000)	Federal Home Loan Bank Board, Savings and Home Financing, Source Book.
X_3	Civilian Population, (000)	Current Population Reports, P-25, Population Estimates.
X_4	Housing Inventory	1970 Census of Housing
X_5	Interest Return on FHLB Mortgage Loans Held, June, (%)	Federal Home Loan Bank Board, Savings and Home Financing, Source Book.
X_6	Interest Return on FHLB Mortgage Loans Held, December, (%)	Federal Home Loan Bank Board, Savings and Home Financing, Source Book.
X_7	Number of Households, (000)	Current Population Reports, P-25, Population Estimates
X_8	Personal Income by Place of Residence, ($000,000)	Survey of Current Business, Vol. 54, No. 8, August 1974.
X_9	Contract Construction Income, ($000,000)	Survey of Current Business, Vol. 54, No. 8, August 1974.
X_{10}	Number of FHA Insured Home Mortgages	HUD Statistical Yearbook
X_{11}	Dollar Volume of FHA Insured Home Mortgages, ($000)	HUD Statistical Yearbook
X_{12}	Square Feet of New Non-Residential Construction Floor Area, (000)	McGraw-Hill Information Systems Company, F.W. Dodge Division; Proprietory Data Provided by Special Permission.
X_{13}	Square Feet of New Residential Construction Floor Area, (000)	McGraw-Hill Information Systems Company, F.W. Dodge Division; Proprietory Data Provided by Special Permission.
X_{14}	Number of FHA Insured Mortgages for New One-Family Houses	HUD Statistical Yearbook
X_{15}	Dollar Volume of FHA Insured Mortgages for New One-Family Houses	HUD Statistical Yearbook
X_{16}	Number of Employees Employed by General Building Contractors	County Business Patterns
X_{17}	Taxable Payroll of General Building Contractors, ($000)	Country Business Patterns
X_{18}	Number of Employees Employed by Special Trade Contractors	Country Business Patterns
X_{19}	Taxable Payroll of Special Trade Contractors, ($000)	County Business Patterns
X_{20}	Number of New Housing Units Constructed in Apartment Buildings.	McGraw-Hill Information Systems Company F.W. Dodge Division; Proprietory Data Provided by Special Permission.

Types of Analyses

The variables with the highest loadings on the factors extracted were selected to be included in stepwise regression analyses. Seven lists of variables were used in the initial analyses.

- All variables for which observations were available for all years included in analysis: X_2, X_3, X_6, X_7, X_8, X_{12}, X_{20} (List 1).
- Combinations of variables with high loadings on factors extracted in factor analyses including one variable per each factor:
  - X_2, X_3, X_6 (List 2)
  - X_2, X_8, X_6 (List 3)
  - X_{12}, X_3, X_6 (List 4)
  - X_{12}, X_8, X_6 (List 5)
  - X_{20}, X_3, X_6 (List 6)
  - X_{20}, X_8, X_6 (List 7)

The first analyses performed were analyses for the periods 1968-1972 and 1968-1973 on observed values and their logarithms. The purpose of the logarithmic regressions was to explore whether a relationship among the rate of change in the variables would provide a better estimate than a linear relationship. The 1968-1972 analyses (both observed values and logarithmic) were performed on regional and national levels. The Durbin-Watson statistic for these analyses indicated that serial correlation existed in the original value series and in the logarithmic series. The coefficients of determination of the observed value series were higher than those obtained for the logarithmic analyses, thus indicating that linear relationships provide an adequate representation of the data. Because of this finding, all subsequent analyses were performed on the observed values only.

The serial correlation indicated by the Durbin-Watson statistic could be due either to relationship over time or to geographic proximity as defined by Dodge Regions. But, since the regional regression Durbin-Watson also indicated the existence of serial correlation, it was assumed that the cause of serial correlation was relationship over time. In order to test this assumption regression analysis was performed on data grouped by year for all the years for which data was available: 1968, 1969, 1970, 1971, 1972, 1973. The Durbin-Watson statistic obtained in these analyses did not indicate an existence of serial correlation, thus confirming the assumption.

Estimating equations to be used in testing the formulated hypotheses were obtaind by performing regression analyses on the average values for the period 1968-1972; 1973 estimates were tested against actual measurements for the period.

In addition, analysis of lagged independent variables was performed to test the hypotheses that for one-family house -- itself a leading series -- estimates based on lagged independent variables will be inferior to estimates obtained using concurrent measures on all variables.

The SPP multiple stepwise regression analysis program was used in obtaining the equations. This program, unlike other stepwise regression programs, uses only forward inclusion. Since backward elimination is not being used, there is a danger of multicolinarity among the variables selected.

Analyses of the Period 1968-1973

For all the lists used in analyses, the coefficient of determination obtained using observed values were higher than those obtained using logarithmic relationships. Thus, the results indicate that a linear relationship provides an adequate description of the variables under consideration.

All of the Durbin-Watson statistics computed indicated the existence of serial correlation.

Analyses of the Period 1968-1972

Data on all variables were collected for the period 1968-1973. In order to test performance of estimating equations obtained in the analyses these equations were obtained using the period 1968-1972 and estimates obtained utilizing them compared to actual observations made in 1973. The analyses for this period were performed on national and regional levels on observed values and on their logarithms.

The coefficients of determination are higher for the observed data. Durbin-Watson statistic indicate serial correlation on all levels of analyses for both forms of the data.

Annual Analyses

If the serial correlation observed in the analyses of 1968-1972 and 1968-1973 was caused by relationship over time, then no serial correlation should be observed in an analysis of the data within a single time period. Thus annual analyses were performed using variables for which observations were available for all the years. For all the years the Durbin-Watson statistic indicates that there is no serial correlation within the years. The variable that appeared in the equations of all the years and was the first to be selected was X_{12} -- Square Feet of Non-Residential Floor Area; the coefficient of determination computed using only non-residential floor area is only slightly lower than the coefficient of determination using other variables as well.

Box-Jenkins' principle of parsimony would indicate that it is more desirable to use equations utilizing only one variable than equations with more variables. In addition, unlike other variables in the equations (X_2, X_3, and X_6) data for X_{12} are available monthly from F.W. Dodge only four weeks after the closing of the period.

Annual regressions using only X_2 and X_{20}, which were also highly correlated with one-family house permits were also obtained.

For every year the coefficients of determination are lower than those obtained using X_{12}. Thus, if a single predictor variable was desired, X_{12} was the best candidate. From the point of view of availability of measurement, X_{20} -- Apartment Building Dwelling Units started -- is equivalent to X_{12} since a measure of its activity is available monthly.

Average Value Regressions

In order to obtain estimating equations free of serial correlation, national regressions were performed on average observed values of observations fro the period 1968-1972. Estimating equations were obtained for simple and weighted averages. The weighted average weights were obtained by solving:

$$W_i = \frac{1}{i_p}$$

$$W_i = 1$$

Where:

W_i -- weight assigned to period i

i -- 1.....n; 1 for the most recent year (1972 for our analyses).

n -- number of years included in the analysis

All the Durbin-Watson statistics obtained indicate no serial correlation at = 0.01. The coefficient of determination obtained for X_{12} was the highest among single variable equations and only a few points lower than the best equation selected which includes variables for which concurrent measurements are not available.

Since single variable equations seem to have high enough coefficients of determination, the weighted average regression analyses included only X_2, X_{12}, and X_{20} as single independent variables.

The results are similar to those obtained in simple average analysis -- no evidence of serial correlation and equation with X_{12} has the highest coefficient of determination.

No significant difference exists among the regression coefficients obtained by the two methods of averaging. Thus, the simple average equations with X_{12} as the single independent variable will be used in estimating 1973.

Lagged Regression

The lagged analysis was performed on X_1 vs prior year X_1, X_2, X_{12}, and X_{20}. Not surprisingly, X_1 turned out to be the best predictor of itself. A one year lag was enough to produce coefficients of determination of .97 and higher. The highest coefficients of determination using other variable was .85.

In some cases the Durbin-Watson statistics indicated existence of serial correlation.

Test of Hypotheses

The hypotheses postulated earlier were represented by the inequalities:

$$R_1^2 \quad R_2^2 \quad R_3^2 \qquad R_2^2 \quad R_4^2$$

$$R_5^2 \quad R_2^2 \quad R_3^2 \quad R_4^2$$

Thus

$$R_2^2 = .87 \qquad R_3^2 = .83$$

$$R_2^2 = .87 \qquad R_4^2 = .85$$

$$R_5^2 = .998 \qquad R_2^2, R_3^2, R_4^2$$

as postulated.

All the coefficients of determination considered are significant at least at the =.0.01 level.

The known tests of significance applicable to multiple correlation coefficients test whether the coefficient differs significantly from zero. I know of no test which tests the significance of the difference between two coefficients of determination. However, since all of the coefficients are significant, the direction of the difference between them may be considered as supporting the postulated hypotheses.

The results of the state analysis support the hypotheses made with regard to the goodness of fit of various estimating equations.

An important result obtained in the analysis of state data was that a single variable -- X_{12}-- square feet of non-residential floor area -- provided a high enough coefficient of determination to be considered a single best estimator of one-family house permits. Use of X_{12} enables forecasting for longer periods of time, since the data for it is available promptly. It also provides an opportunity to use the equations for periods shorter than a year, since data are available monthly. It is also possible that estimates for subdivisions of states could be made using X_{12}, since data for it is available on a county level. The feasibility and goodness of monthly county estimates using X_{12} will not be explored here, but is recommended as further research.

Non-residential construction competes with one-family house construction for resources available. The fact that in the model obtained in our analysis both move in same direction indicates that for the period of analysis both were determined by common factors, rather than by the completion among them. This may not hold for other periods. It is, therefore, recommended that the estimating equation be recomputed utilizing the most recent data available.

Comparison of Estimates Obtained by the State and County Models to Census Reports

The state model equations used in estimating are those selected as most desirable, i.e. those utilizing only X_{12} as an explanatory variable. While this selection is not arbitrary it should not be taken for granted for that other periods X_{12} will also be the best predictor. In order to provide meaningful estimates equations should be revised as new data become available.

The regional and national equations used in obtaining the state model estimates are shown in Table 2. The actual comparison of the three estimates

- county
- regional
- national

are shown in Table 3.

The coefficient of determination -- R^2 -- is used as a measure of deviation of estimates from actual. As postulated, the county model provides the best estimate with an R^2 = .96. No significant difference

TABLE 2
REGIONAL EQUATIONS USED IN OBTAINING 1973 ESTIMATES

REGION I	$X_1 = 1,185.9978 + 0.43621 X_{12}$
REGION II	$X_1 = 8,304.7821 + 0.30516 X_{12}$
REGION III	$X_1 = 10,206.7564 + 1.02047 X_{12}$
REGION IV	$X_1 = 335.4999 + .48979 X_{12}$
REGION V	$X_1 = 1,419.1526 + 0.53803 X_{12}$
REGION VI	$X_1 = 2,496.7241 + 0.52741 X_{12}$
REGION VII	$X_1 = 875.8619 + 0.50877 X_{12}$
REGION VIII	$X_1 = 3,112.8412 + 0.65530 X_{12}$

NATIONAL EQUATION USED IN OBTAINING 1973 ESTIMATES

$$X_1 = 1,420.17 + 0.57211 X_{12}$$

exists between the regional and national estimates at R^2 = .865 and R^2 = .867 respectively. The performance of the state model can be improved by using as the final estimate the average of national and regional estimates.

$$Y_S = (Y_{SR} + Y_{SN}) / 2$$

where:

Y_S -- estimate for the state

Y_{SR} -- estimate for the state using the regional equation

Y_{SN} -- estimate for the state using national equation

When this estimate is used, the coefficient of determination for 1973 estimates goes up to R^2 = .891.

The regional alignment used in our analysis was that used by F.W. Dodge and FHLB. It is conceivable that a different alignment might have produced a better fit for the regional equations. An attempt was made to group states by regression coefficients on various variables (X_2, X_3, X_8, X_{12}, X_{20}) but the results were not encouraging. Other criteria for alignment may be more efficient and may provide a significantly better estimate when utilizing regional equations.

In terms of the hypotheses postualted --

R_1^2 R_2^2 holds -- the coefficient of determination obtained by using the county model is higher than the coefficient of determination obtained using the state model with concurrent measurement of the explanatory variables.

R_5^2 R_2^2 is not supported by the study -- there does not seem to be significant difference between estimates obtained using regional equations and estimates obtained using a single national equation. The two models were also tested by using 1979 and 1980 data. The state model utilized the equations shown in Table 2. The test measure used was the ratio of estimates obtained to figures reported by the Bureau of the Census. These ratios were computed for all the estimates for each state. Thus for each year 51 ratios were obtained. Table 4 shows the results.

For all the years the estimates obtained using the county model are closer to the Census (ratio of 1.00 for 1979 and 1980) and are less widely dispersed than the regression estimates.

The regression equations obtained using data for 1968-1972 are as valid for 1979 and 1980 as they were for 1973, they even performed better for the later period.

Conclusion

Both the state and the county model provided adequate state estimates of one-family house construction activity. Both models, in their final form, utilized direct measurement in the period to be estimated in order to obtain the estimates. The county model, however, has means of providing monthly estimates by county, while the state model was developed using annual state data.

Recommendations

It seems that most serious research is being directed towards development of sophisticated methodologies with little regard to the data to which the methodologies applies. There is a need to improve the quality of data by concentrating more effort on developing methods of data collection.

Further work on the state model presented here is recommended to determine whether different criteria for regional alignment would not improve the quality of estimates.

In the state regression analysis, it was found that X_{12} -- square feet of non-residential floor area -- provided good estimates of one-family house permits. Since X_{12} is measured monthly, and since information on it is available on a county level, it would be worthwhile to explore the goodness of county estimates using equations with this variable versus county estimates obtained using the county model.

TABLE 3
COMPARISON OF THE NUMBER OF ONE-FAMILY
HOUSE PERMIT ISSUED BY STATE TO ESTIMATES

STATE	CENSUS REPORT (C 40)	COUNTY MODEL	REGIONAL REGRESSION	NATIONAL REGRESSION
ALABAMA	10,610	10,594	9,585	15,341
ALASKA	942	1,152	6,230	3,625
ARIZONA	28,740	28,032	18,465	14,354
ARKANSAS	5,519	5,198	8,263	7,174
CALIFORNIA	102,974	118,259	105,697	90,853
COLORADO	20,309	20,839	21,852	17,324
CONNECTICUT	11,766	10,177	8,044	9,926
DELAWARE	4,240	3,964	9,038	4,285
DISTRICT OF COLUMBIA	144	127	11,128	6,207
FLORIDA	69,419	57,551	79,148	51,210
GEORGIA	29,009	25,226	45,770	32,414
HAWAII	5,584	8,508	7,793	4,995
IDAHO	4,829	3,308	6,169	3,571
ILLINOIS	33,372	28,989	41,661	43,873
INDIANA	19,746	19,241	23,467	24,440
IOWA	6,817	7,402	9,957	11,526
KANSAS	6,886	6,384	8,316	9,295
KENTUCKY	9,411	8,250	8,872	11,694
LOUISIANA	10,162	9,977	12,425	13,936
MAINE	3,812	2,949	3,216	3,565
MARYLAND	25,054	22,997	17,333	17,892
MASSACHUSETTS	18,817	17,208	14,064	17,857
MICHIGAN	37,622	36,048	28,216	29,512
MINNESOTA	15,808	15,178	16,116	16,589
MISSISSIPPI	8,184	6,557	7,701	8,600
MISSOURI	14,988	15,419	16,340	15,975
MONTANA	1,192	1,777	5,541	3,021
NEBRASKA	6,139	5,553	6,630	7,390
NEVADA	8,263	7,000	8,371	5,502
NEW HAMPSHIRE	4,554	3,863	3,335	3,721

TABLE 3 - Continued
COMPARISON OF THE NUMBER OF ONE-FAMILY
HOUSE PERMIT ISSUED BY STATE TO ESTIMATES

1973

STATE	CENSUS REPORT (C 40)	COUNTY MODEL	REGIONAL REGRESSION	NATIONAL REGRESSION
NEW JERSEY	28,352	22,917	21,227	25,226
NEW MEXICO	5,775	3,418	7,299	4,562
NEW YORK	33,022	30,258	27,503	37,044
NORTH CAROLINA	24,837	23,342	33,348	25,418
NORTH DAKOTA	1,586	1,763	3,272	2,870
OHIO	33,799	32,515	35,439	42,865
OKLAHOMA	8,515	8,648	11,393	12,770
OREGON	13,175	13,458	13,761	10,229
PENNSYLVANIA	35,905	21,090	25,346	32,982
RHODE ISLAND	3,470	3,027	3,029	3,320
SOUTH CAROLINA	16,659	18,411	11,393	13,054
SOUTH DAKOTA	1,779	1,497	3,159	2,750
TENNESSEE	14,829	14,494	31,841	24,570
TEXAS	41,611	39,594	58,349	65,808
UTAH	7,750	8,984	10,652	7,503
VERMONT	1,926	1,165	1,855	1,772
VIRGINIA	43,736	39,611	20,699	24,231
WASHINGTON	18,032	19,803	18,382	14,282
WEST VIRGINIA	1,855	963	3,268	5,119
WISCONSIN	18,963	17,728	19,768	20,489
WYOMING	1,470	1,480	3,853	1,540
$R^2 = \frac{\sum (Y_c - \bar{Y})^2}{\sum (Y - \bar{Y})^2}$		.960	.865	.867
$\frac{\sum (\text{Estimate/Actual})}{51}$		.943	1.445	1,345
Number of Times that (Estimate-Actual) is Minimum		30	8	13

TABLE 4

SUMMARY OF A COMPARISON OF ESTIMATES TO CENSUS
1973, 1979, 1980

1973	AVERAGE RATIO	RANGE OF RATIOS
NATIONAL REGRESSION	1.34	0.49 - 3.85*
REGIONAL REGRESSION	1.44	0.68 - 6.61*
COUNTY MODEL	0.94	0.61 - 1.52
1979		
NATIONAL REGRESSION	1.12*	0.52 - 5.39*
REGIONAL REGRESSION	1.17*	0.55 - 5.09*
COUNTY MODEL	1.00	0.83 - 1.18
1980		
NATIONAL REGRESSION	1.16*	0.52 - 2.97*
REGIONAL REGRESSION	1.26*	0.56 - 3.89*
COUNTY MODEL	1.00	0.66 - 1.29

*excludes District of Columbia whose ratios were extraordinarily high.

APPENDIX 1

ESTIMATE/CENSUS
1973

Regression

STATE	NATION	REGION	COUNTY
AL	1.45	0.90	1.00
AZ	0.49	0.64	0.98
AR	1.28	1.47	0.93
CA	0.88	1.03	1.15
CO	0.85	1.08	1.03
CT	0.84	0.68	0.86
DE	1.01	2.13	0.93
DC	43.10	77.28	0.88
FL	0.73	1.14	0.83
GA	1.12	1.58	0.87
ID	0.74	1.28	0.69
IL	1.31	1.25	0.87
IN	1.24	1.19	0.97
IA	1.69	1.46	1.09
KS	1.35	1.21	0.93
KY	1.24	0.94	0.88
LA	1.37	1.22	0.98
ME	0.93	0.84	0.77
MD	0.71	0.69	0.92
MA	0.95	0.75	0.91
MI	0.78	0.75	0.96
MN	1.05	1.01	0.96
MS	1.05	0.94	0.80
MO	1.07	1.09	1.03
MT	2.53	4.65	1.49
NE	1.20	1.08	0.90
NV	0.66	1.01	0.85
NH	0.82	0.73	0.85
NJ	0.89	0.75	0.81
NM	0.79	1.26	0.59
NY	1.12	0.83	0.92
NC	1.02	1.34	0.94
ND	1.81	2.06	1.11
OH	1.27	1.05	0.96
OK	1.50	1.34	1.02
OR	0.78	1.04	0.78
PA	0.92	0.71	0.61
RI	0.96	0.87	0.87
SC	0.78	0.68	1.11
SD	1.55	1.78	0.84
TN	1.66	2.15	0.97
TX	1.58	1.40	0.95
UT	0.97	1.37	1.16
VT	0.92	0.96	0.60
VA	0.55	0.47	0.91
WA	0.79	1.02	1.10
WV	2.76	1.76	0.52
WI	1.08	1.04	0.93
WY	1.05	2.62	1.01
HI	0.89	1.40	1.52
AK	3.85	6.61	1.22

APPENDIX 2

ESTIMATE/CENSUS
1979

STATE	NATION	REGION	COUNTY
AL	1.06	0.87	1.05
AZ	0.52	0.64	0.98
AR	1.29	1.39	1.08
CA	0.79	0.92	1.00
CO	0.61	0.74	0.95
CT	1.12	0.86	0.97
DE	1.32	4.07	1.16
DC	12.12	26.32	1.12
FL	0.48	9.73	0.92
GA	0.75	0.91	0.96
ID	0.60	0.91	1.03
IL	1.65	1.56	1.06
IN	1.13	1.06	1.00
IA	1.25	1.19	1.11
KS	1.31	1.12	1.01
KY	1.55	1.46	1.01
LA	1.02	1.02	0.89
ME	1.12	0.89	1.08
MD	0.64	0.71	0.98
MA	1.00	0.78	1.02
MI	0.87	0.82	0.94
MN	0.88	0.84	0.98
MS	1.15	1.28	1.00
MO	1.12	1.11	1.00
MT	1.64	2.60	1.18
NE	0.94	0.78	1.05
NV	0.53	0.73	0.92
NH	0.85	0.67	0.84
NJ	0.93	0.82	0.91
NM	0.66	0.70	1.00
NY	1.07	0.95	0.97
NC	0.72	0.84	0.96
ND	1.44	1.39	0.90
OH	1.32	1.08	1.02
OK	0.87	0.75	1.04
OR	0.88	1.09	1.10
PA	0.69	0.60	0.97
RI	0.96	0.77	0.92
SC	0.72	0.61	0.93
SD	1.21	1.17	1.09
TN	1.13	1.19	1.04
TX	1.12	0.99	0.99
UT	0.80	1.03	0.95
VT	1.61	1.28	0.83
VA	0.62	0.55	0.93
WA	0.82	0.99	1.03
WV	3.16	1.91	1.15
WI	1.12	1.06	1.04
WY	5.39	5.09	1.04
HI	0.55	0.87	0.99
AK	1.99	3.18	1.12

ESTIMATE/CENSUS
1980

STATE	NATION	REGION	COUNTY
AL	1.01	0.70	0.99
AZ	0.77	0.95	0.98
AR	1.35	1.49	1.00
CA	1.11	1.29	0.94
CO	0.85	1.05	0.98
CT	2.97	1.06	0.96
DE	1.28	3.89	1.04
DC	7.80	19.98	1.08
FL	0.52	0.78	0.92
GA	0.83	1.00	0.94
ID	0.86	1.34	1.11
IL	2.71	2.56	1.11
IN	1.64	1.55	0.99
IA	1.71	1.62	1.00
KS	1.56	1.38	1.03
KY	1.91	1.82	1.04
LA	1.03	1.05	0.97
ME	1.43	1.14	1.01
MD	0.79	0.88	0.83
MA	1.19	0.92	0.94
MI	1.32	1.25	0.92
MN	0.90	0.86	0.94
MS	1.27	1.40	0.96
MO	1.80	1.81	1.07
MT	1.84	3.31	1.29
NE	0.97	0.78	0.90
NV	0.88	1.24	0.90
NH	0.83	0.67	0.86
NJ	1.25	1.16	0.89
NM	1.05	1.45	0.97
NY	1.57	1.38	0.95
NC	0.84	0.93	1.04
ND	2.18	2.11	0.93
OH	1.82	1.46	1.01
OK	1.03	0.88	1.10
OR	0.77	0.98	0.97
PA	1.06	0.93	0.98
RI	1.48	1.19	0.98
SC	0.80	0.56	0.90
SD	1.10	1.07	0.88
TN	1.34	1.35	0.98
TX	1.27	1.12	0.97
UT	1.13	1.49	1.00
VT	1.21	0.97	0.66
VA	0.56	0.56	0.89
WA	1.02	1.25	1.11
WV	2.40	1.05	1.02
WI	1.43	1.36	1.08
WY	1.49	2.36	1.03
HI	1.31	1.88	0.99
AK	0.73	1.21	0.99

BIBLIOGRAPHY

A. BOOKS

Abramson, Adolph G. and Russell H. Mack (eds.). Business Forecasting in Practice: Principles and Cases. New York: John Wiley and Sons, Inc., 1956.

Aigner, Dennis J. Basic Econometrics. 1971.

Anthony, Robert N. Planning and Control Systems: A Framework for Analysis. Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1965.

Arrow, K. J. Mathematical Models in Social Sciences. Stanford: Stanford University Press, 1951.

Bassie, V.L. Economic Forecasting. New York: McGraw-Hill, Inc., 1958.

Beach, E. F. Economic Models. New York: John Wiley and Sons, Inc., 1957.

Bean, Louis Hyman. The Art of Forecasting. New York: Random House, Inc., 1969.

Benton, William King. Forecasting for Management. Reading, Massachusettes: Addison-Wesley Publications, 1972.

Blackman, R. B. and J. Tukey. The Measurement of Power Spectra. New York: Dover Publishing, 1959.

Box, George E. P. and Gwilyn M. Jenkins. Time Series Forecasting and Control. San Francisco, California: Holden-Day, 1970.

Boyce, O. E., A. Farhi and R. Weischedel. Optimal Subset Selection Multiple Regression, Interdependence, and Optimal Network Algorithms. Berlin: Springer-Verlag, 1974.

Bratt, Elmer Clark. Business Cycles and Forecasting. Homewood, Illinois: Irwin, 1961.

Bratt, Elmer Clark. Business Forecasting. New York: McGraw-Hill, Inc., 1958.

Bross, Irwin D. J. Design for Decision. New York: The Free Press, 1965.

Brown, Robert G. Smoothing Forecasting and Predictions of Discrete Time Series. Englewood Cliffs, New Jersey: Prentice Hall, 1962.

Bursk, Edward C. and Dan H. Fenn, Jr. (eds.). Planning the Future Strategy of Your Business. New York: McGraw-Hill, Inc., 1956.

Bursk, John F. and Edward C. Chapman (eds.). Modern Marketing Strategy. New York: The New American Library, 1965.

Butler, William F., Robert A. Kavesh and Robert B. Platt. Methods and Techniques of Business Forecasting. Englewood Cliffs, New Jersey: Prentice Hall, 1974.

Chambers, John C., Satinder K. Mullick and Donald D. Smith. An Executive's Guide to Forecasting. New York: John Wiley and Sons, 1974.

Churchman, C. West, Russell L. Ackoff and Leonard Arnoff. Introduction to Operations Research. New York: John Wiley and Sons, Inc., 1957.

Clark, John J. (ed.). The Management of Forecasting. New York: St. John's University Press, 1969.

Cochran, W. G. Sampling Techniques. Second Edition. New York: John Wiley and Sons, Inc., 1963.

Conference on Research in Income and Wealth, Short Term Economic Forecasting. Princeton, New Jersey: Princeton University Press, 1955.

Coppock, Joseph D. "Economics of Decision Making in the Business Enterprise,"Economics of the Business Firm. New York: McGraw-Hill, Inc., 1959.

Cramer, Jan Solomon. Empirical Econometrics. Amsterdam, Holland: North-Holland Publishing Company, 1969.

Crisp, Richard D. Marketing Research. New York: McGraw-Hill, Inc., 1957.

Dale, E. Management Theory and Practice, New York: McGraw-Hill, Inc., 1965.

Dauten, Carl Anton. Business Fluctuations and Forecasting. Cincinnati, Ohio: South-Western Publishing Company, 1954.

Deming, W. E. Sample Design in Business Research. New York: John Wiley and Sons, Inc., 1960.

Drucker, Peter. The Practice of Management. New York: Harper & Row, 1954.

Ezekiel, Mordicai and Karl Fox. Methods of Correlation and Regression Analysis. New York: John Wiley and Sons, Inc., 1959.

Goldberger, A. S. Econometric Theory. New York: John Wiley and Sons, Inc., 1969.

Gordon, Robert Aaron. Business Fluctuations. New York: Harper and Brothers, 1952.

Grebler, Leo and Sherman Maisel. "Determinants of Residential Construction: A Review of Present Knowledge."Impacts on Housing Policy. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1963.

Haberler, Gottfried. Consumer Installment Credit and Economic Fluctuations. New York: National Bureau of Economic Research, 1942.

Hansen, M. H., W. N. Hurwitz, and W. G. Madow, Sample Survey Methods and Theory. New York: John Wiley and Sons, Inc., 1953.

Haynes, Warren W. Management. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

Heckert, J. Brooks and James D. Wilson, Business Budgeting and Control. Third Edition. New York: The Ronald Press Company, 1967.

Heyel, Carl. Encyclopedia of Management. New York: Barnes & Noble, 1966.

Hood, W. C. and T. C. Koopmans (eds.). Studies in Econometric Method, Cowles Commission Monograph No. 14, New York: John Wiley and Sons, Inc., 1953.

Johnston, J. Econometric Methods. Second Edition. New York: McGraw-Hill, Inc., 1972.

Jones Reginald L. and H. George Trentin. Budgeting: Key to Planning and Control. New York: American Management Association, Inc., 1966.

Kelly, Eugene, J. and William Lazer (eds.). Managerial Marketing: Perspective and Viewpoint. Third Edition. Homewood, Illinois: Richard D. Irwin, Inc., 1967.

Kendall, M. G. and A. Stuart. The Advanced Theory of Statistics. New York: Hafner Publishing Company, 1968.

Kish, Leslie. Survey Sampling. New York: John Wiley and Sons, Inc., 1965.

Koontz H, and C. O'Donnell. Principles of Management. New York: McGraw-Hill, Inc., 1964.

Kotler, Philip. Marketing Management. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967.

Lewis, John Prior. Business Conditions Analysis. New York: McGraw-Hill, Inc., 1959.

Maisel, Sherman. Fluctuations, Growth, and Forecasting. New York: John Wiley and Sons, Inc., 1957.

McDonough, Adrian M. Management Systems: Working Concepts and Practice. Homewood. Illinois: Irwin, 1965.

Morrison, Donald F. Multivariate Statistical Methods. New York: McGraw-Hill, Inc., 1967.

Morrison, Peter A. Demographic Information for Cities: A Manual for Estimating and Projecting Local Population Characteristics. Rand Reports R-618-HUD, June 1971.

Myers, John G. "Statistical and Econometric Methods Used in Business Forecasting,"Methods and Techniques of Forecasting. Englewood Cliffs, New Jersey: Prentice Hall, 1974.

Newbury, F. D. Business Forecasting. New York: McGraw-Hill, Inc., 1952.

Newcomb, Robinson. "Housing and Other Construction,"Methods and Techniques of Forecasting. Englewood, New Jersey: Prentice Hall, 1974.

Newman, William M. and Charles E. Summer, Jr. The Process of Management. Englewood Cliffs,

Nie,Norman, Dale H. Bent, and Hadlan C. Hull. SPSS Statistical Package for the Social Sciences. New York: McGraw-Hill, Inc., 1970.

Platt, Robert B. "Statistical Measures of Forecast Accuracy," Methods and Techniques of Forecasting. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1974.

Rigby, Paul H. Conceptual Foundations of Business Research. New York: John Wiley and Sons, Inc., 1965.

Raj, Des. Sampling Theory. New York: McGraw-Hill, Inc., 1968.

Rao, Potluri. Applied Econometrics. 1971.

Rautenstrauch, Walter and Raymond Villers, Budgeting Control. New York: Funk and Wagnall Company, 1950.

Ricks, Bruce R. (ed.). National Housing Models. Lexington, Massachusetts: Lexington Books, 1973.

Robinson, Colin. Business Forecasting. London, England: Nelson Publications, 1971.

Shryock, Henry S. and Jacob S. Siegel. The Methods and Materials of Demography. U. S. Government Printing Office, 1971.

Silk, Leonard Solomon and M. Louis Curley. A Primer on Business Forecasting. New York: Random House, 1970.

Slonim, M. J. Sampling in a Nutshell, New York: Simon & Shuster, 1960.

Snedecor, George W. and William G. Cochran. Statistical Methods. Ames, Iowa: The Iowa University, 1967.

Sord, Bernard M. and Glenn A. Welsch. Business Budgeting: A Survey of Management Planning and Control Practices. New York: Controllership Foundation, Inc., 1960.

Spencer, Milton H. Business and Economic Forecasting; An Econometric Approach. Homewood, Illinois: Richard D. Irwin, Inc., 1961.

Spencer, M. H. and L. Siegelman. Managerial Economics. Homewood, Illinois: Richard D. Irwin, Inc., 1961.

Spivey, Allen W. and William J. Wrobleski. Analyzing and Forecasting Time Series, Part I: Methodoly. Working Paper No. 91, Bureau of Business Administration, Ann Arbor, Michigan: University of Michigan, August 1971.

Stanton, William J. Fundamentals of Marketing. Second Edition. New York: McGraw-Hill, Inc., 1967.

Sukhatme, P. V. Sampling Theory of Surveys With Applications. Ames, Iowa: Iowa State College Press, 1974.

Theil, Henri. Principles of Econometrics. New York: McGraw-Hill, Inc., 1971.

Welsch, Glenn A. Budgeting: Profit Planning and Control. Second Edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964.

Yates, F. Sampling Methods for Censures and Surveys. New York: Hafner Publishing Company, Inc., 1949.

Yates, F. Sampling Methods for Censures and Surveys. Third Edition. London, England: Charles Griffin and Company, 1960.

Zarnowitz, Victor. An Appraisal of Short-Term Economic Forecasts. New York: National Bureau of Economic Research, 1967

Zarnowitz, Victor. "How Accurate Have the Forecasts Been," Methods and Techniques of Forecasting. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974.

B, PERIODICALS

Armitage, P. "A Comparison of Stratified with Unrestricted Sampling from A Finite Population." Biometrika, Vol. 34, 1947.

Ayoma, M. "A Study of the Stratified Random Sampling. "Annals of the Institute of Statistical Mathematics, Vol. 6, 1954.

Beale, E. M. L., M. G. Kendall and D. W. Mann. "The Discarding of Variables in Multivariate Analysis," Biometrica, Vol. 54, No. 3, pp. 357-366.

Bogue, Donald J. "A Technique for Making Extensive Population Estimates." Journal of American Statistical Association, Vol. 45, No. 250, June, 1950, pp. 149-163.

Bogue, Donald J. and Beverly Duncan. "A Composite Method for Estimating Postcensal Population of Small Areas by Age, Sex, and Color." National Office of Vital Statistics, Vital Statistics--Special Reports, Vol. XLVII, No. 6, August 24, 1959.

Booth, Geoffrey G., Roy G., Roy G. Poulsen and James L. Starkey. "Conceptual and Methodological Problems in Constructing A State Econometric Model: The Case of Rhode Island." Rhode Island Business Quarterly, Vol. 8, No. 1, Spring 1972.

Bryant, E. C., H. O. Hartley, and R. J. Jessen. "Design and Estimation in Two-Way Stratification." Journal of American Statistical Association, Vol. 55, 1960.

Buckland, W. R. "A Review of the Literature of Systematic Sampling." Jornal of Royal Statistical Society, B13, 1951, pp. 208-215.

Cochran, W. G. "Relative Accuracy of Systematic and Stratified Random Samples for a Certain Class of Populations." Annals of Mathematical Statistics, Vol. 17, 1946, pp. 164-173.

Cochran, W. G. "Comparison of Methods for Determining Stratum Boundries." Bulletin of International Statistical Institute, Vol. 38, 1961.

Cochran, W. G. "Sampling Theory When the Sampling Units are of Unequal Sizes." Journal of American Statistical Association, Vol. 37, 1942, pp. 199-212.

Cornfield, J. "On Samples From Finite Populations." Journal of American Statistical Association, Vol. 39, 1944, pp. 236-239

Cornfield, J. "The Determination of Sample Size." American Journal of Public Health, Vol. 41, 1951, pp. 654-661.

Crosetti, Albert and Robert Schmitt. "A Method of Estimating the Intercensal Population of Counties." Journal of American Statistical Association, Vol. 51, 1956, pp. 587-596.

Crow, Robert Thomas. "A Nationally-Linked Regional Econometric Model." Journal of Regional Science, Vol. 13, No. 2, 1973, pp. 187-203.

Dalenius, T. and J. C. Hodges, Jr. "Minimum Variance Stratification." Journal of American Statistical Association, Vol. 54, 1959, pp.88-101

Davis, Kenneth R. "Mathematical Marketing Models: Promise vs. Performance. "Talk at the Sixty Fifth Annual Meeting of the Association of National Advertisers, October 1974.

Eckler, A. R. "Rotation Sampling." Annals of Mathematical Statistics, Vol. 26, 1955.

Ericksen, Eugene P. "A Method for Combining Sample Survey Data and Symptomatic Indicators to Obtain Population Estimates for Local Areas." Demography 10, May 1973, pp. 137-160.

Ericksen, Eugene P. "A Regression Method for Estimating Population Changes of LOcal Areas." Journal of American Statistical Association, Vol. 69, No. 348, December 1974, pp. 867-875.

Glejser M. "A New Test for Heteroscedasticity." Journal of American Statistical Association, Vol. 64, 1968, pp. 316-323.

Godambe, V. P. "A Unified Theory of Sampling from Finite Populations." Journal of the Royal Statistical Society , B17, 1955.

Goldberg, David, Allen Feldt, and J. William Smit. "Estimates of Population Change in Michigan, 1950-1960." Michigan Population Studies, No. 1, Ann Arbor, Michigan, University of Michigan, 1960.

Goldfield, S. M. and R. E. Quandt. "Some Tests of Homoscedasticity." Journal of American Statistical Association, Vol. 60, 1965, 539-597.

Goodman, L. A. and H. O. Hartley. "The Precision of Unbiased Ratio Type Estimators." Journal of American Statistical Association,Vol. 53, 1958, pp. 491-508.

Goodman, R. and L. Kish. "Controlled Selection --A Technique in Probability Sampling." Journal of American Statistical Association,Vol. 45, 1950, pp. 350-372.

Hagood, M. J. and E. H. Bernert. "Component Indexes as a Basis for Stratification." Journal of American Statistical Association, Vol. 40, 1945, pp. 330-341.

Hamilton, Horace C. and Josef Perry. "A Short Method for Profecting Population by Age from One Census to Another." Social Forces, December, 1963.

Hansen, M. H., W. N. Hurwitz, and H. Bershad. "Measurement Errors in Censures and Surveys." Bulletin of International Statistical Institute, Vol. 38, No. 2, 1961, pp. 359-374.

Hansen, M. H., W. N. Hurwitz, and M. Gurney. "Problems and Methods of the Sample Survey of Business." Journal of American Statistical Association, Vol. 41, 1946, pp. 173-189.

Hansen, M. H. et al. "Response Errors in Surveys." Journal of American Statistical Association, Vol. 46, 1951, pp. 147-190.

Hansen, M. H. and W. H. Hurwitz. "The Problem of Nonresponse in Sample Surveys." Journal of American Statistical Association, Vol. 41, 1946, pp. 517-529.

Hartley, H. O. and J. N. K. Rao. "Sampling with Unequal Probabilities Without Replacement." Annals of Mathematical Statistics,

Hartley, H. O. and D. Ross. "Unbiased Ration Estimates." Nature, Vol. 174, 1954, pp. 270-277.

Hogg, Robert V. "Adaptive Robust Procedures: A Partial Review and Some Suggestions for Future Applications and Theory." Journal of the American Statistical Association, Vol. 69, No. 348, December 1974, pp. 909-927.

Horvitz, D. G. and D. J. Thomson. "A Generalization of Sampling Without Replacement from a Finite Universe." Journal of American Statistical Association, Vol. 47, 1952, pp. 663-685.

Huang, David S. "A Study of the Market for New Housing Units." 1969 Proceedings of the Business and Economics Section, American Statistical Association, Washington, D. C., 1969.

Huang, David S. "Short-Run Instability in Single Family Housing Starts." Journal of American Statistical Association, Vol. 68, December, 1973, pp. 788-792.

Keyfitz, N. "Sampling with Probabilities Proportional to Size-Adjustment for Change in the Probabilities." Journal of American Statistical Association, Vol. 46, 1951.

Kieruff, Herbert E., Jr. "Best Estimate Forecasting -- A Better Alternative." California Management Review, Vol. 15, No. 1, Fall 1972, pp. 79-85.

Kish L. and I. Hess. "On Variances of Ratios and Their Differences in Multistage Samples." Journal of American Statistical Association, Vol. 54, 1959, pp. 416-446.

Kish L. and J.B. Lansing. "Response Errors in Estimating the Value of Homes." Journal of American Statistical Association, Vol. 49, 1954, pp. 520-538.

Klein, Lawrence R. "Econometric Methods in Business Applications." Journal of Contemporary Business, University of Washington, Seattle, Washington, Spring, 1972.

Lahiri, D.B. "A Method of Sample Selection Providing Unbiased Ratio Estimates." Bulletin of the International Institute of Statistics, Vol. 33, 1951, pp. 133-140.

Liebenberg, Maurice, Albert Hirsh, and Joel Popkin. "A Quarterly Model of the United States: A Progress Report." Survey of Current Business, Vol. 46, No. 5, May 1966, pp. 13-39.

Liv, Ta-Chung. "A Monthly Recursive Econometric Model of United States: A Test of Feasibility." The Review of Economics and Statistics, February 1969, Vol. II, No. 1.

Logan, Robert. "An Empirical Test of the Power of the Shapiro-Wilk Test for Normality." 1974 Proceedings of the Business and Economic Statistics Section, American Statistical Association.

McKenna, Joseph P. and Herbert D. Werner. "The Housing Market in Integrating Areas." Annals of Regional Science 4, No. 2, December 1970.

Madow, L.H. "Systematic Sampling and Its Relation to Other Designs." Journal of American Statistical Association, Vol. 41, 1946, pp. 207-214.

Madow, W.G. and L.H. Madow. "On the Theory of Systematic Sampling." Annals of Mathematical Statistics, Vol. 15, 1944, pp. 1-24.

Mahalonobis, P.C. "Recent Experiments in Statistical Sampling in the Indian Statistical Institute." Journal of the Royal Statistical Society, Vol. 109, 1946, pp. 325-370.

Midzuno, H. "On the Sampling System with Probability Proportionate to Sum of Sizes." American Institute of Statistical Mathematics, Vol. 2, 1951, pp. 99-108.

Neter, J. and J. Waksberg. "A Study of Response Errors in Expenditures Data from Household Surveys." Journal of American Statistical Association, Vol. 59, 1964.

Neyman, J. "Contribution to the Theory of Sampling Human Populations." Journal of American Statistical Association, Vol. 33, 1938, pp. 101-116.

Neyman, J. "On the Two Different Aspects of the Representative Method: The Method of Stratified Sampling and the Method of Purposive Selection." Journal of the Royal Statistical Society, Vol. 97, 1934.

Osborne, J.G. "Sampling Errors of Systematic and Random Surveys of Cover-Type Areas." Journal of American Statistical Association, Vol. 37, 1942, pp. 256-264.

Patterson, H.D. "Sampling on Successive Occassions with Partial Replacement of Units." Journal of the Royal Statistical Society, B12, 1950, pp. 241-255.

Raj, Des. "On a Method of Using Multiauxiliary Information in Sample Surveys." Journal of American Statistical Association, Vol. 60, 1965.

Raj, Des. "On a Method of Using Multiauxiliary Information in Sample Surveys." Journal of American Statistical Association, Vol. 60, 1965.

Raj, Des. "On Sampling Over Two Occassions with Probability Proportionate to Size." Annals of Mathematical Statistics, Vol. 36, 1965.

Raj, Des. "On Sampling With Probabilities Proportional to Size." Ganita, Vol. 5, 1954, pp. 175-182.

Raj, Des. "On the Estimate of Variance in Sampling with Probability Proportionate to Size." Journal of Social Science, Vol. 1, 1958.

Raj, Des. "On the Relative Accuracy of Some Sampling Techniques." Journal of American Statistical Association, Vol. 53, 1958, pp. 98-101.

Raj, Des. "Some Estimators in Sampling with Varying Probabilities Without Replacement." Journal of American Statistical Association, Vol. 51, 1956, pp. 269-284.

Raj, Des and S.H. Khamis. "Some Remarks of Sampling with Replacement." Annals of Mathematical Statistics, Vol. 29, 1958, pp. 550-557.

Raj, Des. "Some Remarks of A Simple Procedure of Sampling Without Replacement." Journal of American Statistical Association, Vol. 61, 1966.

Raj, Des. "The Use of Systematical Sampling with Probability Proportionate to Size in a Large Scale Survey." Journal of American Statistical Association, Vol. 59, 1964.

Raj, Des. "Variance Estimation in Randomized Systematic Sampling with Probability Proportionate to Size." Journal of American Statistical Association, Vol. 60, 1965.

Rao, J.N.K., H.O. Hartley and W.G. Cochran. "A Simple Procedure of Unequal Probability Sampling Without Replacement." Journal of the Royal Statistical Society, B24, 1962.

Rosenberg, Harry. "Improving Current Population Estimates Through Stratification." Land Economics, Vol. 44, No. 3, August, 1968.

Schmitt, Robert C. "Short-Cut Methods of Estimating County Population." Journal of the American Statistical Association, Vol. 47, June,1952, pp. 232-238.

Siegel, Jacob, S. "Status of Research Methods of Estimating State and Local Population." Proceedings of Social Statistics Section, American Statistical Association, 1960, pp. 172-179.

Tukey, J.W. "Some Sampling Simplified." Journal of American Statistical Association, Vol. 45, 1950, pp. 501-519.

Woodruff, R.S. "The Use of Rotating Samples with Census Bureau's Monthly Surveys." Proceedings of the Social Statistics Section, American Statistical Association, 1959, pp. 130-138.

Yates, F. and P.M. Grundy. "Selection Without Replacement From Within Strata With Probability Proportionate to Size." Journal of Royal Statistical Society, B15, 1953.

Zitter, Meyer and Henry S. Shryock. "Accuracy of Methods of Preparing Postcensal Population Estimates for States and Local Areas." Demography, Vol. 1, No. 1, 1964, pp. 227-24.

Zitter, Meyer. "Federal -- State Cooperative Program for Local Population Estimates." The Registrar and Statistician, Vol. 33, No. 11, January 1968, pp. 4-8.

C. REPORTS

American Statistical Association, Proceedings of the Business and Economic Statistics Section.

National Bureau of Economic Research, Input-Output Analysis: An Appraisal, Studies in Income and Walth, Vol. 18, Princeton, Princeton University Press, 1955.

OECD Working Symposium On Long-Range Forecasting and Planning, Paris, OECD, 1969.

Sales Management, Survey of Buying Power.

U.S. Bureau of Economic Analysis, Survey of Current Business.

U.S. Bureau of the Census, Business Cycle Developments.

U.S. Bureau of the Census, Construction Reports, C20.

U.S. Bureau of the Census, Construction Reports, C40.

U.S. Bureau of the Census, Construction Reports, C50.

U.S. Bureau of the Census, Current Population Reports, Series P-23.

U.S. Bureau of the Census, Current Population Reports, Series P.25.

U.S. Bureau of the Census, Current Population Reports, Series P-26.

U.S. Department of Agriculture, Projections of Demand for Housing by Type of Unit and Region, Agriculture Handbook, No. 423, May 1972.

U.S. Department of Commerce, Small Area Statistics Papers, GE-41.

U.N. Statistical Office, The Preparation of Sample Survey Reports, Statistical Papers Series C, No. 1, 1950.

University of Sydney, Symposium, on Forecasting, Sydney, Australia.

FOOTNOTES

1. In 1978 the number of permit issuing places reporting to the Census was increased to 16,000. The study was conducted using the 14,000 permit universe.

2. Housing Authorized by Building Permits, Construction Reports, C40, U.S. Department of Commerce, Bureau of the Census.

3. Housing Starts, Construction Reports, C20, U.S. Department of Commerce, Bureau of the Census.

4. Value of New Construction Put in Place, Construction Reports, C50, U.S. Department of Commerce, Bureau of the Census.

5. A paper based on the distribution of e_1 was presented at the 1975 International Statistical Institute Conference in Warsaw, Poland.

6. The designation of Interest Return on Mortgage Loans as a supply variable is arbitrary. The variable could have been as easily designated as a demand determinant since in it, more than in all other variables considered, the equality of demand and supply at the point at which transactions are conducted reveals itself. The decision to include it among supply determinants was made mainly based on the fact that it measures the bank's return rather than the rate paid by the borrowers.