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A Study of Alternative Imputation Techniques for Surveys in the Current Industrial Reports Series

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A STUDY OF ALTERNATIVE IMPUTATION TECHNIQUES FOR SURVEYS IN THE CURRENT INDUSTRIAL REPORTS SERIES

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ABSTRACT

The Current Industrial Reports (CIR) imputation research effort was designed to provide a general assessment of the effectiveness of the existing imputation methodology for surveys in the CIR series, and to identify, evaluate, and compare the potential statistical and practical effects of plausible alternative procedures. This report provides a summary of the principal results of the completed research effort and present specific recommendations for potential improvement in the current imputation methodology for the surveys in the CIR series.

A major conclusion of the CIR imputation research was that the presently-used screened sums imputation methodology is reasonably effective for many of the CIR surveys, particularly for the monthly surveys. Consequently continuation of that procedure for the monthly surveys has been recommended. Moreover, the use of two distinct ratio adjustments for both the quarterly and annual surveys is suggested.

1. Introduction

For more than a year a staff of researchers in SRD, with support from survey analysts and researchers from Industry Division, has been examining the effectiveness of various establishment-level imputation techniques for surveys in the Current Industrial Reports (CIR) series. The principal procedure that is used to produce imputes for missing establishments in CIR surveys is based on aggregate measures of change for specific survey respondents or on perceived item relationships. However, there was no formal documentation that provided justification for this procedure, referred to as the screened sums or ratio of identicals adjustment, based on either its theoretical properties or on empirical results and evaluations. The recently completed CIR imputation research effort was designed to provide a general assessment of the existing CIR imputation methodology, and to identify, evaluate and compare the potential statistical and practical effects of plausible alternatives.

Five preliminary reports on the CIR imputation research have been issued; they provided a general evaluation of the imputation methodology currently in use and partially examined the merits of other suggested procedures. This report summarizes the principal results of the preliminary reports and offers specific recommendations for potential improvements in the imputation methodology for the CIR surveys.

2. Evaluation of Current Procedures

The examination of the existing CIR imputation techniques covered four general areas -- statistical properties, general utility, procedural complexity and plausibility. To enhance the manageability of the project, which related to all of the more than 100 CIR surveys, the research staff categorized the surveys by product line, unit and average item nonresponse rates, reporting frequency and size. A random selection of surveys was

selected from the resultant categories and formed the empirical basis for the research and evaluation of the effects of alternative imputation procedures on survey estimates. The major items of the surveys selected for the imputation research are shown in Table 1.

2.1 Statistical Properties

For the ith establishment and the tth reporting period (month, quarter, or year), let $Y_{it}(k)$ represent the kth survey characteristic for a given CIR survey. The following are the analytical expressions and brief characterizations of the existing CIR imputation methods.

For Delinquent Respondents or Unit Nonrespondents

Two imputation options are used for most items for unit nonrespondents, which are referred to by the survey methodologists as delinquent respondents.

$$\text{Method 1 - } \hat{Y}_{1it}(k) = Y_{i(t-1)}(k)\left[\frac{\sum_{j\epsilon S} Y_{jt}(k)}{\sum_{j\epsilon S} Y_{j(t-1)}(k)}\right]$$

where S represents the group of responding establishments which passed the screened sums ratio test of the computer editing process for the current reporting period. The ratio within the brackets will be called the screened sums ratio or adjustment factor. The major assumptions of this approach are that the screened sums ratio and therefore the industry's overall period-to-period rates of change are "good" estimates of the trend or change ratios for the establishments in question.

$$\text{Method 2 - } \hat{Y}_{2it}(k) = Y_{i(t-1)}(k)\left[\frac{\sum_{j\epsilon S} Y_{jt}(\ell)}{\sum_{j\epsilon S} Y_{j(t-1)}(\ell)}\right]$$

This estimator is analogous to that shown as Method 1, however the distinguishing assumption is that the perceived relationship between the ℓth and kth items would permit the effective use of the screened sums ratio for item ℓ to estimate the current period value for the kth item.

For Item Nonresponse

The four principal estimators designated for item nonresponse are provided below.

$$\text{Method 3 - } \hat{Y}_{3it}(k) = Y_{i(t-1)}(k)\left[\frac{Y_{it}(\ell)}{Y_{i(t-1)}(\ell)}\right]$$

Unlike the delinquent respondents, survey establishments which are identified as "partial respondents" may respond to one item, but not to another. For those partial respondents for which there is a response for a "related" or strongly correlated item, Method 3 requires the use of the period-to-period ratio for the related item i.e., $Y_{it}(\ell) / Y_{i(t-1)}(\ell)$, as an estimate of the corresponding rate for the kth item.

$$\text{Method 4 - } \hat{Y}_{4it}(k) = Y_{it}(\ell)\left[\hat{T}_t(k)/\hat{T}_t(\ell)\right],$$

where the estimated total for item * for the current period can be represented by

$$\hat{T}_t(*) = T_{t-1}(*)\left[\sum_{j\epsilon S} Y_{it}(*) \Big/ \sum_{j\epsilon S} Y_{i(t-1)}(*)\right].$$

Here $T_{t-1}(*)$ is the total that was published for the item for the previous reporting period. This procedure is also designed to take advantage of the relationship believed to exist between items k and ℓ. It is analogous to the more familiar representation of a combined ratio estimator.

$$\text{Method 5 - } \hat{Y}_{5it}(k) = Y_{i(t-1)}(k)\left[\sum_{j\epsilon S} Y_{jt}(k) \Big/ \sum_{j\epsilon S} Y_{j(t-1)}(k)\right]$$

This estimator is identical in form to that of Method 1; however, a survey respondent that fails to respond to, say item k may respond to item ℓ and therefore has an opportunity to be included in the screened sums ratio for item k.

$$\text{Method 6 - } \hat{Y}_{6it}(k) = Y_{i(t-1)}(k)\left[\frac{Y_{it}(\ell)}{Y_{i(t-1)}(\ell)}\right]\left[\frac{\sum_{j\epsilon S} Y_{jt}(k)}{\sum_{j\epsilon S} Y_{j(t-1)}(k)} \Big/ \frac{\sum_{j\epsilon S} Y_{jt}(\ell)}{\sum_{j\epsilon S} Y_{j(t-1)}(\ell)}\right].$$

For this estimator the adjustment to $Y_{i(t-1)}$ takes the form of a double ratio, it is the product of the current-to-previous period ratio for item ℓ and an estimate of the ratio of the current-to-previous period change ratios for items k and ℓ.

In view of the similarities between the six estimators given above, our look at the primary statistical properties of the current imputation methods was restricted to the most frequently used technique, Method 1 (Method 5 for partial respondents).

The linear model that best describes the screened sums estimator for establishment-level nonresponse is:

$$Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it};\ \varepsilon_{it} \sim (0, Y_{i(t-1)}\sigma^2) \qquad (2.1.1)$$

The regression coefficient is given by β_1 and ε_{it} denotes the associated error term. Equation (2.1.1) leads to the transformed model

$$Y_{it} \Big/ Y_{i(t-1)}^{1/2} = \beta_1 Y_{i(t-1)}^{1/2} + \varepsilon_{it} \Big/ Y_{i(t-1)}^{1/2};\ Y_{i(t-1)} \neq 0$$

and

$$\varepsilon_{it} \Big/ Y_{i(t-1)}^{1/2} \sim (0, \sigma^2)$$

Assume a sample of size n from a population of size N for which there are r respondents and n-r nonrespondents to a survey item. Then the estimate corresponding to the least squares estimate of Y_{it} under the model given in (2.1.1) is

$$\hat{Y}_{it} = b_1\, Y_{i(t-1)},$$

where $b_1 = \dfrac{\sum_{j\in P} Y_{jt}}{\sum_{j\in P} Y_{j(t-1)}}$ and P represents the set of survey respondents for a given item. This is essentially the screened sums estimator.

Let's consider the bias of $\hat{Y}_{1it}(k)$. Given knowledge of the previous period estimate or value for a given item, the bias of $\hat{Y}_{1it}(k)$ can be expressed as

$$B(\hat{Y}_{1it}(k)) = Y_{i(t-1)}(k)\, E\,(\hat{R}(k)) - Y_{it}(k),$$

where $\hat{R}(k)$ is the screened sums ratio for the kth item. Now if we let $R'(k)$ represent the value of the screened sums ratio if the imputes in the denominator (from the previous reporting period) are replaced by their true values, and let $R_i(k)$ denote the "true" change ratio for establishment i, $B(\hat{Y}_{1it}(k))$ can then be further decomposed as follows.

$$\begin{aligned} B(\hat{Y}_{1it}(k)) &= Y_{i(t-1)}(k)\left[E\ \hat{R}(k) - R_i(k)\right] \\ &= Y_{i(t-1)}(k)\left\{E\left[\hat{R}(k) - R'(k)\right]\right. \\ &\quad \left. + \left[E\,(R'(k)) - R_i(k)\right]\right\} \end{aligned} \tag{2.1.2}$$

Therefore $\hat{Y}_{1it}$ is generally a biased estimator and the magnitude of the bias depends on how well the basic assumptions of the imputation approach are met. As shown in (2.1.2), the first component of the bias is a function of the mean of the difference between the "true" screened sums ratio for a given response pattern, and the corresponding survey estimate of this ratio, which may include a number of imputes. The second component is a multiple of the difference between the mean (over all possible response patterns) of the true screened sums ratio and the true change ratio for establishment i. From this we concluded that a small imputation rate (the percentage of the item total ascribed to imputed data) for the previous reporting period or for those establishments included in the screened sums ratio, coupled with limited variability among the establishments, would ensure that the bias of the current imputation procedure is small.

The samples for most of the CIR surveys are intended to include the entire target population. Therefore our discussion of variability in survey estimates will relate to those surveys. For such surveys we have essentially no sampling variation; however, we have what can be referred to as "imputation variance" relating to the possibility of different response/nonresponse

patterns for the surveys and the mechanism that determines what establishments are included in the screened sums ratio. In order to develop some sense of the nature of the imputation variance of CIR estimates, we present below an expression based on assumptions consistent with those used in determining sampling variability under simple random sampling. The current CIR estimators for an item total for a given establishment can be shown to conform to the expressions for either a ratio or a double ratio estimator of a mean. Under the assumption that the nonresponding CIR establishments are missing at random,

$$\text{Var}\,[\hat{Y}_{1it}(k)] \doteq \frac{(N-r)}{Nr}\,[Y_{i(t-1)}(k)\;\hat{R}(k)]^2\left[\frac{S_{tk}^2}{\tilde{Y}_{tk}^{\,2}} + \frac{S_{(t-1)k}^2}{\tilde{Y}_{(t-1)k}^{\,2}} - \frac{2\,R_{12}S_{tk}\,S_{(t-1)k}}{\tilde{Y}_{tk}\,\tilde{Y}_{(t-1)k}}\right] \qquad (2.1.3)$$

where N and r are the size of the target population and the number of survey respondents; $\tilde{Y}_{tk}$ and $\tilde{Y}_{(t-1)k}$ are the current and previous reporting period screened sums totals for the kth item (or the two items involved in an inter-item ratio); S_{tk} and $S_{(t-1)k}$ are the corresponding standard deviations; and R_{12} is the correlation coefficient for the two variables. Therefore under the implicit general assumptions of the current CIR imputation procedures, (2.1.3) suggests that the variability of the survey estimates could be quite dependent on the quality and behavior of the screened sums adjustment.

2.2 General Utility

The concept of general utility for imputation techniques stemming from the imputation research went beyond considering the application of the techniques to different survey items and survey diversity; it also included the sensitivity of the procedures to changes in general survey conditions over

time. For example, if there is a major change in the distribution of a survey characteristic among the survey respondents or a change in the overall level of imputation, how does this affect the effectiveness of the designated methods of imputation?

As can be noted from Table 2.1-2.3 and Figures 1.1-2.4 of Appendix B, imputation rates for a survey item can be quite different for different years and for different reporting periods within a given year. Moreover, different items of a specific survey behave quite differently relative to imputation rates, and as will be observed in section 3, there is considerable variation in the statistical models to which the various items are fitted. Therefore the empirical results from the 12 surveys included in the imputation study suggest that the optimal fit of survey data could require the use of several different imputation techniques to account for different items and changes in the items over time. Specifically, the utility of the screened sums imputation approach was limited in some cases, particularly for some of the quarterly surveys. More appropriate procedures have been recommended for those situations. However in general, for the selected items, the differences between item totals based on the models which achieved the best fits and the models that are recommended were insignificant. We again note that this conclusion is based on no more than four items for each of the 12 surveys studied, which were examined for a period of three to five years. Nevertheless we believe the results adequately reflect the potential for the suggested imputation procedures for other items, surveys and reporting periods.

2.3 Plausibility

The effectiveness of the current CIR procedures is largely dependent on the application of aggregate level inter-item relationships and items' rates

of change to the establishment level. Moreover important assumptions that undergird the procedures can be violated by various patterns of nonresponse and the consequential imputes.

If within reporting periods the variability of the establishment's contribution to specific item totals is small, the contributions of the responding establishments to estimates of period-to-period change will be similar. Under that assumption the screened sums ratio adjustment should be reasonably accurate.

We observed between establishment variation in the survey estimates for all three types of reporting periods, and often found that the variability was considerable. Table 2.4 provides examples of this result. It gives the 1984 coefficients of variation (CV's) between the establishments for a selected set of items from monthly surveys. For a given item the CV is defined as the ratio of the square root of the variance between the establishments to the mean estimate over the establishments. Note that all of the CV's are quite large; they range from a low of 0.932 in March for item 11112 of the Iron and Steel Castings Survey, to a high of 6.907 in September for item 1202 of the Finished Fabrics Survey. Therefore an initial concern regarding the plausibility of the current imputation procedures, was that the size of the observed between establishment variability in the estimates for the five selected surveys could easily occasion unacceptable biases in the survey estimates.

Finally recall that the currently-used approaches to CIR imputation assumes considerable similarity of the distribution of survey items among the responding and nonresponding items. Our preliminary review of 1982-84 data from the Flour Milling Survey (2001) indicated that the imputes for the nonrespondents in the survey tended to be smaller than the corresponding

reported data for the other establishments. However, this pattern did not persist over the other surveys that were examined, nor were we able to identify other characteristics that drew a distinction between survey respondents and nonrespondents for these surveys.

Thus, relative to the appropriateness of assuming similar characteristics for responding and nonresponding establishments, our results suggested that this assumption was not a major drawback of the screened sums approach or to the development of other imputation models.

2.4 Procedural Complexity

Based on the description of the existing CIR imputation methodology and our perception of its implications, we considered it a relatively simplistic approach, irrespective of its many facets. In general we found little reason to be concerned about the level of the complexity of the techniques; however, we were apprehensive about the capability of the imputation process to develop a sufficiently detailed history of the data that could facilitate the monitoring and evaluation of the adjustment procedures. In addition we thought that the procedure was deficient in its ability to utilize late reported data. Although such data may not have been included in current period estimates, it is desirable to have imputation methods that will include these data on computer files and ensure that they are available for use in imputation during the next reporting period.

The evaluation results that have been discussed are obviously less than definitive. In addition to their conformity to an intuitive sense about the data, there is some statistical justification for the currently-used CIR imputation procedures. The relevant concern is still the effect of deviation from the basic assumptions of the underlying models. The other empirical

results of the evaluation of the current imputation techniques will be presented in the next section with those of alternative approaches.

3. Detailed Results and Recommendations

To supplement our efforts to evaluate the current CIR imputation methodology and to identify acceptable alternatives, we attempted to fit data from the 12 selected surveys to known statistical models and proceeded with the adaptation of these models or the development of others based on the initial results. We produced and reviewed extensive summary statistics and graphical representations based on data from the 1979-84 CIR historical data files of the selected surveys. This section will identify the "reasonable" alternatives that resulted from this process and present specific recommendations for the CIR imputation process, based on the complete set of results from the imputation study.

3.1 Model Selection

Efforts were made to ensure that the recommended CIR imputation procedures have desirable statistical properties and rather general applicability. In addition, we believed that the level of complexity associated with the implementation of the procedures should also be included among the principal criteria that are used to evaluate various techniques. With this in mind we sought desirable imputation alternatives that would (1) take advantage of perceived functional relationships between reporting periods; and (2) assume an ignorable response mechanism, i.e. the nonrespondents would be considered missing at random.

In determining the more plausible imputation options, regression analysis techniques were used to identify the strength of the functional relationships and to assess the quality of the fits of the corresponding models. Prescribed regression procedures were performed for a set of proposed models, and the

following are the models associated with what was considered the more desirable imputation procedures among those considered.

Model Alternatives for Monthly Surveys

Model MS 1: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, \sigma^2)$

Model MS 2: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, Y_{i(t-1)}\sigma^2)$

Model Alternatives for Quarterly Surveys

Model QS 1: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$; $\varepsilon_{it} \sim (0, \sigma^2)$

Model QS 2: $Y_{it} = \beta_4 Y_{i(t-4)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, \sigma^2)$

Model QS 3: $Y_{it} = \beta_1 Y_{i(t-1)} + \beta_4 Y_{i(t-4)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, \sigma^2)$

Model QS 4: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, Y_{i(t-1)}\sigma^2)$

Model QS 5: $Y_{it} = \beta_4 Y_{i(t-4)} + \varepsilon_{it}$, $\varepsilon_{it} \sim (0, Y_{i(t-4)}\sigma^2)$

Model Alternatives for Annual Surveys

Model AS 1: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$; $\varepsilon_{it} \sim (0, \sigma^2)$

Model AS 2: $Y_{it} = \beta_1 Y_{i(t-1)} + \varepsilon_{it}$; $\varepsilon_{it} \sim (0, Y_{i(t-1)}\sigma^2)$

Model AS 3: $Y_{it} = \beta_1 Y_{i(t-1)} + \beta_2 Y_{i(t-2)} + \varepsilon_{it}$

$\varepsilon_{it} \sim (0, \sigma^2)$

The definitions of the notation given earlier in the section also apply for the above expressions.

In addition to those considerations relating to statistical properties and general application, the major factors that led to the selection of the alternatives included the following:

- The basic results of the analysis of variance associated with the models;
- The relative sizes of the comparable coefficients of determination (R^2);
- The precision with which the parameters of the models could be estimated.

Models were considered acceptable if (1) the significance level relating to the regression was 0.05 or better; (2) the R^2's ($R^2 = 1 - \frac{\sum (Y_{it} - \hat{Y}_{it})^2}{\sum (Y_{it} - \bar{Y})^2}$) were at least 0.85; (3) the principal scatter and residual plots did not provide indications of "serious" violations of the model assumptions; and (4) the coefficients of variation of the estimates of the model parameters were less than 30 percent.

3.2 Discussion of Summary Results

Tables 4.1-4.11 provide 1983-84 summary statistics for the major items of the 12 surveys considered for the study and estimates of the model parameters. We should note that for the transformed models, which assumed that the variance of the error term was directly proportional to the regressor or "independent" variable, the R^2's were not completely comparable to those of other models, and the model estimates and other summary statistics must be appropriately adjusted to describe the results relating to the original models.

Summary results relating to the monthly surveys are given in Tables 4.1-4.5. We can observe indications of a number of reasonably good "fits" of the data from these results. Again the results were examined in conjunction with the review of the corresponding plots, some of which are provided in Appendix B. For models MS 1 and MS 2 we detected considerable variation in the corresponding statistics for 1983 and 1984 and for different months in the same year. This variability was very noticeable for MS 2, which we have

identified as the model that most closely resembles the principal imputation procedures used for the establishment-level imputation. The value of R^2 for the model was as low as 0.002 in June, 1984 for item 1201 of the Finished Fabrics Survey, however the corresponding value for 1983 was 0.950. In general the parameter estimates and coefficients of determination for the two models were reasonably close, which increased the importance of the data plots and other criteria used in determining the recommended procedures.

Summary results for the quarterly surveys are included in Tables 4.6 and 4.7. The data entries have been arbitrarily restricted to 1984 to help keep the number of tables included in the report to a manageable size. However the principal results are essentially applicable to data for 1980 and 1982-84.

Like the monthly surveys, one model was not appropriate for all of the quarterly surveys. However some of the models, for example QS 5, provided good fits of the data more frequently than did other models.

Notice that for Survey 2220, the simple linear models (Model QS 2) with the zero intercept and the value of the survey item one year earlier as the regressor variable performed well in 1984. Based on the summary statistics and the corresponding plots, the model would be the preferable alternative for three of the four selected items for the survey. The existing imputation procedure, represented by Model QS 4, appeared to be the most appropriate choice only for item 13041. Model QS 5 which surfaced as the more dominant model for the Sheets, Pillowcases, and Towels Survey, is closely related to Model QS 4. However the model requires the value of the response variable for the previous year to be the regressor variable, rather than the corresponding value for the preceding quarter. The other model that seemed promising for the survey was Model QS 3, which is a weighted combination of QS 1 and QS 2.

We can observe the selected summary statistics for the annual surveys in Tables 4.8-4.11. These statistics and their attending plots tend to suggest the continuation of the screened sums imputation approach for the annual surveys, which is represented by Model AS 2. It was identified as the preferred alternative (over four years) for each of the items for three of the four selected surveys. The simple linear model with the zero intercept, Model AS 1, was preferable for the Industrial Gases Survey (2802). Model AS 3, which used the survey values of the two previous years as auxiliary variables, was generally less desirable because of the level of precision for estimates of its regression coefficients.

3.2 Other Considerations for Decisions on Imputation Methodology

Although imputation techniques other than those that are currently used for the CIR's may improve the overall quality of the reported data, the improvement may not be statistically significant or the cost of the improvement may be unacceptable.

Rather crude estimates based on the data that were used for the imputation research suggest that the cost of regularly fitting the CIR data to regression models may increase the cost of the imputation process by 10-15 percent, depending on the model that's used. At this point we are not in a position to assess the effect of the increase on the total processing costs.

Tables 5.1a and 5.1b give us indications of how the two imputation alternatives for the monthly surveys compared for March and December of 1984. For most of the survey items the estimated totals for the two estimators were very close. For the two smallest surveys with the larger imputation rates, relative changes of six or seven percent for three of the four items were noted when the simple linear model estimates with the zero intercept is substituted for the screened sums adjustments during

imputation. However, none of the changes were considered statistically significant.

In Tables 5.2a-5.3d summary data from a simulation study involving the quarterly surveys are included. The respondents for surveys 2220 and 2324 were established as quasi-sampling frames from which a set of establishments was randomly selected. Imputes were developed for these establishments based on the five models proposed for the quarterly surveys, and they were combined with the corresponding reported data from the other establishment to form five separate estimates of the item totals for simulated response/nonresponse patterns. Estimates of the bias of the respective estimator were obtained by comparing the five estimates with the reported item totals. We caution that these estimates are based only on those responding establishments for which the data from previous quarters required for the specified models were available. With that limitation in mind we note the estimated relative biases ranged from 0.00 to nearly 50 percent. There did not seem to be any discernible pattern in the data other than that the estimates for the smaller survey (2324) were usually larger than the corresponding estimates within the quarter for survey 2220. There was a great deal of variation in the data over models, items and quarters. This, of course, does not facilitate the task of selecting imputation strategies.

Our coarse analysis of the computing costs for imputation alternatives and some of the empirical results for the monthly and annual surveys seem to favor continued use of the screened sums approach to CIR imputation. However, other results from the annual surveys and those from the quarterly surveys suggest the need to at least consider using other procedures for a limited number of surveys in these groups. Recommendations to that effect will follow.

4. Final Recommendations

4.1 Suggested Imputation Procedures

The various results (both theoretical and empirical) of the CIR imputation research have led us to conclude that the presently-used imputation procedures based on the screened sums adjustment are reasonably effective for many of the CIR survey situations and particularly for those of the monthly and annual surveys. If cost, data processing constraints or some other factors force the planners of surveys in the CIR series to use a uniform approach to imputation, then we would have to recommend a continuation of the current methodology. But if such constraints are not imposed, we recommend the use of the screened sums model for the monthly surveys and the application of two distinct models for both the quarterly and annual surveys. This recommendation is summarized in the table below.

Recommended Imputation Models for CIR Surveys

Survey Type	Survey Code	Recommended Model
Monthly	All monthly surveys	MS 2 (current procedure)
Quarterly	2324	QS 5
	3201	
	3411	
	3602	
	3603	
	3704	
	All other quarterly surveys	QS 2
Annual	2206	AS 1
	2305	
	2307	
	2420	
	2508	
	2601	
	2602	
	2701	
	2801	
	2802	
	2807	
	3514	
	All other annual surveys	AS 2 (current procedure)

The analytical form of the screened sums estimator has already been given. The estimator associated with Model QS 5 is of the same form but the previous quarter estimate is replaced by the value for the current quarter in the preceding year as the regressor variable. The least squares solution or estimator for Model AS 1 is

$$\hat{Y}_{it} = b_1 Y_{i(t-1)},$$

$$\text{where } b_1 = \frac{\sum_{j \in P} Y_{jt} Y_{j(t-1)}}{\sum_{j \in P} Y^2_{i(t-1)}}$$

and P is the set of responding establishments.

The recommendations are again based on the review of the regression analysis results, including the related plots; computing cost estimates; perceived computing convenience of the alternatives; various simulation results; and other empirical observations relating to the imputation options and the surveys that were considered. If drastic changes have occurred in the survey estimates or response patterns during recent reporting periods or if such changes will occur in the near future, the suggested procedures may not be appropriate. At that point the relevant aspects of the data processing for the surveys should be reevaluated relative to their effects on imputation methodology.

4.2 Other Related Suggestions

The following recommendations represent a reiteration of suggestions that surfaced repeatedly during discussions throughout the conduct of the project.

Initially we raise the question of whether there is an inordinate dependency of the CIR imputation procedures on the data editing operation. For establishments that respond to some of the survey items, but not to all of

them (item nonrespondents) the general editing procedure could produce imputes derived from various combinations of several estimators, depending on the results of the reliability testing. Although the editing procedure may produce good edits, it is not clear that the procedure could routinely lead to estimates or imputes that are at least as good as those taken directly from a determined model. We recommend that the extent to which the editing influences imputation be reassessed, and that the relationship be relaxed if it is warranted.

We also reassert the need to make better use of late reported data for imputation and in assessing the properties of proposed data adjustment methodology. These data should be readily accessible and incorporated in the surveys' historical files.

Finally we recommend recurring monitoring of the effectiveness of the imputation process and its effects on survey estimates. Routine tabulation of descriptive statistics for establishment-level measures of change, delinquent and respondent imputation rates and establishments' response status codes should probably be among those data that are reviewed and available for short term research efforts. Moreover, as we have mentioned previously, the behavior of the establishment can change considerably; and if we are able to determine how such changes influence the effectiveness of the imputation procedures during periodic reviews, we would be in a better position to detect and to compensate for unacceptable measurement errors.

5. Concluding Remarks

The constraints imposed by the number of surveys and items involved in the CIR series did not permit a very comprehensive study of alternative imputation procedures. Therefore our findings are, and we would hope, understandably general; we have alluded to some of their limitations.

Nevertheless we believe that we have gained considerable insight into the effectiveness of the current imputation techniques and of other imputation options and how those alternatives compared. We believe that the final recommendations should improve the imputation process, but more narrowly-focused research in this area is certainly warranted.

Detailed research proposals for some of this work will follow subsequently. However as an example of needed research we suggest that modified weighting procedures for the larger surveys can be explored further. In addition we should consider developing procedures that are more appropriate for the small surveys which experience frequent change and have "large" imputation rates. The suggested procedures may work fairly well for many of these surveys, but there are obviously a number of situations where the predicted values are of poor quality in deference to the more general utility of the suggested procedure. As another example, the researchers should work more closely with survey analysts in search of some explanations for some of the phenomena and disparities encountered in the research data, so as to enhance their proposals and sharpen the direction of the research.

We have concluded a phase of an investigation that should be part of a recurring effort and we hope that appropriate research activities will be developed to ensure that the effects of missing data are adequately assessed and considered in the estimation process.

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Appendix A - Summary Data Tables

Table 1a. Principal Items for Selected Monthly Surveys

Survey Code	Item	Description
2001	2120	Flour Milling: Wheat - Flour Manufactured
	2130	Flour Milling: Wheat - Millfeed Produced
2202	1201	Cotton Whites
	1202	Cotton Plain Dyes
2806	2001	Architectural Coatings - Quantity of Shipments
	2002	Architectural Coatings - Value of Shipments
3207	11101	Narrow Neck-Food, Net Packed Weight
	11903	Narrow Neck Beverage Refillable Production
3301	11111	Gray Iron Castings Molds - Shipments for Sale
	11112	Shipment for Own Use

Table 1b. Principal Items for Selected Quarterly Surveys

Survey Code	Item	Description
2220	13011	Consumption of 100% Carded Cotton Yarns
	13021	Consumption of 100% Carded Cotton Yarns
	13031	Consumption of 100% Filament Rayon Acetate, and Triacetate Yarns
	13041	Consumption of 100% Filament Polyester Yarns
2324	13011	Sheets, Total - Production
	13012	Sheets, Total - Quantity
	13013	Sheets, Total - Value
	13111	Flat Sheets - Production
3603	10101	Uncorrected Power Factor Type: Rapid Start - Quantity of Shipments
	10102	Uncorrected Power Factor Type: Rapid Start - Value of Shipments
	10103	Uncorrected Power Factor Type: Rapid Start - Produced and Consumed in Plant
	10104	Uncorrected Power Factor Type: Switch Start - Quantity of Shipments

Table 1c. Principal Items for Selected Annual Surveys

Survey Code	Item	Description
2304	31200	All Leather - Total Quantity Shipped
	31210	All Leather - Total Net Value of Shipments
	33200	All Fabric - Total Quantity Shipped
	33210	All Fabric - Total Net Value of Shipments
2802	44141	Oxygen Produced for Pipeline Shipment - Quantity Produced
	44142	Oxygen Produced for Pipeline Shipment - Quantity of Shipments
	44143	Oxygen Produced for Pipeline Shipment - Value of Shipments
	44251	Oxygen Produced for Bulk Shipment to Pipelines or to Other Air Separation Plants - Quantity Produced
3002	13121	Rubber Hose, Mandrel Made and All Hydraulic - Textile Hydraulic--Production
	16631	Types of Construction Not Elsewhere Classified - Production
	16632	Types of Construction Not Elsewhere Classified - Total Shipments (Quantity)
	16633	Types of Construction Not Elsewhere Classified - Total Shipments (Value)
3611	31291	Special Purpose Switches (Excluding Dimmers), Automotive Types - Quantity
	31292	Special Purpose Switches (Excluding Dimmers), Automotive Types - Value
	41122	Pole and Transmission Line Construction Materials - Value of Shipments
	42291	Electric Metallic Tubing - Quantity

Table 2.1a Monthly Imputation Rates (%)
for Selected Monthly CIR Survey Items - 1982

Survey and Item Codes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	N
Flour Milling (2001)													
2120	4.786	5.184	4.873	9.294	5.423	6.492	5.729	5.877	6.433	6.474	6.204	7.377	182
2130	8.059	4.920	5.202	9.344	5.161	6.335	6.522	6.284	6.326	6.299	6.083	6.534	183
Finished Fabrics (2202)													
1201	15.258	25.198	25.478	15.839	32.352	3.023	16.442	17.255	9.325	9.112	12.449	11.620	80
1202	30.887	30.898	32.643	31.185	1.286	27.108	27.783	30.062	27.389	27.397	30.241	30.642	103
Paint, Varnish, Lacquer (2806)													
2001	6.686	0.830	5.367	21.210	2.178	11.241	2.138	36.460	36.630	38.163	42.196	48.023	174
2002	99.973	80.321	40.827	32.279	33.614	14.555	12.126	41.850	41.801	42.705	47.939	53.823	174
Glass Containers (3207)													
11101	24.759	24.908	25.075	24.948	26.954	26.959	26.937	28.747	42.210	28.621	29.318	40.949	23
11903	0.000	0.000	0.000	0.000	26.338	0.000	0.000	0.000	2.475	0.000	0.000	5.349	16
Iron and Steel Castings (3301)													
11111	4.251	4.250	4.324	4.343	4.318	4.351	4.310	3.085	3.450	3.586	4.401	3.729	25
11112	71.190	47.261	40.969	24.893	21.695	22.375	21.134	34.921	31.816	36.754	42.673	65.578	20

N - Number of establishments from which survey data were expected.

**Table 2.1b Monthly Imputation Rates (%)
for Selected Monthly CIR Survey Items - 1983**

Survey and Item Codes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	N
Flour Milling (2001)													
2120	3.869	15.831	7.211	14.789	6.684	8.540	10.625	9.498	5.884	6.458	5.045	7.620	193
2130	3.249	15.915	6.970	15.313	6.445	8.475	10.212	9.256	5.262	6.095	4.451	7.096	194
Finished Fabrics (2202)													
1201	14.829	15.458	17.578	18.851	17.829	18.344	13.733	15.038	17.421	15.671	13.031	18.718	71
1202	25.564	26.383	28.560	27.627	26.191	26.018	26.967	26.335	26.613	28.376	26.148	26.512	89
Paint, Varnish, Lacquer (2806)													
2001	11.646	6.078	38.122	19.328	25.980	9.682	36.732	9.742	10.408	8.475	36.865	36.388	211
2002	42.232	80.153	80.473	20.920	29.677	11.471	34.691	11.008	10.535	9.588	33.230	35.260	210
Glass Containers (3207)													
11101	29.245	29.186	29.390	0.000	19.291	20.101	20.277	19.808	21.396	20.062	22.434	28.965	23
11903	0.893	1.672	4.762	0.000	0.000	10.405	0.000	9.357	5.556	3.879	16.387	18.421	17
Iron and Steel Castings (3301)													
11111	3.499	3.580	3.615	3.535	2.818	27.336	23.784	3.450	3.450	3.775	3.477	3.481	21
11112	19.081	46.268	39.792	38.622	21.746	38.054	27.823	42.943	42.793	43.060	27.328	45.112	17

**Table 2.1c Monthly Imputation Rates (%)
for Selected Monthly CIR Survey Items - 1984**

Survey and Item Codes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	N
Flour Milling (2001)													
2120	6.153	6.507	5.286	5.218	7.643	8.858	6.665	7.016	6.338	6.605	5.630	12.531	202
2130	5.673	5.946	5.243	4.746	7.647	8.998	7.161	6.759	5.981	6.207	5.766	12.322	203
Finished Fabrics (2202)													
1201	17.260	14.639	14.201	15.097	14.143	7.365	12.544	13.000	7.442	17.627	16.181	22.708	73
1202	23.401	34.612	25.620	25.089	24.930	23.467	18.618	18.189	4.623	27.966	30.409	27.353	96
Paint, Varnish, Lacquer (2806)													
2001	19.196	19.725	20.157	21.012	20.058	19.871	21.994	21.798	24.499	22.083	21.499	39.902	76
2002	21.035	19.918	20.950	21.976	20.864	20.793	23.392	25.275	23.977	23.835	22.921	37.809	75
Glass Containers (3207)													
11101	20.977	20.853	21.812	22.684	38.302	37.709	42.443	33.477	32.717	23.431	29.127	30.724	26
11903	0.000	0.000	0.000	0.000	42.000	1.800	58.187	3.042	1.980	0.000	0.000	0.000	13
Iron and Steel Castings (3301)													
11111	3.259	3.254	1.854	3.368	3.372	3.421	3.233	3.233	3.324	3.573	3.689	7.620	24
11112	29.546	26.558	10.985	26.865	29.602	30.459	38.502	43.117	29.687	41.236	32.178	39.875	14

Table 2.2a Quarterly Imputation Rates (%) for Selected Quarterly CIR Survey Items - 1982

Survey and Item Codes	Quarter 1	Quarter 2	Quarter 3	Quarter 4	N
Broadwoven Fabrics (2220)					
13011	15.639	9.585	11.423	10.070	176
13021	13.241	12.815	15.537	14.389	54
13031	35.043	37.822	38.157	40.988	76
13041	10.904	43.763	44.542	45.333	118
Sheets, Pillowcases, and Towels (2324)					
13011	*	*	*	*	*
13012	*	*	*	*	*
13013	*	*	*	*	*
13111	*	*	*	*	*
Fluorescent Lamp Ballasts (3603)					
10101	0.000	0.000	0.945	0.000	10
10102	0.000	0.000	0.845	0.000	10
10201	0.000	0.000	0.124	0.000	9
10202	0.000	0.000	0.127	0.000	9

*-Data required to compute imputation rate were inaccessible.

2.2b Quarterly Imputation Rates (%) for Selected Quarterly CIR Survey Items - 1983

Survey and Item Codes	Quarter 1	Quarter 2	Quarter 3	Quarter 4	N
Broadwoven Fabrics (2220)					
13011	7.583	3.939	9.422	13.926	162
13021	13.555	4.039	14.480	15.902	47
13031	17.502	7.917	18.348	32.215	68
13041	21.096	31.013	40.247	47.113	113
Sheets, Pillowcases, and Towels (2324)					
13011	5.223	23.196	22.293	1.235	12
13012	5.691	23.699	24.516	1.361	12
13013	7.614	24.118	24.110	39.463	12
13111	0.000	0.221	19.156	39.411	13
Fluorescent Lamp Ballasts (3603)					
10101	0.000	0.000	0.000	0.000	8
10102	0.000	0.000	0.000	0.000	8
10201	0.000	0.000	0.000	0.000	7
10202	0.000	0.000	0.000	0.000	7

Table 2.2c Quarterly Imputation Rates (%) for Selected Quarterly CIR Survey Items - 1984

Survey and Item Codes	Quarter 1	Quarter 2	Quarter 3	Quarter 4	N
Broadwoven Fabrics (2220)					
13011	8.473	7.441	4.515	16.481	170
13021	14.999	14.940	17.720	20.790	54
13031	1.955	5.480	22.286	25.260	75
13041	7.512	6.618	16.158	19.926	123
Sheets, Pillowcases, and Towels (2324)					
13011	2.380	2.752	33.607	52.459	11
13012	2.778	3.030	29.007	32.432	11
13013	4.551	4.360	34.390	34.991	11
13111	1.865	1.836	7.328	23.986	20
Fluorescent Lamp Ballasts (3603)					
10101	0.000	0.000	0.011	0.008	8
10102	0.000	0.000	0.954	0.038	8
10201	0.000	0.000	0.054	0.059	7
10202	0.000	0.000	0.134	0.141	4

Table 2.3 Imputation Rates (%) for Selected Annual CIR Surveys--1982-84

Survey and Item Codes	1982	N	1983	N	1984	N
Gloves and Mittens (2304)						
31200	0.004	50	0.006	41	0.003	41
31210	0.436	49	0.007	41	0.270	41
33200	1.617	81	0.373	74	0.669	69
33210	0.000	80	0.235	73	0.586	69
Industrial Gases (2802)						
44141	0.000	98	0.000	91	0.000	88
44142	0.000	97	0.000	92	0.000	87
44143	0.000	96	0.000	91	0.089	84
44251	0.000	51	0.000	52	0.000	60
Rubber & Plastic Hose and Beltings (3002)						
13121	0.200	12	0.124	15	8.832	13
16631	2.731	13	0.119	16	0.000	15
16632	3.314	18	0.745	20	0.000	17
16633	0.872	17	0.191	21	0.000	18
Wiring Devices and Supplies (3611)						
31291	0.000	21	1.694	32	1.608	32
31292	0.000	21	2.099	32	2.033	32
41122	0.000	39	0.000	43	0.000	41
42291	0.000	15	7.664	14	0.000	15

N - Number of establishments for which survey data were expected.

Table 2.4 Coefficients of Variation (Between Establishments) in Monthly Estimates - 1984

Survey and Item Codes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flour Milling (2001)												
2120	1.041	0.999	1.049	1.011	1.054	1.076	1.063	1.061	1.103	1.043	1.032	1.089
2130	1.066	1.027	1.207	1.039	1.070	1.085	1.081	1.078	1.127	1.054	1.050	1.109
Finished Fabrics (2202)												
1201	1.962	2.068	2.043	2.042	2.093	4.174	2.004	2.165	4.068	1.984	1.984	1.992
1202	1.723	1.612	1.645	1.653	1.639	1.700	2.599	1.878	6.907	1.777	1.688	1.828
Paint, Varnish, Lacquer (2806)												
2001	1.963	1.994	2.105	1.982	1.977	2.036	1.932	1.954	1.945	1.959	2.267	1.996
2002	1.809	1.795	1.933	1.779	1.862	1.925	1.814	1.853	1.802	1.856	2.167	1.871
Glass Containers (3207)												
11101	1.622	1.509	1.636	1.568	1.609	1.738	1.540	1.562	1.554	1.704	1.534	1.714
11903	1.396	1.826	1.337	1.440	1.489	1.780	2.046	1.734	2.251	1.730	1.719	2.324
Iron and Steel Castings (3301)												
11111	1.465	1.494	1.497	1.330	1.560	1.683	1.671	1.755	1.895	1.726	2.082	2.030
11112	0.999	1.104	0.932	0.939	0.921	1.228	1.313	1.284	1.395	1.139	1.269	1.238

Table 3.1 Distribution of Survey Establishments by Imputation Frequency for the "Principal" Items of Selected Surveys

Flour Milling - Item 2120

Imputation Frequency (Number of Imputes During The Year)	Number of Establishments 1982	1983	1984
0	120	115	134
1-3	18	36	24
4-6	4	1	4
7-9	1	3	4
10-12	39	38	36
Totals	182	193	202

Finished Fabrics - Item 1201

Imputation Frequency	Number of Establishments 1982	1983	1984
0	45	44	47
1-3	5	6	4
4-6	9	0	3
7-9	1	2	2
10-12	20	19	17
Totals	80	71	73

Table 3.1 Distribution of Survey Establishments by Imputation Frequency for the "Principal" Items of Selected Surveys - Continued

Paint, Varnish, Lacquer - Item 2001

Imputation Frequency	Number of Establishments 1982	1983	1984
0	49	58	30
1-3	24	138	13
4-6	4	4	1
7-9	2	6	1
10-12	95	5	31
Totals	174	211	76

Glass Containers - Item 11101

Imputation Frequency	Number of Establishments 1982	1983	1984
0	19	16	15
1-3	3	6	5
4-6	0	0	4
7-9	0	0	1
10-12	1	1	1
Totals	23	23	26

Table 3.1 Distribution of Survey Establishments by Imputation Frequency for the "Principal" Items of Selected Surveys - Continued

Iron and Steel Castings - Item 11111

Imputation Frequency	Number of Establishments 1982	1983	1984
0	14	12	13
1-3	2	2	2
4-6	1	0	3
7-9	1	0	2
10-12	7	7	4
Totals	25	25	24

Table 4.1 Parameter Estimates and Summary Statistics for Alternative Regression Models - Flour Milling (2001)

Item 2120 - 1984

Estimates/Statistics	Feb		Mar		June	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.980	1.028	1.032	0.929	0.893	0.905
$SD(b_1)$	0.018	0.023	0.013	0.035	0.018	0.034
R^2	0.878	0.934	0.945	0.836	0.869	0.845

Item 2130 - 1984

Estimates/Statistics	Jul		Aug		Dec	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.906	0.953	1.042	1.072	0.977	0.917
$SD(b_1)$	0.023	0.082	0.038	0.179	0.020	0.024
R^2	0.800	0.504	0.618	0.211	0.871	0.928

Table 4.2 Parameter Estimates and Summary Statistics for Alternative Regression Models - Finished Fabrics (2202)

	Item 1201 - 1984					
	Feb		Mar		June	
Estimates/Statistics	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.998	0.971	1.282	1.317	1.151	2.465
$SD(b_1)$	0.032	0.047	0.030	0.411	0.581	7.465
R^2	0.939	0.905	0.965	0.192	0.005	0.002

	Item 1202 - 1984					
	Jul		Aug		Dec	
Estimates/Statistics	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.614	0.669	0.367	0.985	1.060	1.243
$SD(b_1)$	0.152	0.968	0.077	0.106	0.110	0.173
R^2	0.072	0.652	0.009	0.612	0.474	0.512

Table 4.3 Parameter Estimates and Summary Statistics for Alternative Regression Models - Paint, Varnish, and Lacquer (2806)

	Item 2001 - 1984					
	Feb		Mar		June	
Estimates/Statistics	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	1.146	1.147	1.290	1.248	1.053	1.041
$SD(b_1)$	0.035	0.046	0.431	0.047	0.024	0.027
R^2	0.950	0.942	0.942	0.946	0.971	0.973

	Item 2002 - 1984					
	Jul		Aug		Dec	
Estimates/Statistics	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.812	0.865	0.865	0.926	0.647	0.761
$SD(b_1)$	0.029	0.035	0.064	0.061	0.022	0.033
R^2	0.930	0.941	0.752	0.860	0.948	0.931

Table 4.4 Parameter Estimates and Summary Statistics for Alternative Regression Models - Glass Containers (3207)

Item 11101 - 1984

Estimates/Statistics	Feb		Mar		June	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.975	1.098	1.133	1.039	0.950	0.919
$SD(b_1)$	0.065	0.107	0.059	0.090	0.744	0.144
R^2	0.859	0.868	0.924	0.893	0.862	0.772

Item 11903 - 1984

Estimates/Statistics	Jul		Aug		Dec	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.994	1.051	0.600	0.752	2.136	1.947
$SD(b_1)$	0.229	0.410	0.095	0.274	0.366	0.654
R^2	0.525	0.552	0.705	0.600	0.687	0.689

Table 4.5 Parameter Estimates and Summary Statistics for Alternative Regression Models - Iron and Steel Castings (3301)

Item 11111 - 1984

Estimates/Statistics	Feb		Mar		June	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	1.047	1.176	1.063	1.073	0.752	0.727
$SD(b_1)$	0.142	0.218	0.039	0.080	0.078	0.097
R^2	0.607	0.726	0.961	0.932	0.773	0.837

Item 11112 - 1984

Estimates/Statistics	Jul		Aug		Dec	
	MS 1	MS 2	MS 1	MS 2	MS 1	MS 2
b_1	0.596	0.587	0.881	0.923	0.703	0.716
$SD(b_1)$	0.073	0.117	0.064	0.789	0.030	0.055
R^2	0.868	0.834	0.953	0.215	0.977	0.977

Table 4.6a Parameter Estimates and Summary Statistics for Alternative Regression Models- Broadwoven Fabrics (2220) -- Quarter 1, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.836	0.961	0.126	0.966	1.027
b_2	--	--	0.838	--	--
$SD(b_1)$	0.379	0.023	0.051	0.035	0.063
$SD(b_2)$	--	--	0.055	--	--
R^2	0.823	0.942	0.945	0.884	0.729

Item 13021

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.948	1.376	0.235	0.867	1.343
b_2	--	--	1.096	--	--
$SD(b_1)$	0.079	0.051	0.068	0.855	0.098
$SD(b_2)$	--	--	0.091	--	--
R^2	0.836	0.962	0.974	0.798	0.883

Item 13031

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.096	1.237	1.035	1.076	1.236
b_2	--	--	0.071	--	--
$SD(b_1)$	0.025	0.441	0.130	0.040	0.078
$SD(b_2)$	--	--	0.149	--	--
R^2	0.977	0.945	0.977	0.941	0.854

Item 13041

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.900	1.019	0.843	0.966	0.109
b_2	--	--	0.067	--	--
$SD(b_1)$	0.018	0.027	0.117	0.039	0.062
$SD(b_2)$	--	--	0.134	--	--
R^2	0.968	0.947	0.968	0.882	0.806

Table 4.6b Parameter Estimates and Summary Statistics for Alternative Regression Models- Broadwoven Fabrics (2220) -- Quarter 2, 1984

Item 13011

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.961	0.917	0.935	0.972	0.965
b_2	--	--	0.025	--	--
$SD(b_1)$	0.012	0.024	0.058	0.015	0.040
$SD(b_2)$	--	--	0.056	--	--
R^2	0.981	0.932	0.981	0.972	0.856

Item 13021

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.582	0.820	0.349	0.727	0.831
b_2	--	--	0.353	--	--
$SD(b_1)$	0.025	0.049	0.070	0.053	0.073
$SD(b_2)$	--	--	0.101	--	--
R^2	0.963	0.908	0.952	0.836	0.838

Item 13031

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.938	0.901	1.056	0.916	0.925
b_2	--	--	-0.223	--	--
$SD(b_1)$	0.030	0.053	0.254	0.035	0.071
$SD(b_2)$	--	--	0.276	--	--
R^2	0.937	0.864	0.902	0.923	0.791

Item 13041

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.984	0.870	1.093	0.935	0.914
b_2	--	--	-0.018	--	--
$SD(b_1)$	0.014	0.025	0.077	0.028	0.063
$SD(b_2)$	--	--	0.070	--	--
R^2	0.977	0.934	0.979	0.923	0.719

Table 4.6c Parameter Estimates and Summary Statistics for Alternative Regression Models- Broadwoven Fabrics (2220) -- Quarter 3, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.831	0.796	0.619	0.891	0.873
b_2	--	--	0.210	--	--
$SD(b_1)$	0.148	0.018	0.063	0.027	0.040
$SD(b_2)$	--	--	0.061	--	--
R^2	0.962	0.950	0.974	0.911	0.833

Item 13021

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.152	0.895	0.526	0.959	0.762
b_2	--	--	0.525	--	--
$SD(b_1)$	0.086	0.074	0.250	0.087	0.077
$SD(b_2)$	--	--	0.189	--	--
R^2	0.815	0.844	0.867	0.796	0.804

Item 13031

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.184	0.914	0.904	1.044	0.918
b_2	--	--	0.044	--	--
$SD(b_1)$	0.025	0.052	0.056	0.032	0.065
$SD(b_2)$	--	--	0.057	--	--
R^2	0.978	0.886	0.985	0.958	0.831

Item 13041

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.881	0.798	0.840	0.855	0.782
b_2	--	--	0.038	--	--
$SD(b_1)$	0.012	0.023	0.067	0.022	0.049
$SD(b_2)$	--	--	0.062	--	--
R^2	0.982	0.944	0.982	0.948	0.776

Table 4.6d Parameter Estimates and Summary Statistics for Alternative Regression Models- Broadwoven Fabrics (2220) -- Quarter 4, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.938	0.632	0.879	0.977	0.792
b_2	--	--	0.049	--	--
$SD(b_1)$	0.020	0.036	0.047	0.035	0.060
$SD(b_2)$	--	--	0.035	--	--
R^2	0.950	0.765	0.951	0.880	0.658

Item 13021

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.954	0.844	0.384	1.184	0.771
b_2	--	--	0.573	--	--
$SD(b_1)$	0.074	0.056	0.097	0.143	0.072
$SD(b_2)$	--	--	0.081	--	--
R^2	0.815	0.900	0.940	0.703	0.834

Item 13031

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.520	0.584	0.578	0.682	0.653
b_2	--	--	0.085	--	--
$SD(b_1)$	0.025	0.056	0.154	0.049	0.082
$SD(b_2)$	--	--	0.142	--	--
R^2	0.900	0.740	0.812	0.825	0.632

Item 13041

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.966	0.768	0.529	1.027	0.768
b_2	--	--	0.359	--	--
$SD(b_1)$	0.017	0.016	0.056	0.033	0.050
$SD(b_2)$	--	--	0.045	--	--
R^2	0.974	0.969	0.986	0.926	0.770

Table 4.7a Parameter Estimates and Summary Statistics for Alternative Regression Models- Sheets, Pillowcases and Towels (2324) -- Quarter 1, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.880	1.237	0.096	1.010	1.276
b_2	--	--	1.113	--	--
$SD(b_1)$	0.132	0.095	0.253	0.218	0.197
$SD(b_2)$	--	--	0.343	--	--
R^2	0.899	0.971	0.972	0.812	0.894

Item 13012

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.858	1.132	-1.155	0.952	1.179
b_2	--	--	2.549	--	--
$SD(b_1)$	0.169	0.131	0.344	0.210	0.226
$SD(b_2)$	--	--	0.428	--	--
R^2	0.837	0.937	0.983	0.805	0.845

Item 13013

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.999	1.359	-0.704	1.059	1.377
b_2	--	--	2.266	--	--
$SD(b_1)$	0.146	0.099	0.327	0.194	0.172
$SD(b_2)$	--	--	0.429	--	--
R^2	0.904	0.974	0.988	0.857	0.927

Item 13111

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.869	1.120	0.610	0.877	1.122
b_2	--	--	0.341	--	--
$SD(b_1)$	0.038	0.063	0.215	0.066	0.093
$SD(b_2)$	--	--	0.279	--	--
R^2	0.981	0.969	0.983	0.946	0.935

Table 4.7b Parameter Estimates and Summary Statistics for Alternative Regression Models- Sheets, Pillowcases and Towels (2324) -- Quarter 2, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.847	0.620	0.690	0.862	0.667
b_2	--	--	0.100	--	--
$SD(b_1)$	0.033	0.070	0.071	0.042	0.136
$SD(b_2)$	--	--	0.056	--	--
R^2	0.989	0.941	0.997	0.986	0.827

Item 13012

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.885	0.654	0.531	0.914	0.693
b_2	--	--	0.255	--	--
$SD(b_1)$	0.053	0.063	0.206	0.064	0.140
$SD(b_2)$	--	--	0.160	--	--
R^2	0.976	0.955	0.983	0.971	0.830

Item 13013

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.841	0.694	0.557	0.885	0.755
b_2	--	--	0.237	--	--
$SD(b_1)$	0.051	0.093	0.043	0.077	0.136
$SD(b_2)$	--	--	0.038	--	--
R^2	0.975	0.917	0.998	0.950	0.860

Item 13111

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.016	0.982	1.169	1.016	1.012
b_2	--	--	-0.159	--	--
$SD(b_1)$	0.020	0.099	0.095	0.025	0.135
$SD(b_2)$	--	--	0.096	--	--
R^2	0.993	0.907	0.995	0.990	0.849

Table 4.7c Parameter Estimates and Summary Statistics for Atlernative Regression Models- Sheets, Pillowcases and Towels (2324) -- Quarter 3, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.141	0.946	1.141	1.110	0.930
b_2	--	--	0.383	--	--
$SD(b_1)$	0.118	0.142	0.146	0.129	0.154
$SD(b_2)$	--	--	2.054	--	--
R^2	0.968	0.957	0.968	0.961	0.948

Item 13012

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.313	1.031	0.602	1.328	1.082
b_2	--	--	0.577	--	--
$SD(b_1)$	0.104	0.079	0.208	0.116	0.182
$SD(b_2)$	--	--	0.163	--	--
R^2	0.976	0.983	0.997	0.970	0.922

Item 13013

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	1.311	1.089	1.531	1.265	1.075
b_2	--	--	-0.182	--	--
$SD(b_1)$	0.048	0.097	0.338	0.109	0.099
$SD(b_2)$	--	--	0.283	--	--
R^2	0.995	0.977	0.998	0.971	0.975

Item 13111

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	.0904	1.010	0.715	0.869	0.993
b_2	--	--	0.216	--	--
$SD(b_1)$	0.035	0.060	0.262	0.048	0.067
$SD(b_2)$	--	--	0.294	--	--
R^2	0.986	0.972	0.986	0.970	0.965

Table 4.7d Parameter Estimates and Summary Statistics for Alternative Regression Models- Sheets, Pillowcases and Towels (2324) -- Quarter 4, 1984

Item 13011

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.365	0.381	-0.733	0.358	0.304
b_2	--	--	0.988	--	--
$SD(b_1)$	0.211	0.164	0.610	0.205	0.173
$SD(b_2)$	--	--	0.527	--	--
R^2	0.500	0.729	0.889	0.504	0.608

Item 13012

Estimates/Statistics	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.890	0.941	0.478	0.882	0.949
b_2	--	--	0.447	--	--
$SD(b_1)$	0.071	0.099	0.382	0.076	0.103
$SD(b_2)$	--	--	0.404	--	--
R^2	0.981	0.978	0.991	0.978	0.977

Item 13013

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.787	0.834	0.895	0.785	0.853
b_2	--	--	-0.124	--	--
$SD(b_1)$	0.027	0.177	0.145	0.066	0.175
$SD(b_2)$	--	--	0.160	--	--
R^2	0.996	0.917	0.998	0.979	0.922

Item 13111

Estimates/Statistics	QS 1	QS 2	QS 3	QS 4	QS 5
b_1	0.984	0.835	0.828	1.017	0.821
b_2	--	--	0.139	--	--
$SD(b_1)$	0.042	0.077	0.167	0.048	0.084
$SD(b_2)$	--	--	0.145	--	--
R^2	0.987	0.944	0.989	0.985	0.932

Table 4.8a Parameter Estimates and Summary Statistics for Alternative Regression Models - Gloves and Mittens (2304) - 1983

Item 31200

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.298	1.146	1.651
b_2	---	---	-0.253
$SD(b_1)$	0.073	0.067	0.362
$SD(b_2)$	---	---	0.280
R^2	0.900	0.892	0.894

Item 31210

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.046	1.015	2.076
b_2	---	---	-0.266
$SD(b_1)$	0.021	0.042	0.516
$SD(b_2)$	---	---	0.316
R^2	0.986	0.944	0.832

Item 33200

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.942	0.956	0.412
b_2	---	---	0.382
$SD(b_1)$	0.022	0.030	0.082
$SD(b_2)$	---	----	0.070
R^2	0.967	0.942	0.875

Item 33210

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.930	0.953	0.889
b_2	---	---	0.059
$SD(b_1)$	0.017	0.026	0.033
$SD(b_2)$	---	---	0.035
R^2	0.978	0.954	0.978

Table 4.8b Parameter Estimates and Summary Statistics for Alternative Regression Models - Gloves and Mittens (2304) - 1984

Item 31200

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.812	0.888	0.052
b_2	---	---	0.793
$SD(b_1)$	0.051	0.065	0.237
$SD(b_2)$	---	---	0.248
R^2	0.861	0.841	0.886

Item 31210

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.740	0.841	0.391
b_2	---	---	0.680
$SD(b_1)$	0.034	0.053	0.055
$SD(b_2)$	---	---	0.101
R^2	0.934	0.881	0.975

Item 33200

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.166	1.171	0.325
b_2	---	---	0.843
$SD(b_1)$	0.024	0.074	0.077
$SD(b_2)$	---	---	0.071
R^2	0.975	0.812	0.962

Item 33210

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.175	1.186	2.895
b_2	---	---	-1.725
$SD(b_1)$	0.025	0.061	0.402
$SD(b_2)$	---	---	0.380
R^2	0.974	0.867	0.883

Table 4.9a Parameter Estimates and Summary Statistics for Alternative Regression Models - Industrial Gases (2802) - 1983

	Item 44141		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.062	0.992	0.416
b_2	---	---	0.597
$SD(b_1)$	0.033	0.038	0.127
$SD(b_2)$	---	---	0.122
R^2	0.927	0.893	0.818
	Item 44142		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.062	0.992	0.421
b_2	---	---	0.572
$SD(b_1)$	0.033	0.038	0.147
$SD(b_2)$	---	---	0.141
R^2	0.927	0.893	0.792
	Item 44143		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.244	1.308	1.359
b_2	---	---	-0.296
$SD(b_1)$	1.131	0.181	0.271
$SD(b_2)$	---	---	0.297
R^2	0.539	0.404	0.454
	Item 44251		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.983	1.069	0.504
b_2	---	---	0.442

Table 4.9b Parameter Estimates and Summary Statistics for Alternative Regression Models - Industrial Gases (2802) - 1984

	Item 44141		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.005	1.118	0.770
b_2	---	---	0.085
$SD(b_1)$	0.042	0.107	0.194
$SD(b_2)$	---	---	0.231
R^2	0.887	0.599	0.611

	Item 44142		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.005	1.118	0.393
b_2	---	---	0.519
$SD(b_1)$	0.042	0.107	0.182
$SD(b_2)$	---	---	0.204
R^2	0.887	0.599	0.594

	Item 44143		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.958	1.068	0.081
b_2	---	---	0.829
$SD(b_1)$	0.041	0.062	0.076
$SD(b_2)$	---	---	0.132
R^2	0.885	0.801	0.595

	Item 44251		
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.861	0.934	0.629
b_2	---	---	0.337
$SD(b_1)$	0.063	0.182	0.224
$SD(b_2)$	---	---	0.200
R^2	0.824	0.397	0.784

Table 4.10a Parameter Estimates and Summary Statistics for Alternative Regression Models - Rubber & Plastic Hose and Beltings (3002) - 1983

Item 13121

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.285	1.347	1.418
b_2	---	---	-0.387
$SD(b_1)$	0.090	0.357	0.024
$SD(b_2)$	---	---	0.268
R^2	0.953	0.587	0.997

Item 16631

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.994	1.086	---
b_2	---	---	1.365
$SD(b_1)$	0.070	0.123	---
$SD(b_2)$	---	---	0.116
R^2	0.953	0.887	0.958

Item 16632

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.147	1.266	---
b_2	---	---	1.364
$SD(b_1)$	0.113	0.119	---
$SD(b_2)$	---	---	0.118
R^2	0.888	0.897	0.957

Item 16633

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.240	1.239	1.593
b_2	---	---	-0.133
$SD(b_1)$	0.043	0.058	0.181
$SD(b_2)$	---	---	0.196
R^2	0.984	0.970	0.995

Table 4.10b Parameter Estimates and Summary Statistics for Alternative Regression Models - Rubber & Plastic Hose and Beltings (3002) - 1984

Item 13121			
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.283	1.285	0.621
b_2	---	---	0.905
$SD(b_1)$	0.086	0.098	0.363
$SD(b_2)$	---	---	0.485
R^2	0.965	0.956	0.978

Item 16631			
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.218	1.200	2.667
b_2	---	---	-1.452
$SD(b_1)$	0.039	0.059	0.241
$SD(b_2)$	---	---	0.250
R^2	0.986	0.968	0.991

Item 16632			
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.172	1.171	1.769
b_2	---	---	-0.540
$SD(b_1)$	0.043	0.053	0.280
$SD(b_2)$	---	---	0.287
R^2	0.982	0.972	0.953

Item 16633			
Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.178	1.172	1.279
b_2	---	---	-0.125
$SD(b_1)$	0.047	0.058	0.177
$SD(b_2)$	---	---	0.237
R^2	0.976	0.964	0.980

Table 4.11a Parameter Estimates and Summary Statistics for Alternative Regression Models - Wiring Devices and Supplies (3611) - 1983

Item 31291

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.239	1.233	0.302
b_2	---	---	1.071
$SD(b_1)$	0.065	0.070	0.316
$SD(b_2)$	---	---	0.328
R^2	0.933	0.922	0.887

Item 31292

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.173	1.206	1.203
b_2	---	---	0.037
$SD(b_1)$	0.044	0.066	0.118
$SD(b_2)$	---	---	0.108
R^2	0.965	0.927	0.986

Item 41122

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	0.978	0.969	0.517
b_2	---	---	0.441
$SD(b_1)$	0.017	0.025	0.165
$SD(b_2)$	---	---	0.170
R^2	0.988	0.975	0.898

Item 42291

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.093	1.075	1.081
b_2	---	---	-0.231
$SD(b_1)$	0.028	0.045	1.295
$SD(b_2)$	---	---	1.204
R^2	0.993	0.981	0.577

Table 4.11b Parameter Estimates and Summary Statistics for Alternative Regression Models - Wiring Devices and Supplies (3611) - 1984

Item 31291

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.134	1.155	0.045
b_2	---	---	1.109
$SD(b_1)$	0.024	0.172	0.192
$SD(b_2)$	---	---	0.165
R^2	0.987	0.608	0.863

Item 31292

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.248	1.244	0.712
b_2	---	---	0.341
$SD(b_1)$	0.014	0.079	1.531
$SD(b_2)$	---	---	2.262
R^2	0.996	0.895	0.699

Item 41122

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.021	1.051	0.847
b_2	---	---	0.138
$SD(b_1)$	0.011	0.019	0.082
$SD(b_2)$	---	---	0.077
R^2	0.996	0.989	0.980

Item 42291

Estimates/Statistics	AS 1	AS 2	AS 3
b_1	1.053	1.086	1.033
b_2	---	---	0.007
$SD(b_1)$	0.045	0.050	0.038
$SD(b_2)$	---	---	0.042
R^2	0.980	0.977	0.995

Table 5.1a Comparison of Alternative Estimators for Selected Monthly Surveys - March, 1984

Survey and Item Code	Model Alternative MS 1	MS 2	Relative Change MS 1 - MS 2 / MS 2
Flour Milling			
2120	25,993	25,972	0.0008
2130	494,243	492,961	0.0026
Finished Fabrics			
1201	135,988	135,839	0.0011
1202	99,282	99,601	-0.0032
Paint, Varnish and Lacquer			
2001	30,668	30,576	0.0030
2002	223,683	221,578	0.0095
Glass Containers			
11101	264,374	261,162	0.0123
11903	No Imputation Required		
Iron and Steel Castings			
11111	90,025	90,052	-0.0003
11112	70,148	72,662	-0.0346

Table 5.1b Comparison of Alternative Estimators for Selected Monthly Survey - December, 1984

Survey and Item Code	Model Alternative MS 1	MS 2	Relative Change MS 1 - MS 2 / MS 2
Flour Milling			
2120	24,531	24,548	-0.0007
2130	439,401	439,621	-0.0005
Finished Fabrics			
1201	96,340	97,382	-0.0107
1202	74,278	74,487	-0.0028
Paint, Varnish and Lacquer			
2001	14,990	16,098	-0.0688
2002	118,185	126,754	-0.0676
Glass Containers			
11101	138,224	137,372	0.0062
11903	No Imputation Required		
Iron and Steel Castings			
11111	55,252	55,379	-0.0023
11112	24,105	25,614	-0.0589

Table 5.2a Reported and Estimated Totals for Selected Quarterly Surveys - Quarter 1, 1984

Survey 2220

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	286356	282831	291041	290517	286438	293197	130
13021	14623	15724	14648	15023	15425	14589	39
13031	41019	41045	41160	41053	41036	41174	63
13041	127875	127769	126501	127708	128465	119151	107

Survey 2324

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	123	118	118	118	118	119	8
13012	87	0	89	81	88	82	7
13013	3817	3741	3752	3756	3744	3753	8
13111	4260	4394	4274	4360	4398	4275	17

Table 5.2b Reported and Estimated Totals for Selected Quarterly Surveys - Quarter 2, 1984

Survey 2220

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	280292	281360	278450	280866	281606	279420	134
13021	10557	10467	10606	10576	10884	10630	45
13031	40121	40387	39756	40232	40329	39803	65
13041	121605	121921	118355	122809	121417	118686	107

Survey 2324

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	105	105	112	105	106	114	8
13021	96	97	101	98	97	102	8
13031	3378	3371	3330	3360	3407	3386	8
13111	4345	4381	4396	4370	4381	4404	18

Table 5.2c Reported and Estimated Totals for Selected Quarterly Surveys - Quarter 3, 1984

Survey 2220

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	265626	265316	264659	265241	266131	265687	126
13021	9966	11025	10131	10582	10555	9847	42
13031	32726	35274	34155	33014	34219	34190	53
13041	94624	97589	95072	96821	97057	94762	94

Survey 2324

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	81	79	81	92	78	80	4
13012	92	95	93	94	96	94	5
13013	2940	3006	3036	3001	2974	3025	5
13111	3503	3524	3445	3510	3503	3437	11

Table 5.2d Reported and Estimated Totals for Selected Quarterly Surveys - Quarter 4, 1984

Survey 2220

Item	Reported Total	Estimated Totals Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	266396	229289	233844	228387	230719	243702	114
13021	10949	10466	11346	11178	10830	11139	39
13031	22162	20407	20854	21177	21261	21231	49
13041	89549	92945	90685	90457	94060	90685	89

Survey 2324

Item	Reported Total	Estimated Total Model 1	Model 2	Model 3	Model 4	Model 5	N
13011	28	15	21	24	15	17	4
13012	75	71	78	75	71	78	4
13013	2261	2316	2282	2314	2315	2296	4
13111	3017	2936	2853	2931	2971	2837	8

Table 5.3a Relative Bias (%) of Estimated Totals for Items - Quarter 1, 1984

Survey 2220

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	1.23	1.64	-1.45	-0.03	-2.39	130
13021	-10.24	-2.70	-5.33	-8.15	-2.29	39
13031	-0.06	-0.34	-0.08	-0.04	-0.38	63
13041	0.08	1.07	0.13	-0.46	6.82	107

Survey 2324

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	4.07	4.07	4.07	4.07	3.25	8
13012	0.00	-2.30	6.90	-1.15	5.75	7
13013	1.99	1.70	1.60	1.91	1.68	8
13111	3.15	-0.33	-2.35	-3.24	-0.35	17

Table 5.3b Relative Bias (%) of Estimated Totals for Selected Items - Quarter 2, 1984

Survey 2220

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	-0.38	0.66	-0.20	-0.63	0.31	134
13021	0.85	-0.46	-0.18	-3.10	-0.69	45
13031	0.66	0.91	0.28	-0.52	0.79	65
13041	-0.26	2.67	0.99	0.15	2.40	107

Survey 2324

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011		-6.67		-0.95	-8.57	8
13012	-1.04	-5.21	-2.08	-1.04	-6.25	8
13013	0.21	1.42	0.53	-0.86	-0.24	8
13111	-0.83	-1.17	-0.58	-0.83	-1.36	18

Table 5.3c Relative Bias (%) of Estimated Totals for Selected Items - Quarter 3, 1984

Survey 2220

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	0.12	0.36	0.14	-0.19	-0.02	126
13021	-10.63	-1.66	-6.18	-5.91	1.19	42
13031	-7.79	-4.37	-0.88	-4.56	-4.47	53
13041	-3.04	-0.47	-2.32	-2.57	-0.15	94

Survey 2324

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	2.47		-13.58	3.70	1.23	4
13012	-3.26	-1.09	-2.17	-4.35	-2.17	5
13013	-2.24	-3.27	-2.07	-1.16	-2.89	5
13111	-0.60	1.66	-0.20	0.00	1.88	11

Table 5.3d Relative Bias (%) of Estimated Totals for Selected Items - Quarter 4, 1984

Survey 2220

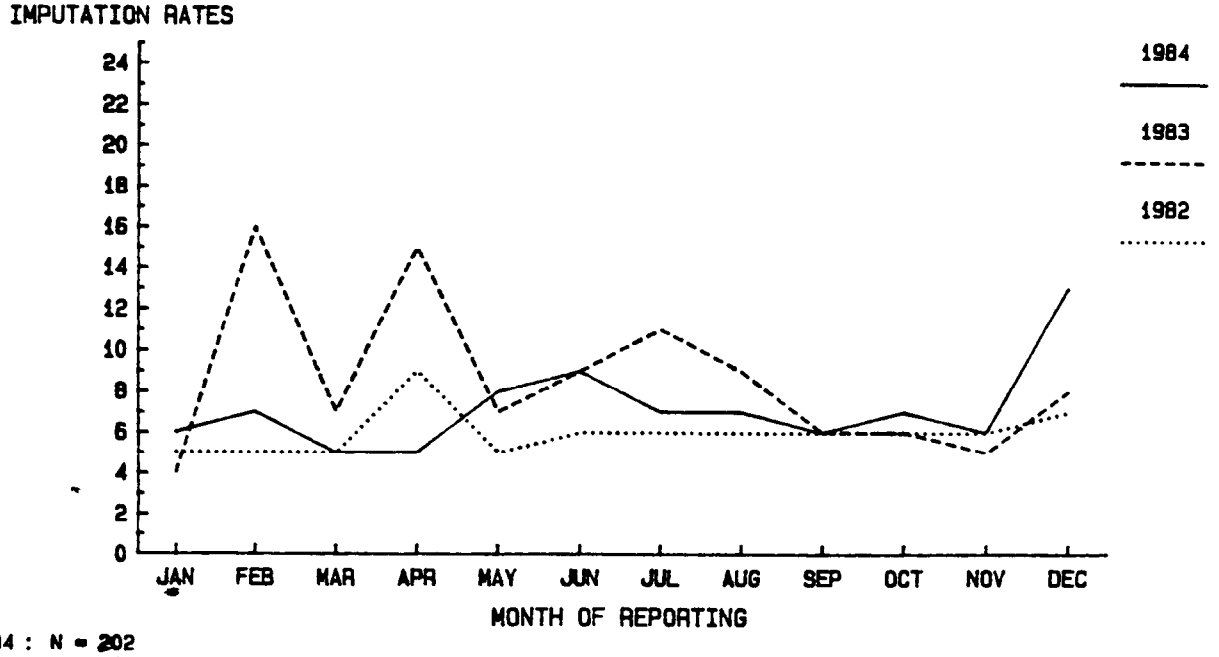
Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	-1.28	-3.29	-0.88	-1.91	-7.64	114
13021	4.41	-3.63	-2.09	1.09	-1.74	39
13031	7.92	-0.07	4.44	4.07	4.20	49
13041	-3.79	-1.27	-1.01	-5.04	1.27	89

Survey 2324

Item	Alternative Models QS 1	QS 2	QS 3	QS 4	QS 5	N
13011	46.43	25.00	14.29	46.43	39.29	4
13012	5.33	-4.00		5.33	-4.00	4
13013	-2.43	-0.93	-2.34	-2.39	-1.55	4
13111	2.68	5.44	2.85	1.52	5.97	8

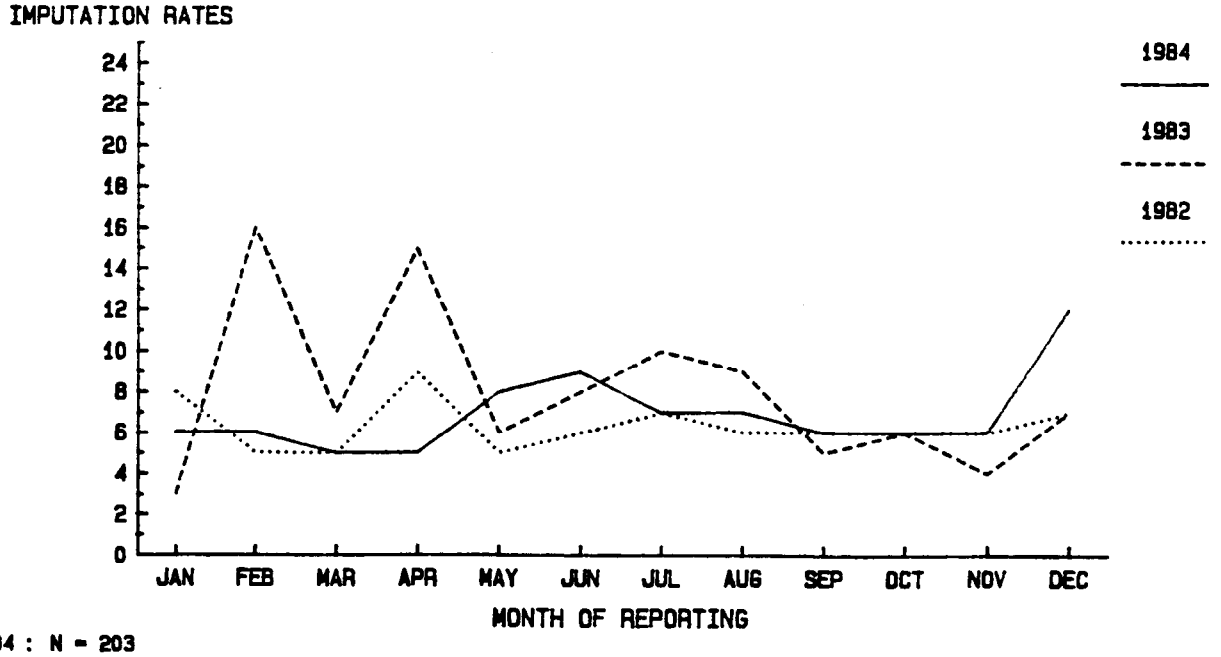
Appendix B - Data Plots

SURVEY 2001 AND ITEM 2120



1984 : N = 202
1983 : N = 193
1982 : N = 182

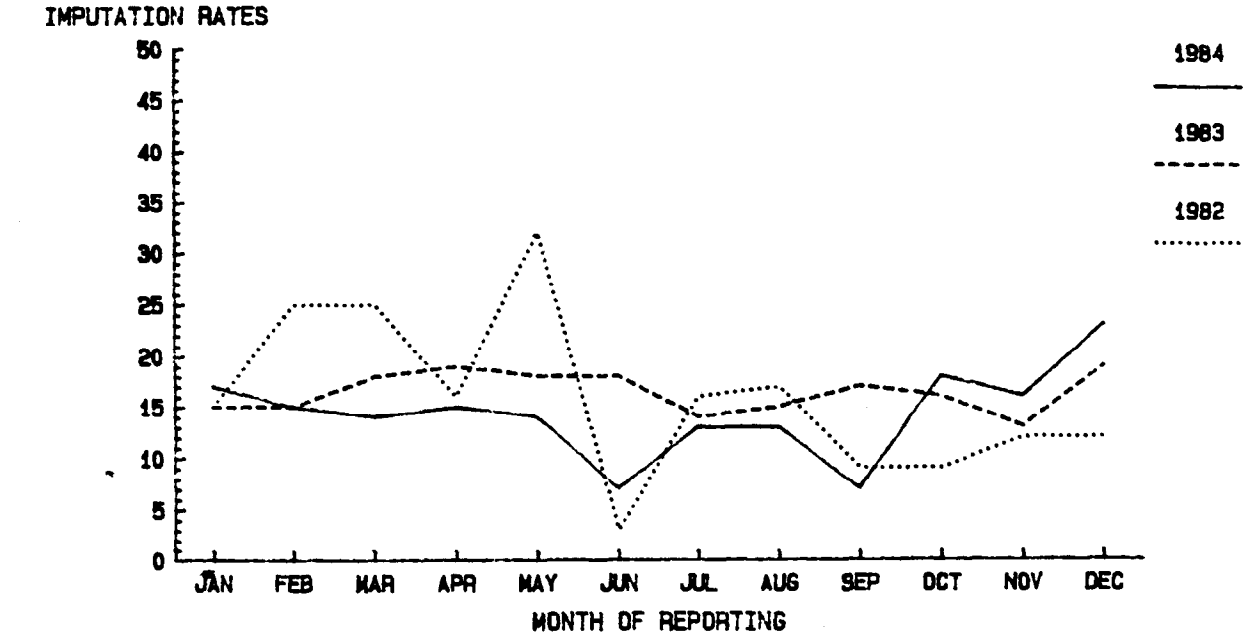
SURVEY 2001 AND ITEM 2130



1984 : N = 203
1983 : N = 194
1982 : N = 183

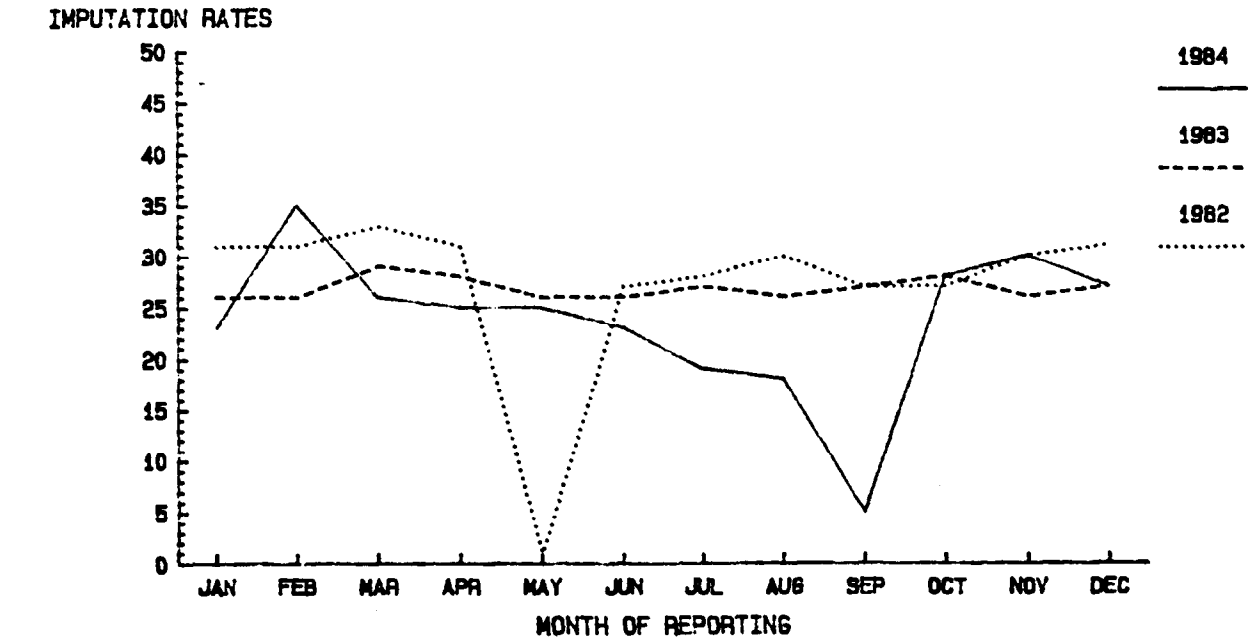
Figure 1.1 Imputation Rates (%)
For Selected Monthly CIR
Survey Items--1982-84

SURVEY 2202 AND ITEM 1201



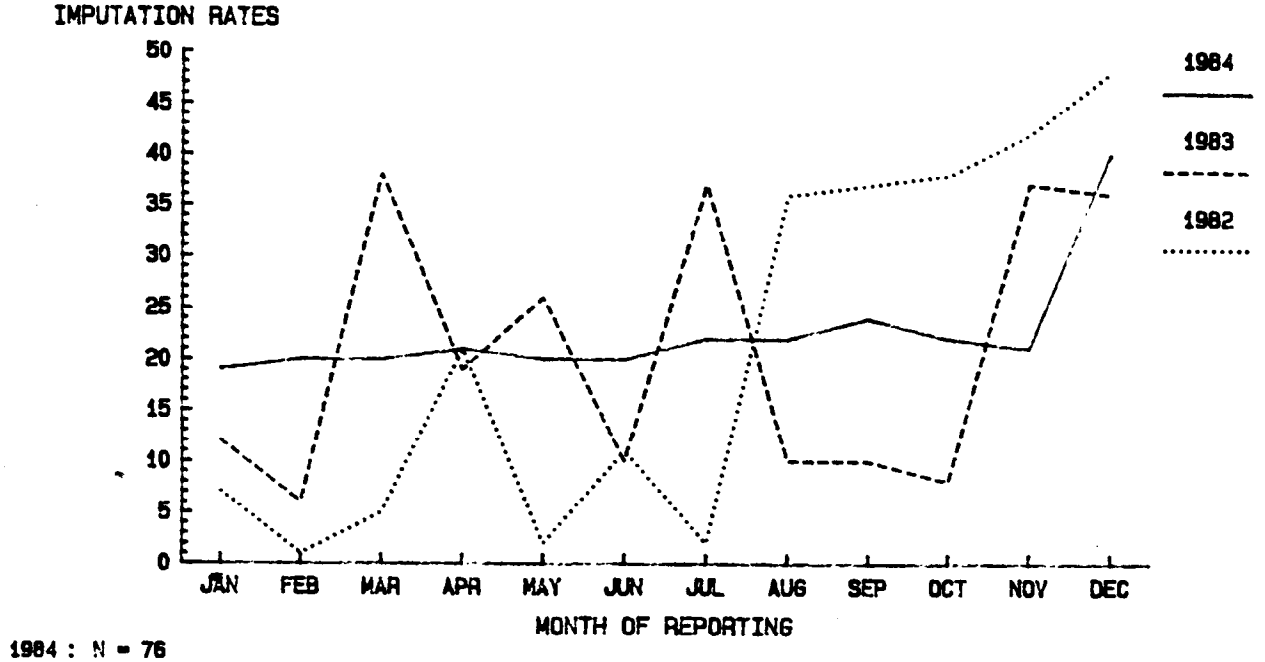
1984 : N = 73
1983 : N = 71
1982 : N = 80

SURVEY 2202 AND ITEM 1202



1984 : N = 96
1983 : N = 89
1982 : N = 103

Figure 1.2 Imputation Rates (%)
For Selected Monthly CIR
Survey Items--1982-84



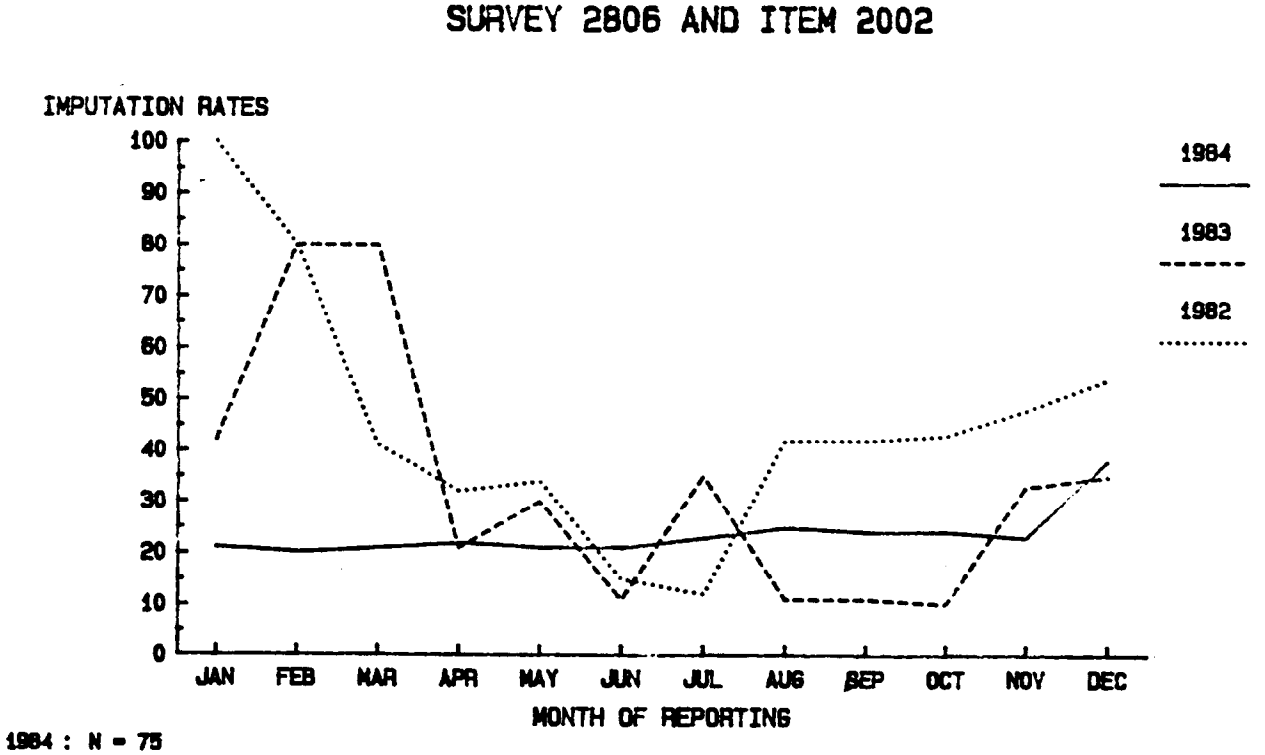
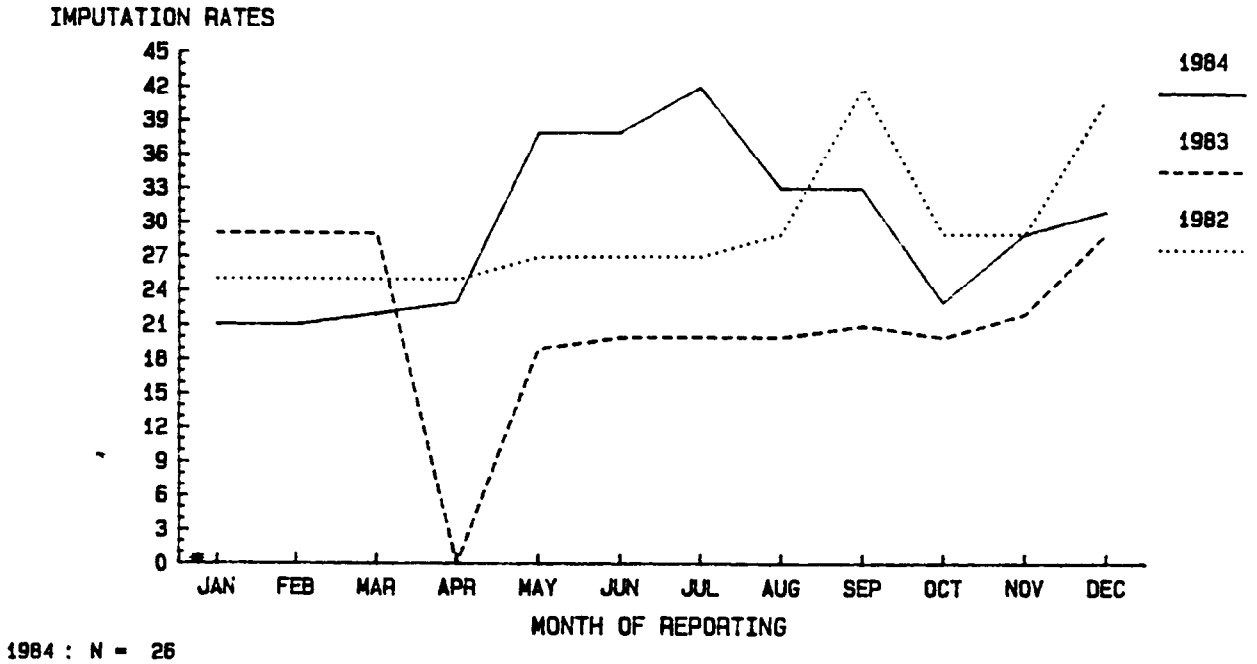


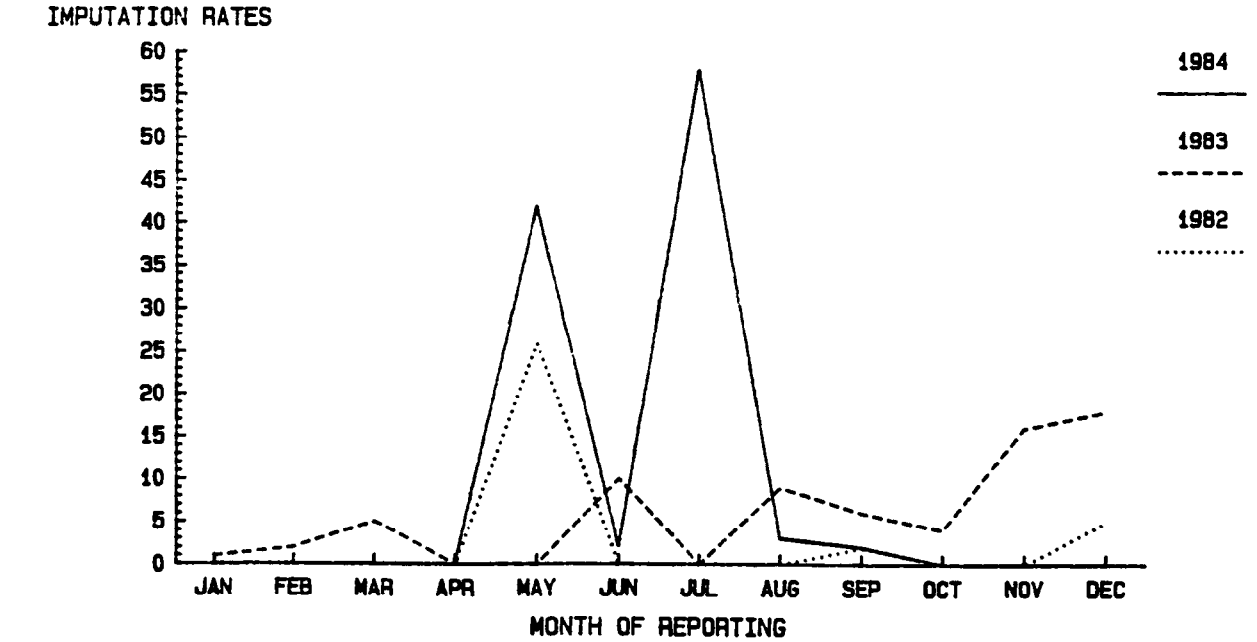
Figure 1.3 Imputation Rates (%)
For Selected Monthly CIR
Survey Items--1982-84

SURVEY 3207 AND ITEM 11101



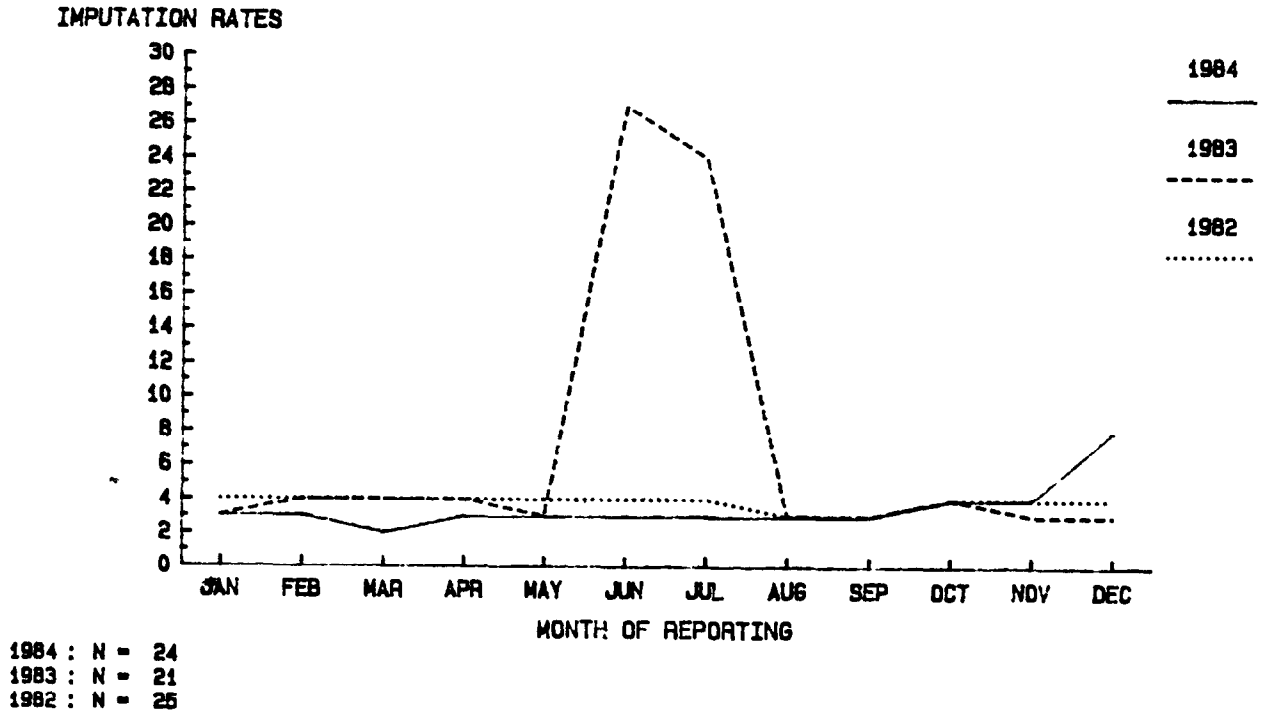
1984 : N = 26
1983 : N = 23
1982 : N = 21

SURVEY 3207 AND ITEM 11903



1984 : N = 13
1983 : N = 17
1982 : N = 16

Figure 1.4 Imputation Rates (%)
For Selected Monthly CIR
Survey Items--1982-84



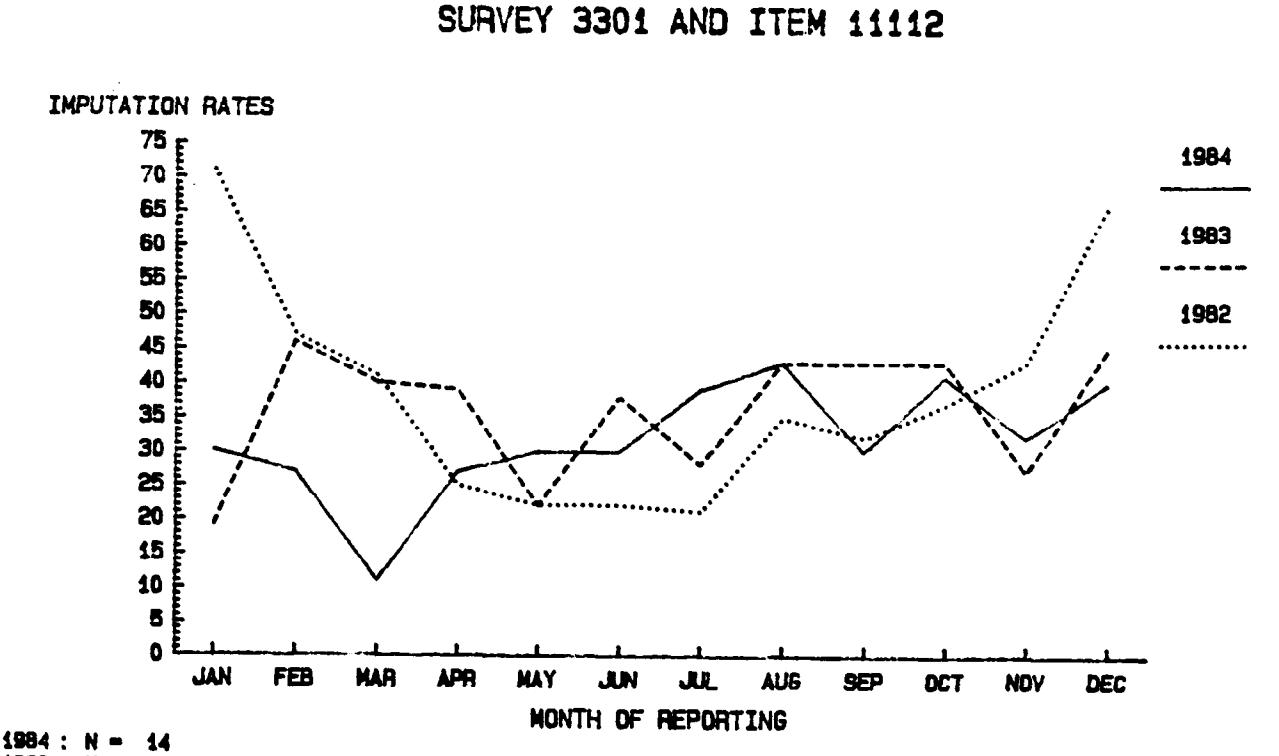
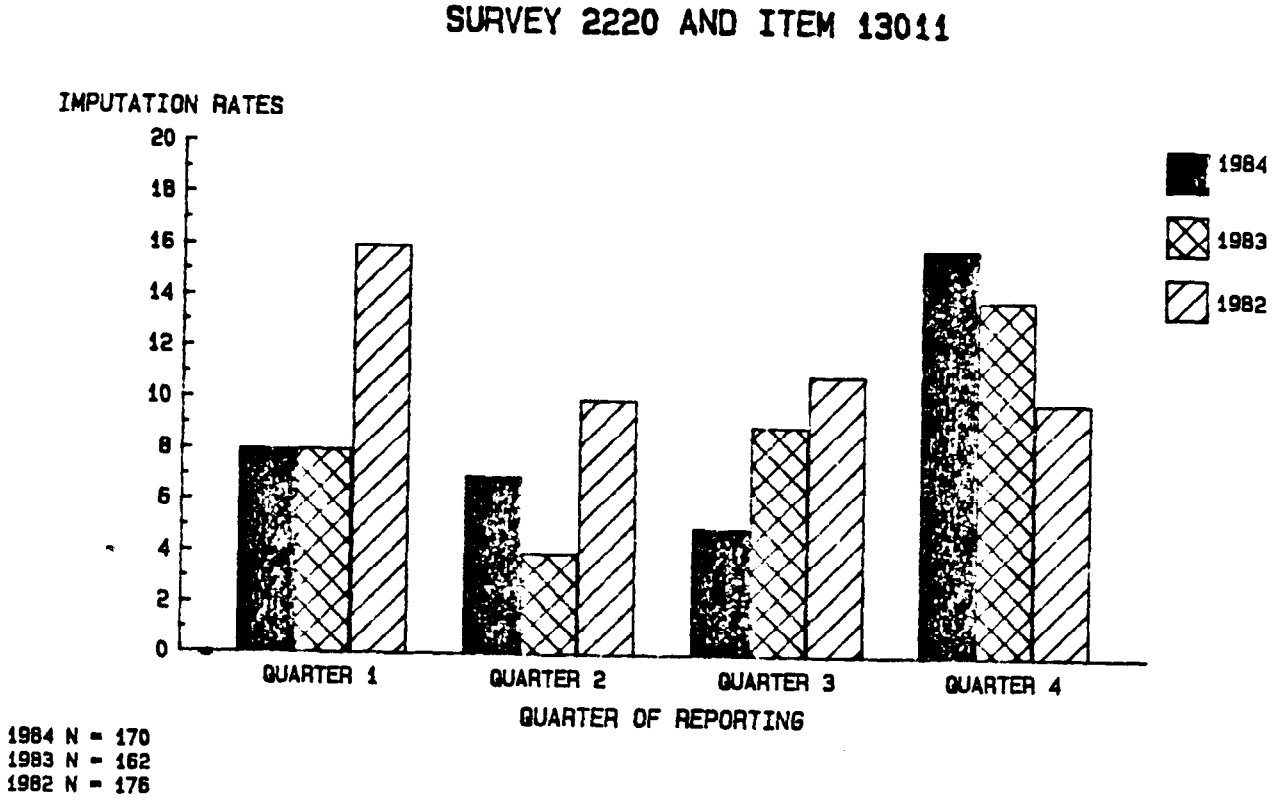


Figure 1.5 Imputation Rates (%)
For Selected Monthly CIR
Survey Items--1982-84



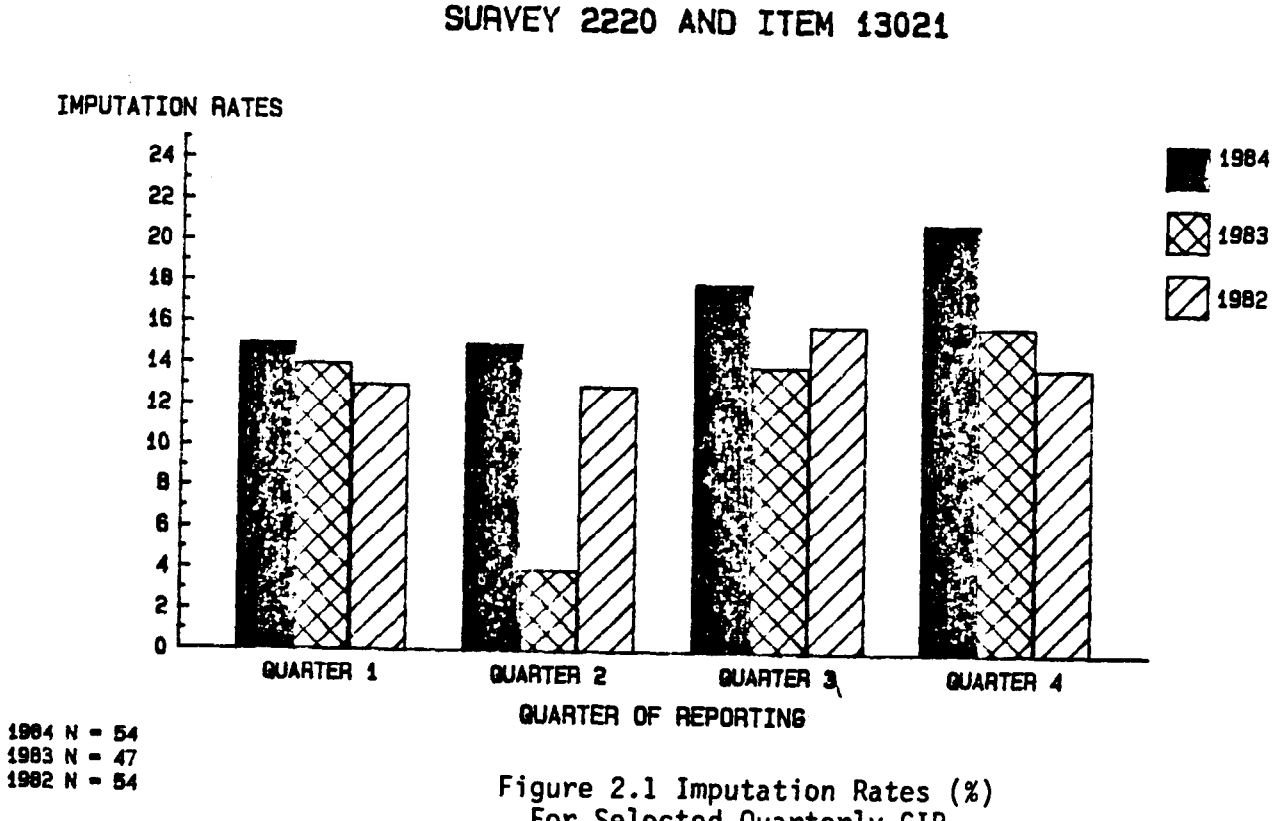
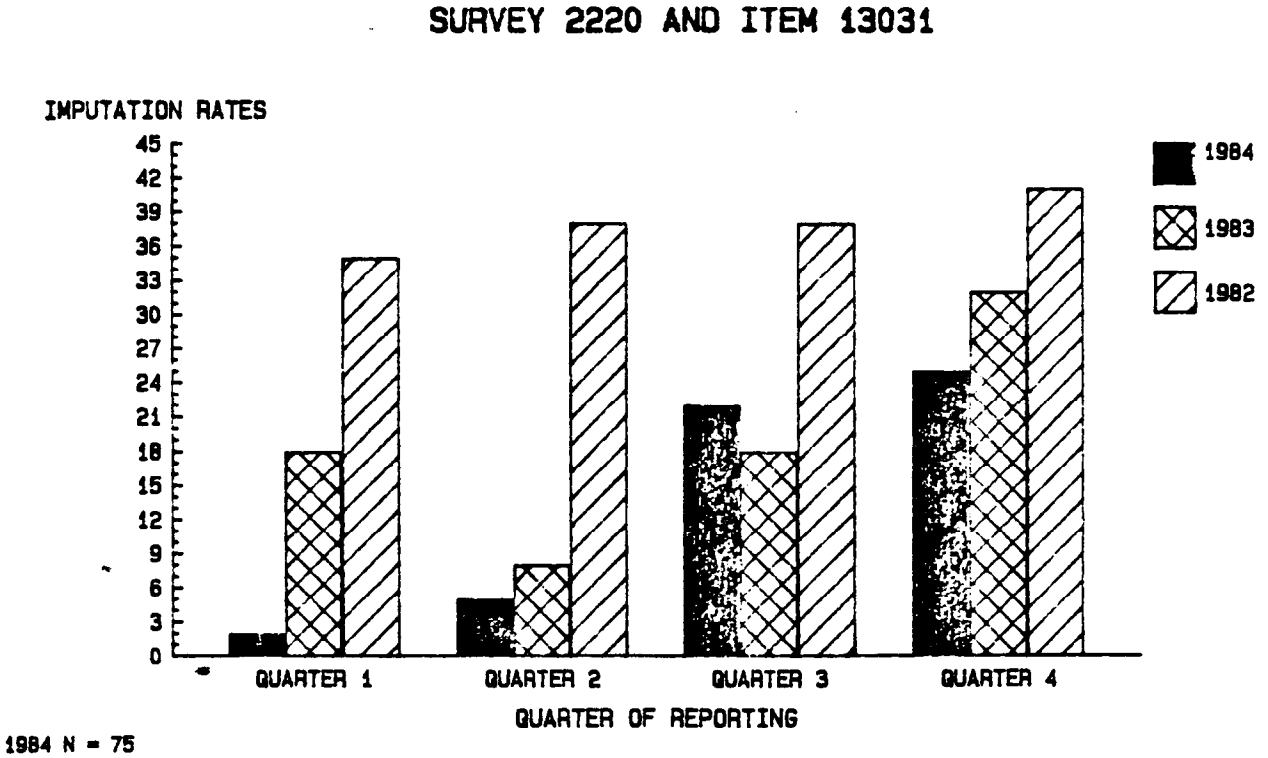


Figure 2.1 Imputation Rates (%)
For Selected Quarterly CIR
Survey Items--1982-84



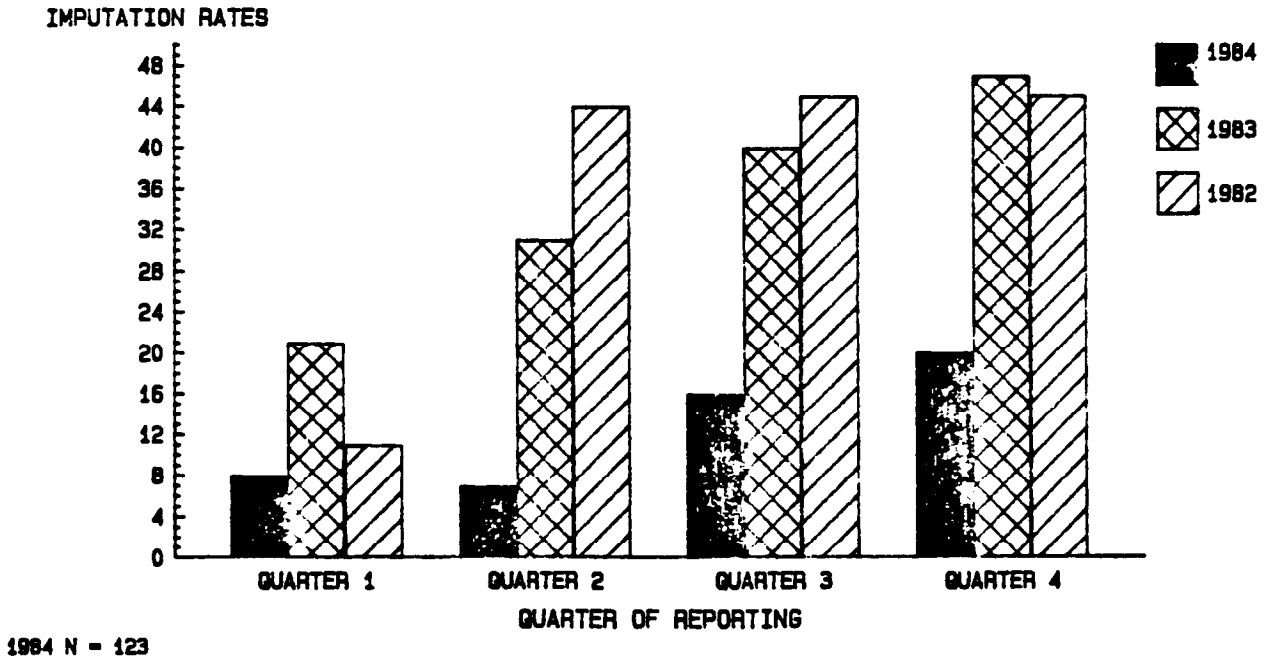
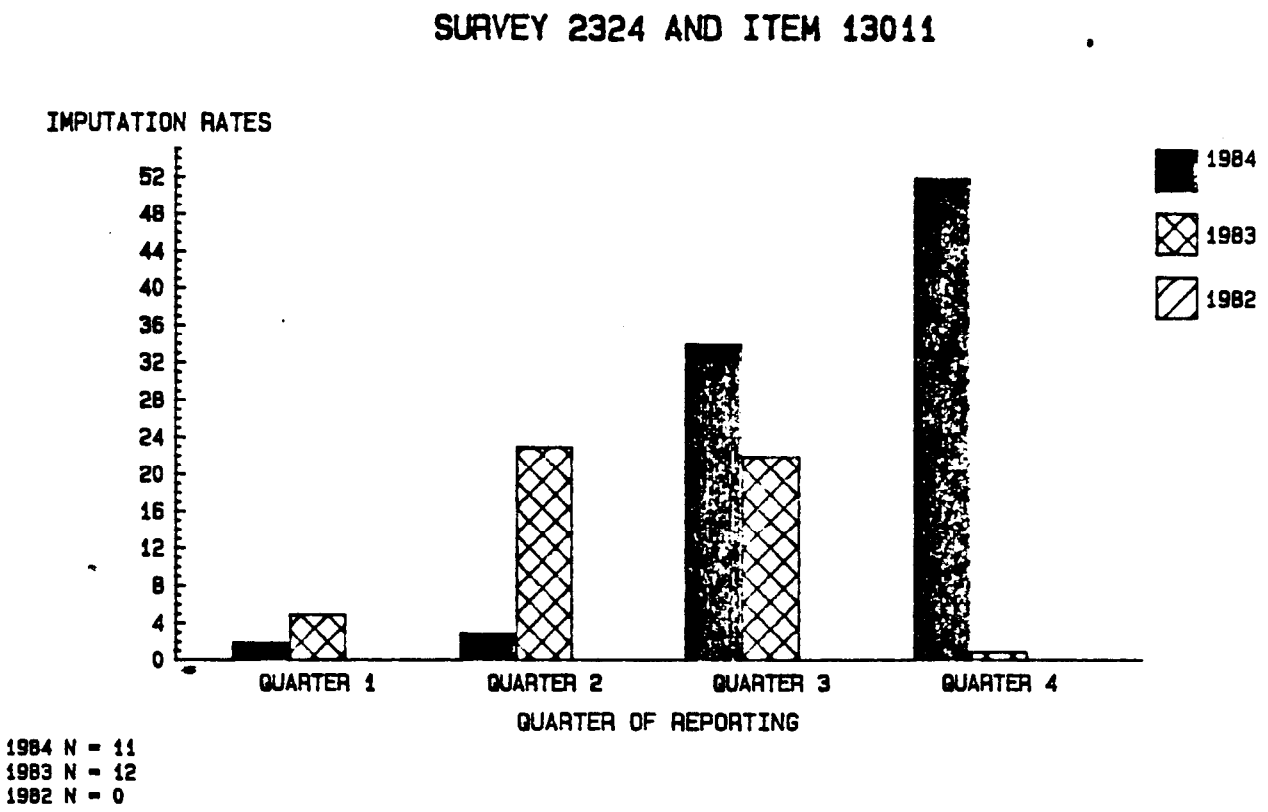


Figure 2.2 Imputation Rates (%)
For Selected Quarterly CIR
Survey Items--1982-84



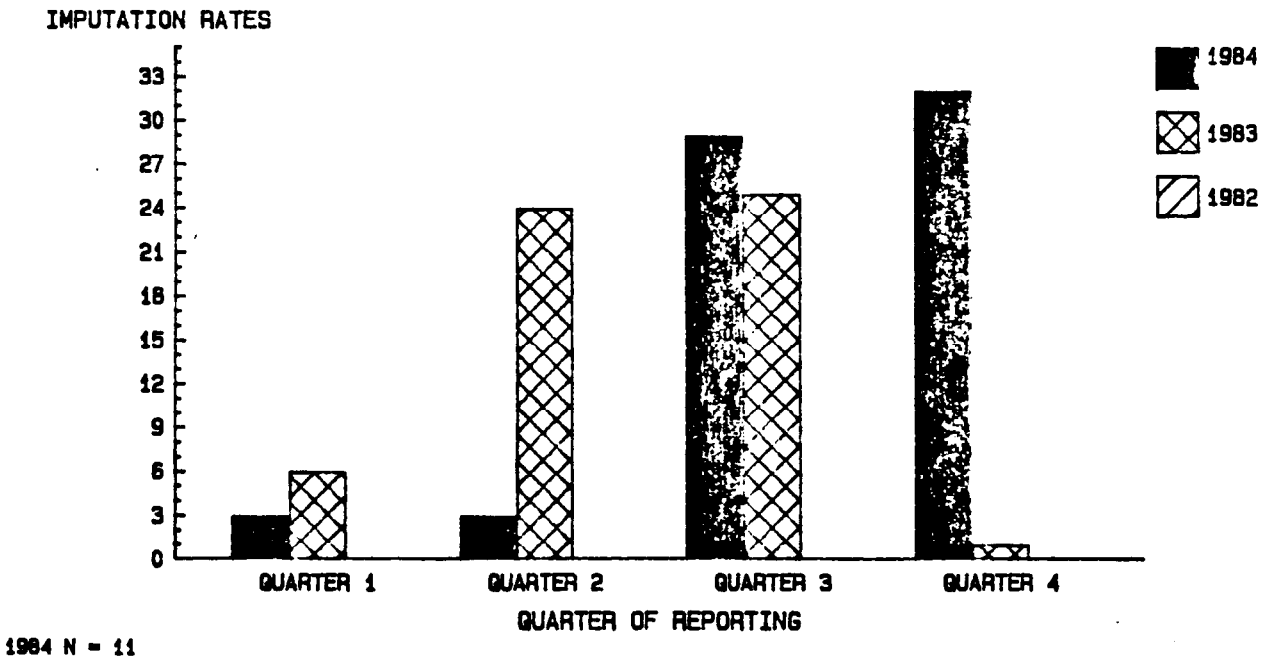
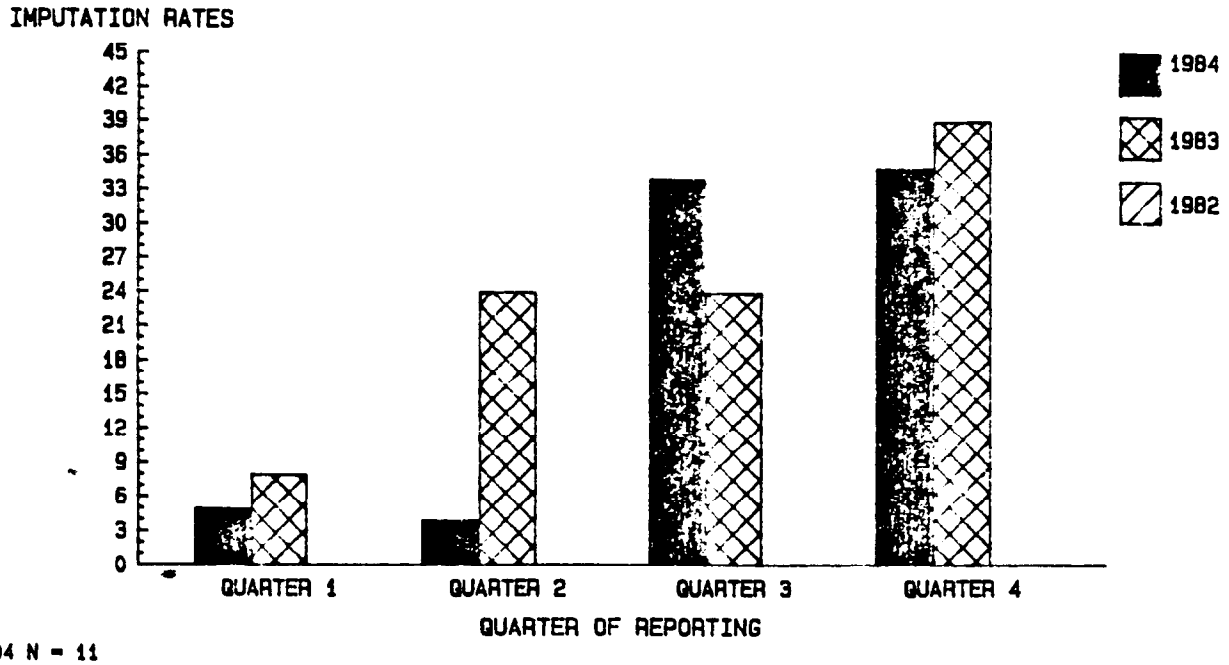


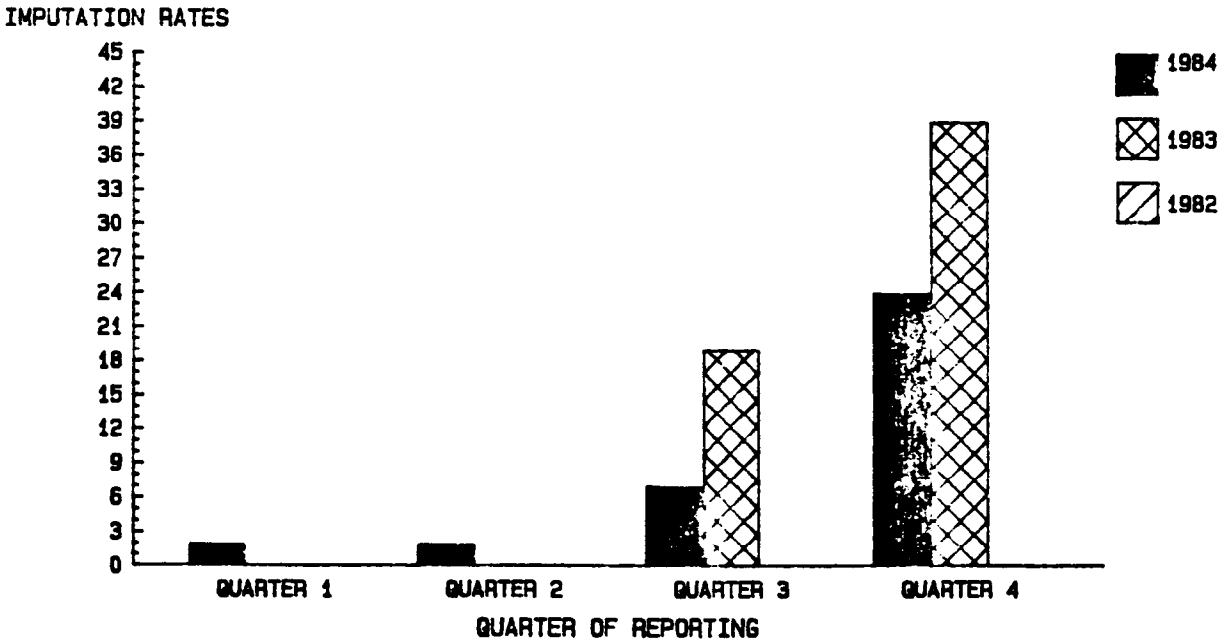
Figure 2.3 Imputation Rates (%)
For Selected Quarterly CIR
Survey Items--1982-84

SURVEY 2324 AND ITEM 13013



1984 N = 11
1983 N = 12
1982 N = 0

SURVEY 2324 AND ITEM 13111



1984 N = 20
1983 N = 13
1982 N = 0

Figure 2.4 Imputation Rates (%)
For Selected Quarterly CIR
Survey Items--1982-84

FLOUR MANUFACTURED - ITEM 2120

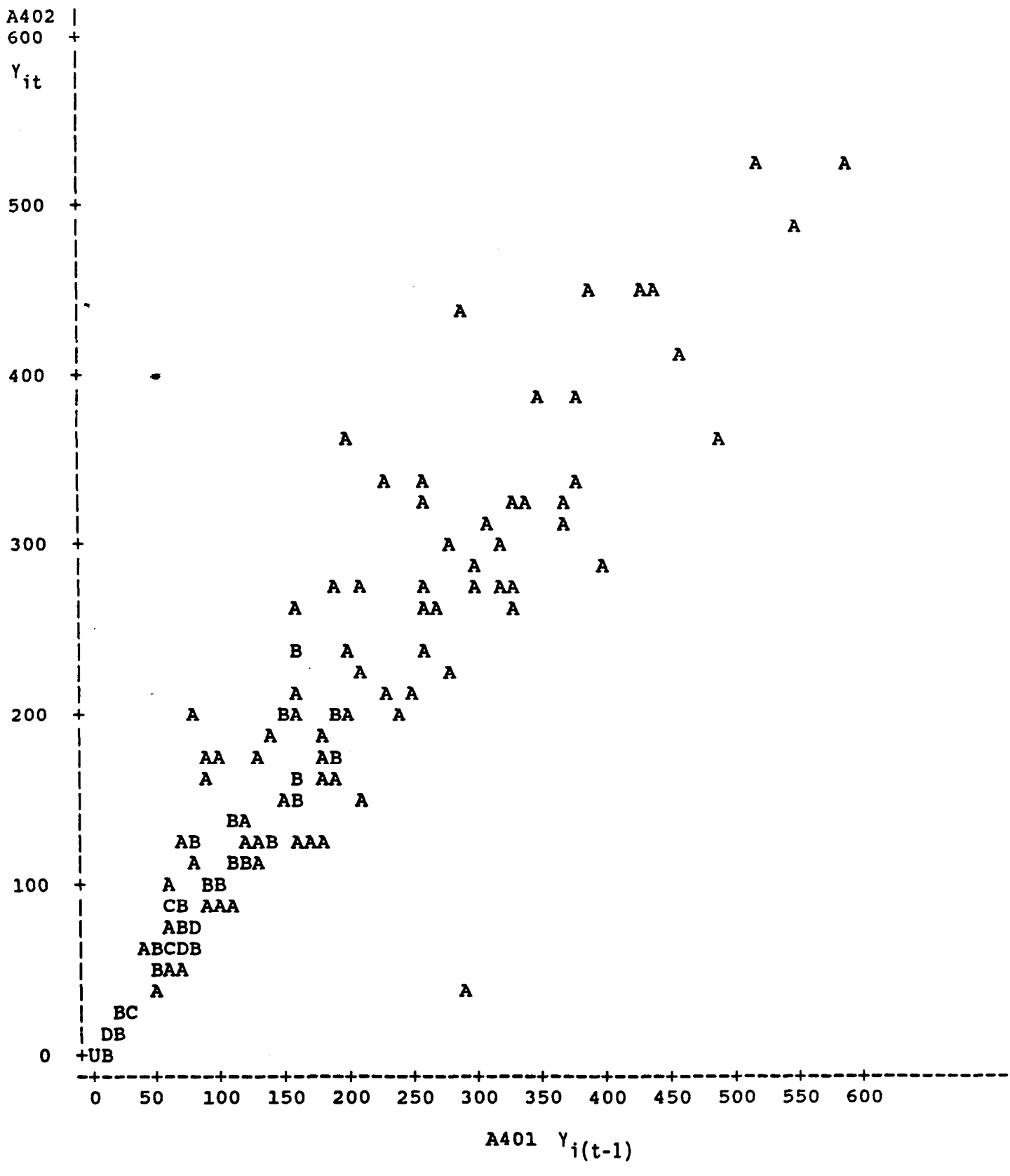


FIGURE 3.1a SCATTER PLOT FOR MONTHLY SURVEY 2001 - FEBRUARY, 1984

FLOUR MANUFACTURED - ITEM 2120

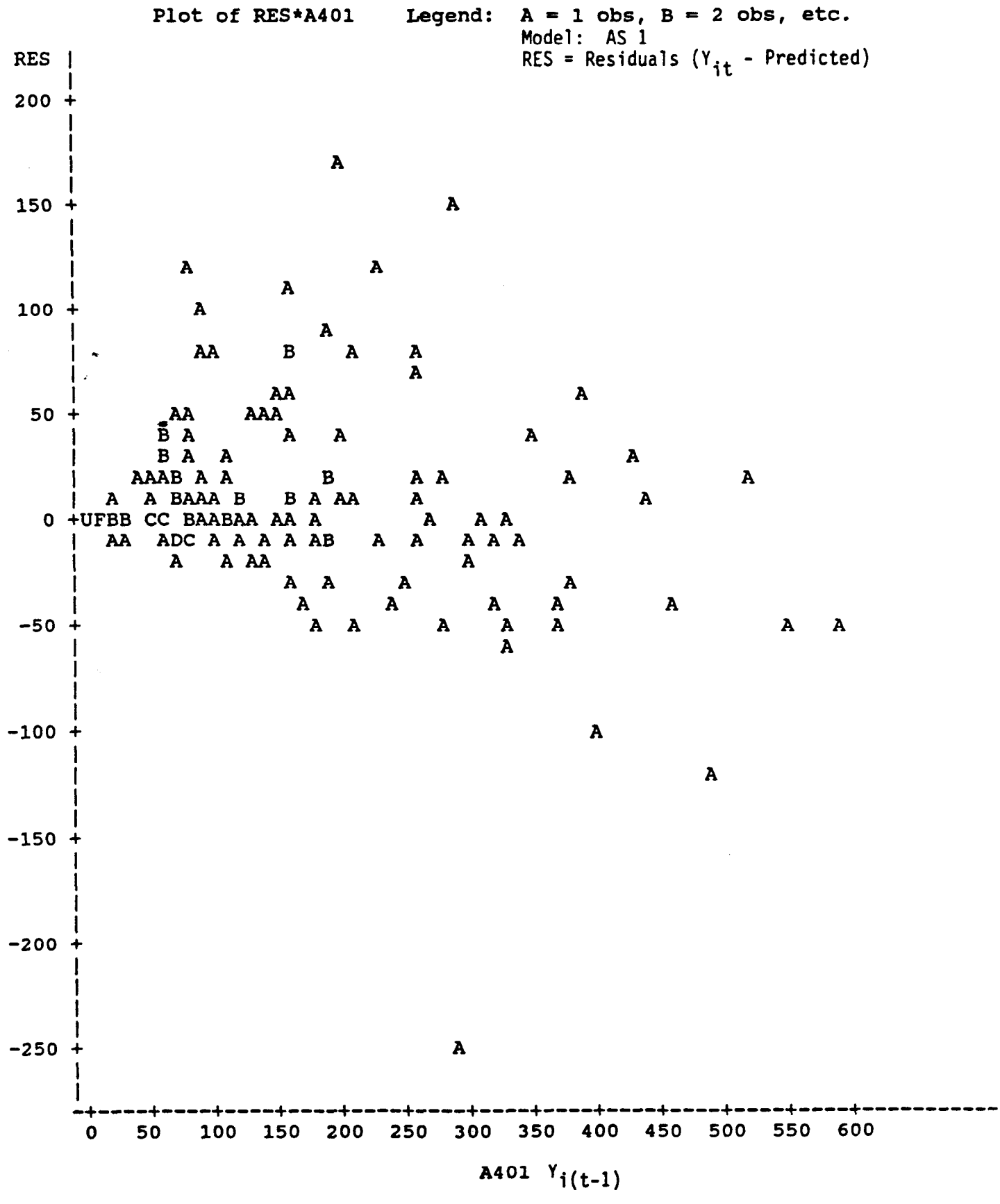


FIGURE 3.1b RESIDUAL PLOT FOR MONTHLY SURVEY 2001 - FEBRUARY, 1984

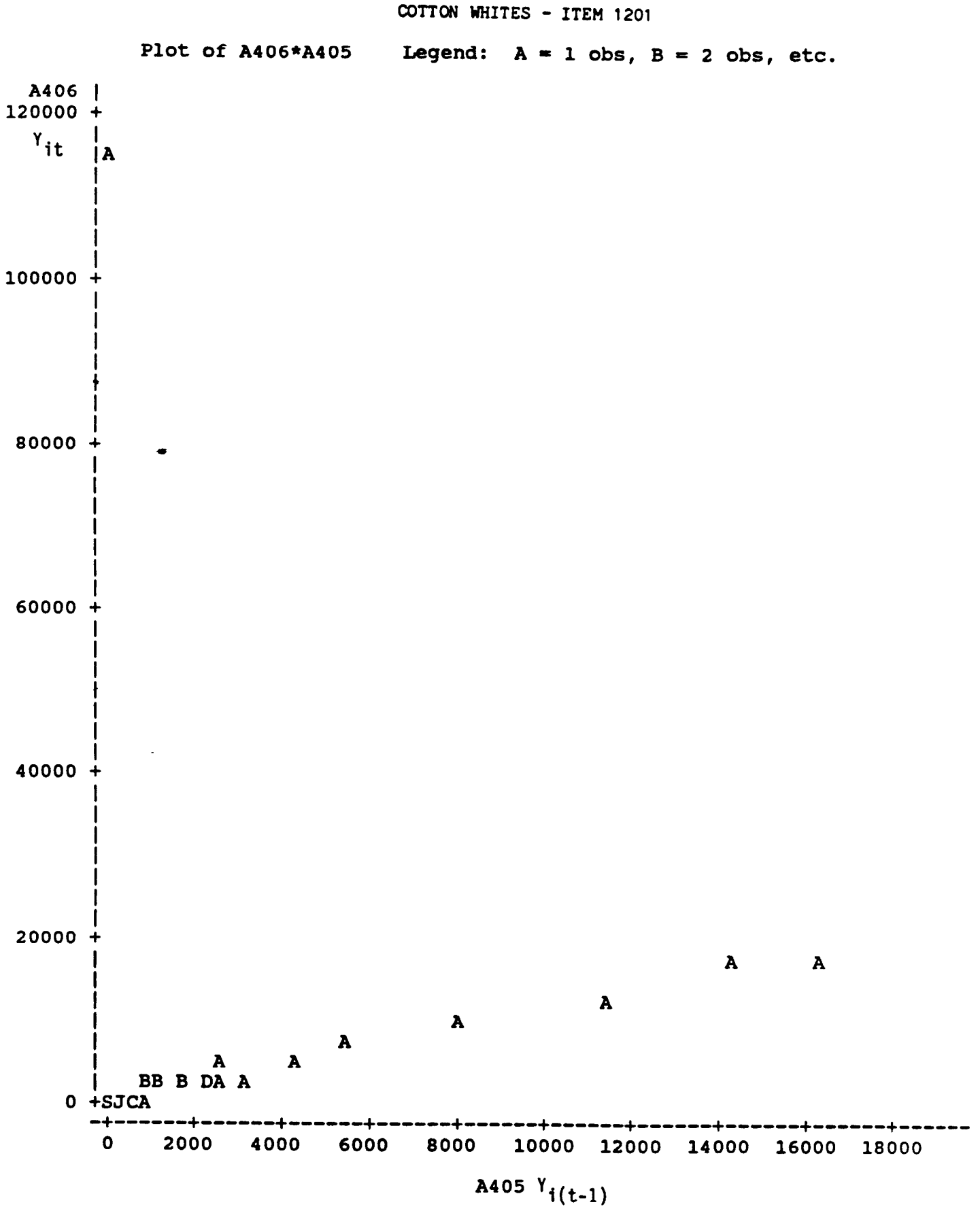


FIGURE 3.2a SCATTER PLOT FOR MONTHLY SURVEY 2202 - JUNE, 1984

COTTON WHITES - ITEM 1201

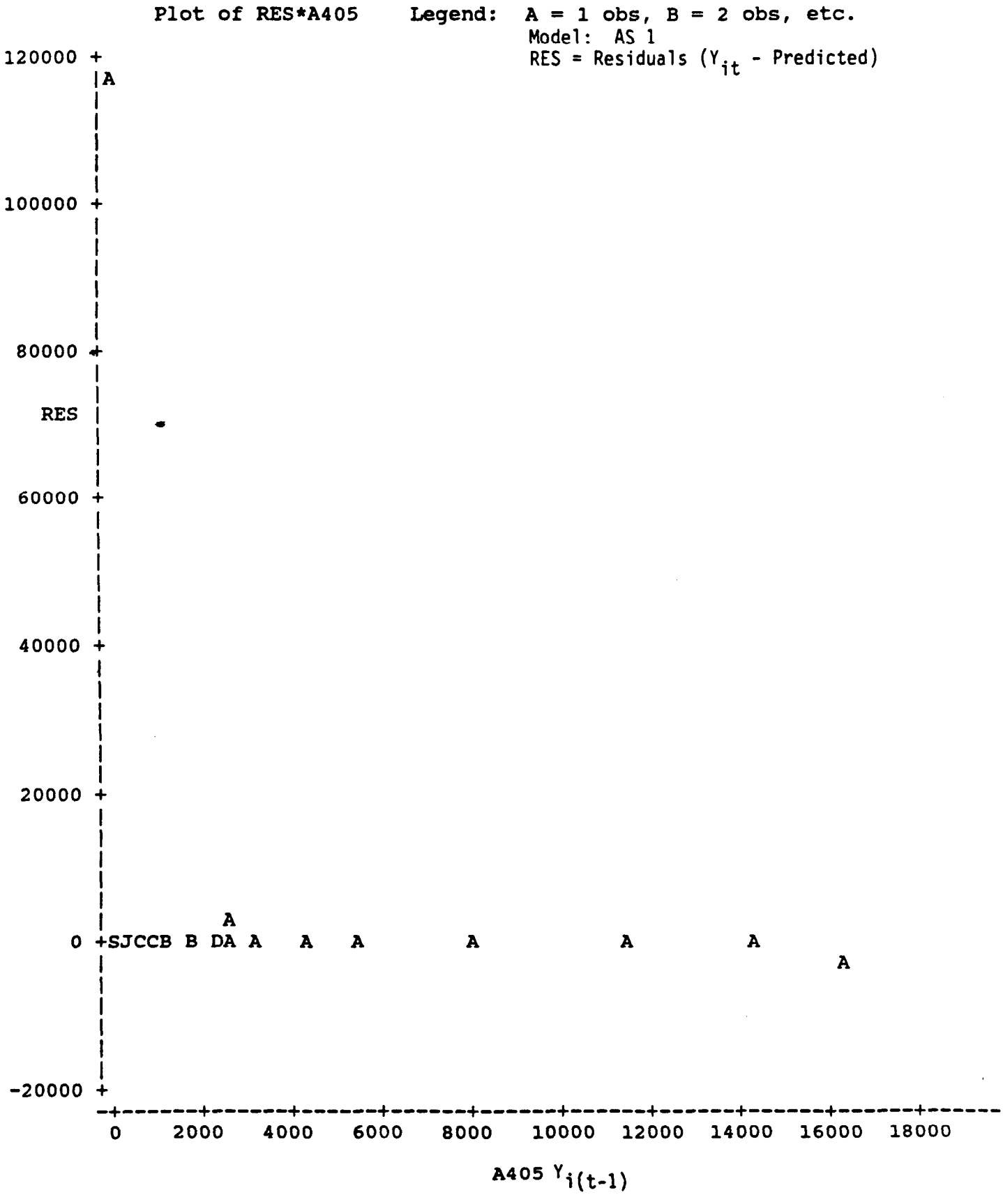


FIGURE 3.2b RESIDUAL PLOT FOR MONTHLY SURVEY 2202 - JUNE, 1984

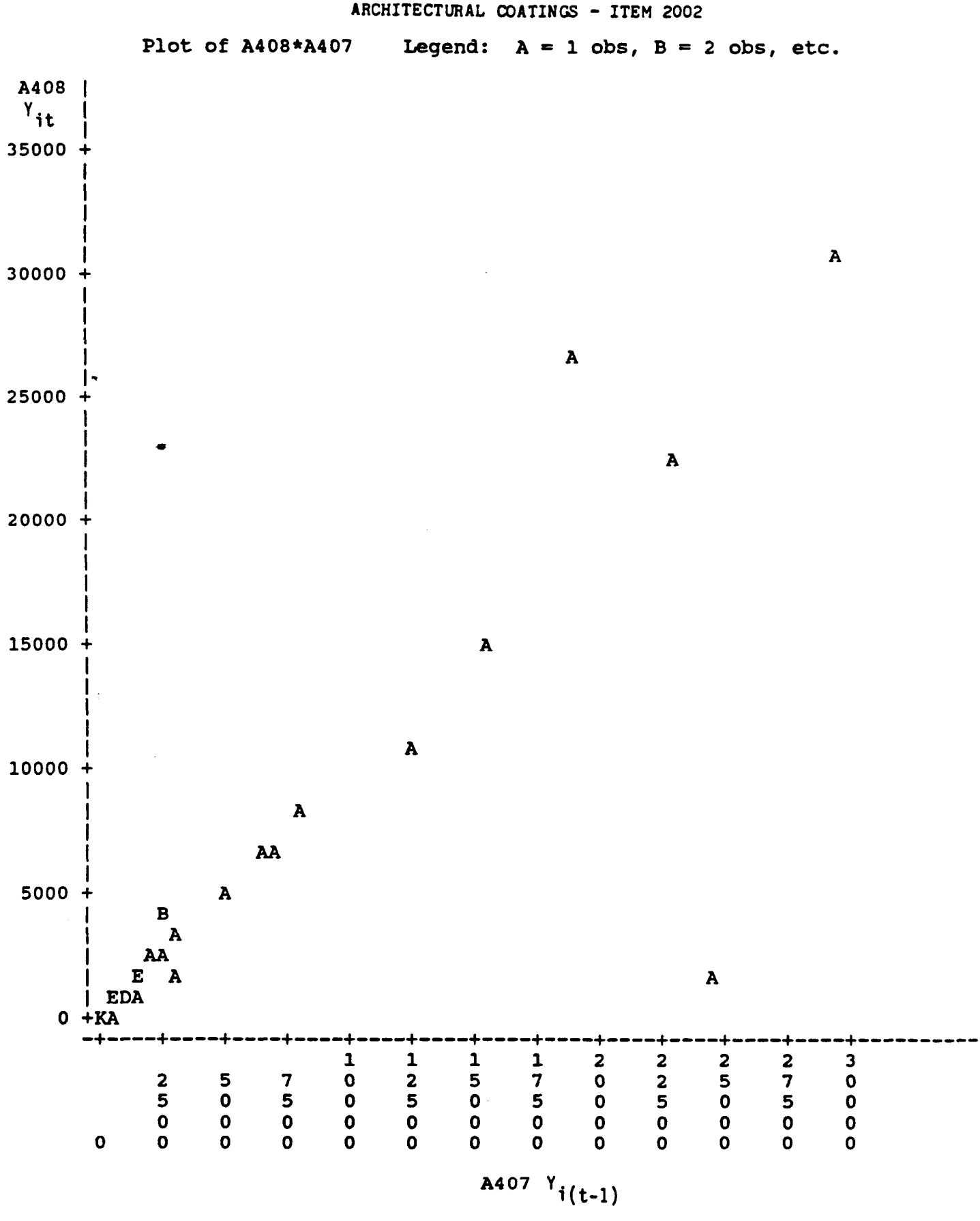


FIGURE 3.3a SCATTER PLOT FOR MONTHLY SURVEY 2806 - AUGUST, 1984

ARCHITECTURAL COATINGS - ITEM 2002

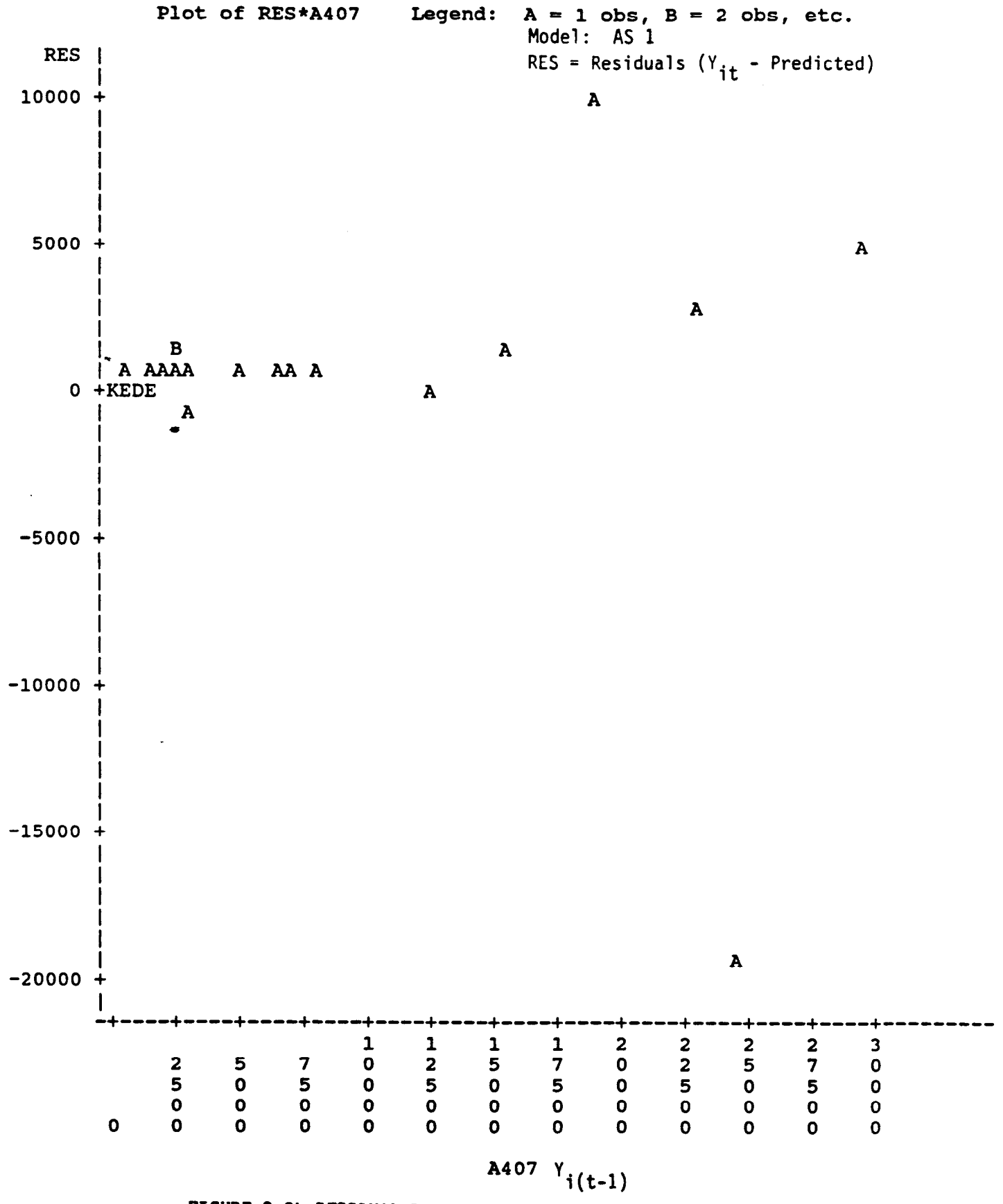


FIGURE 3.3b RESIDUAL PLOT FOR MONTHLY SURVEY 2806 - AUGUST, 1984

SHEETS, PILLOWCASES, AND TOWELS - TOTAL PRODUCTION - ITEM 13011

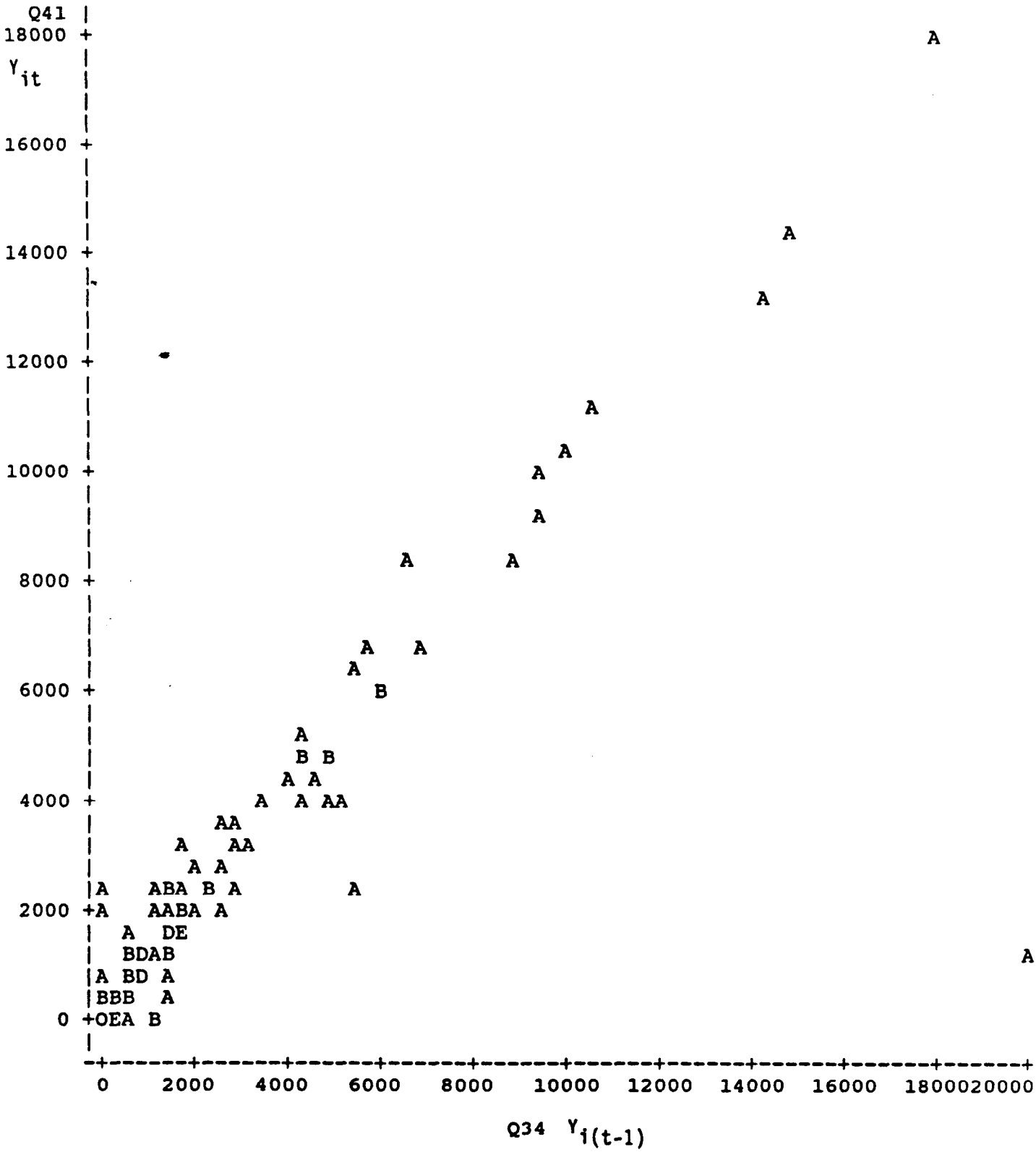


FIGURE 4.1a SCATTER PLOT FOR QUARTERLY SURVEY 2324 - QUARTER 1, 1984

SHEETS, PILLOWCASES, AND TOWELS - TOTAL PRODUCTION - ITEM 13011

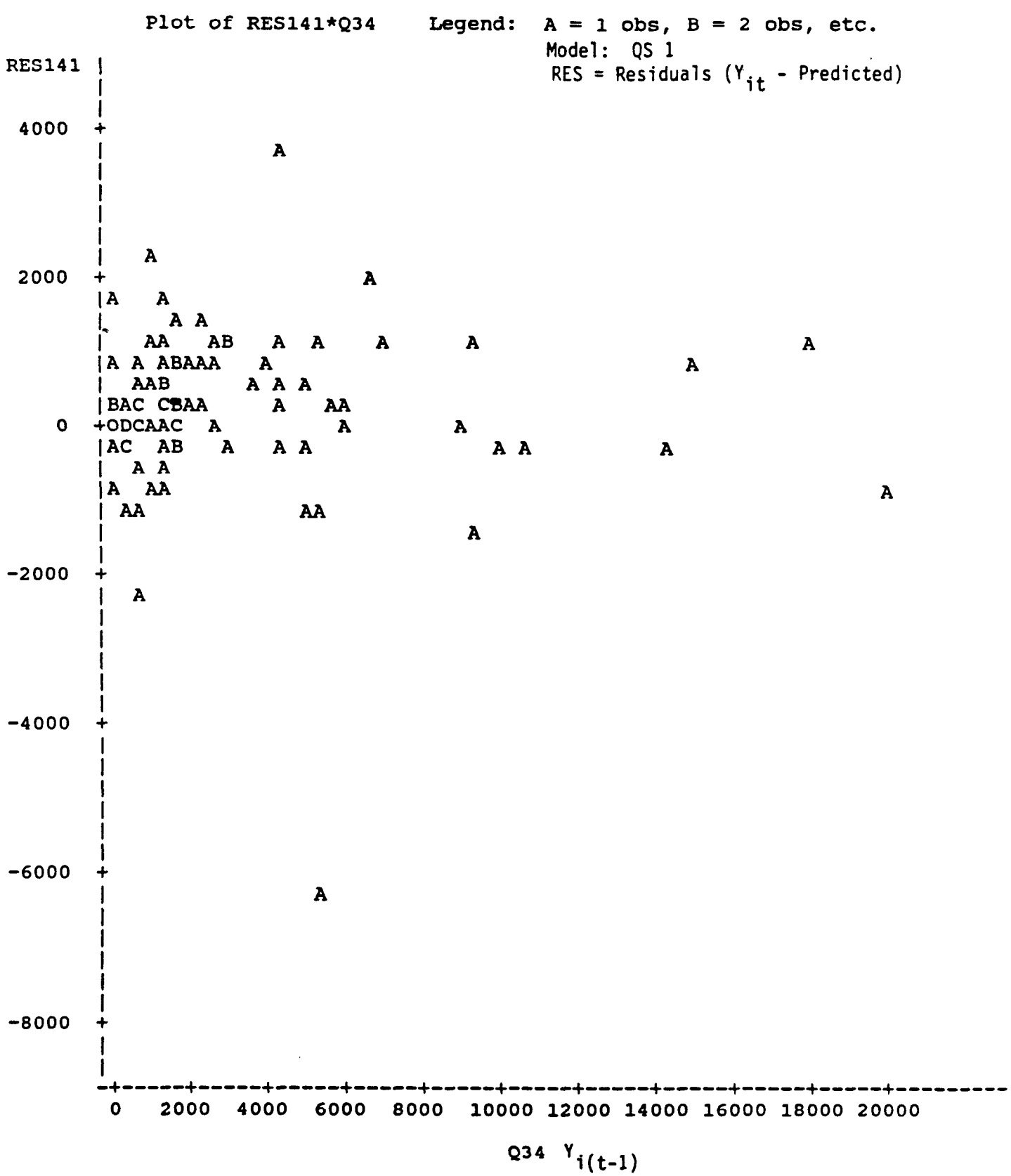


FIGURE 4.1b RESIDUAL PLOT FOR QUARTERLY SURVEY 2324 - QUARTER 1, 1984

BROADWOVEN FABRICS - ITEM 13011

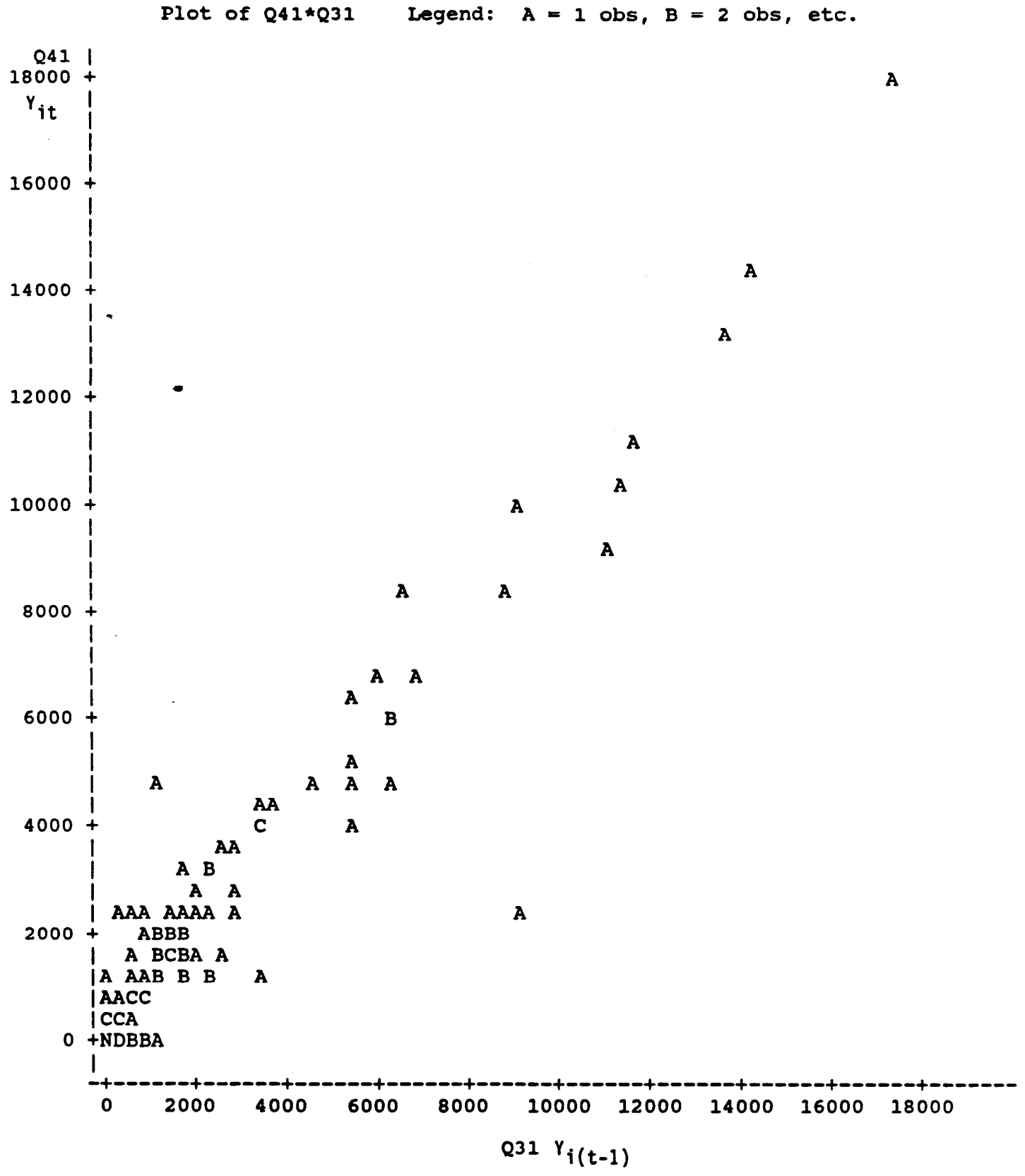


FIGURE 4.2a SCATTER PLOT FOR QUARTERLY SURVEY 2220 - QUARTER 1, 1984

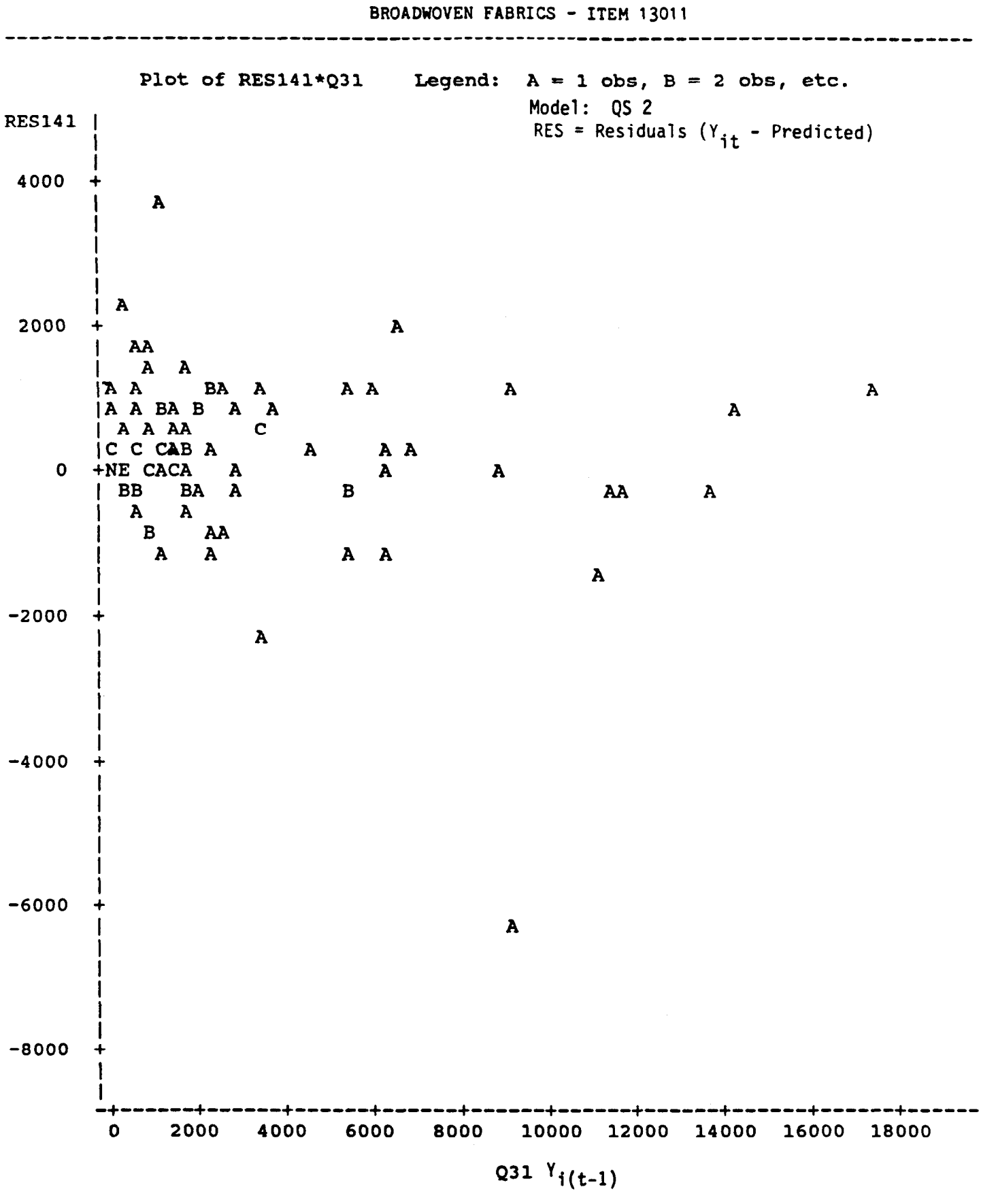


FIGURE 4.2b RESIDUAL PLOT FOR QUARTERLY SURVEY 2220 - QUARTER 1, 1984

GLOVES AND MITTENS - ITEM 33210

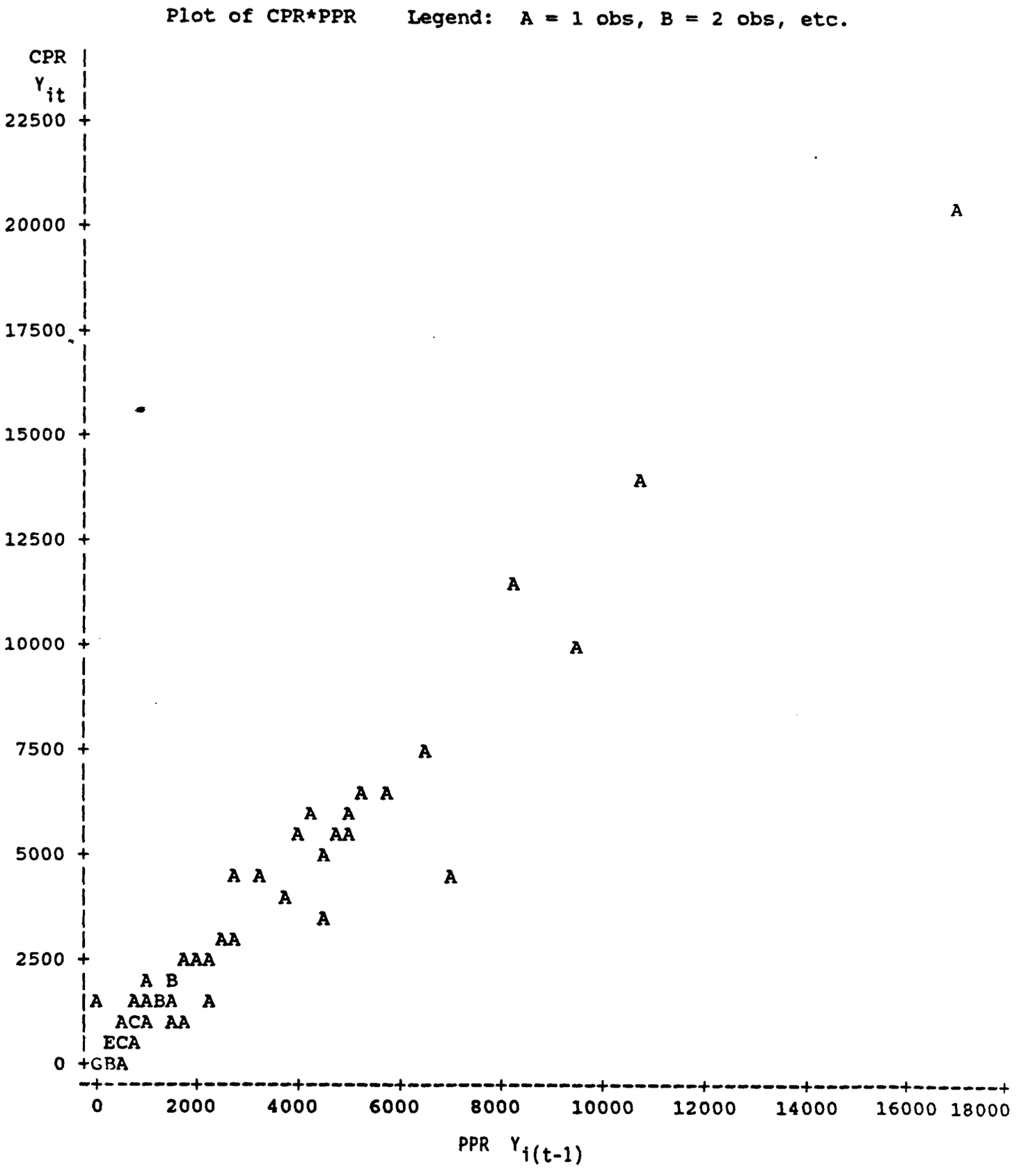


FIGURE 5.1a SCATTER PLOT FOR ANNUAL SURVEY 2304 - 1984

GLOVES AND MITTENS - ITEM 33210

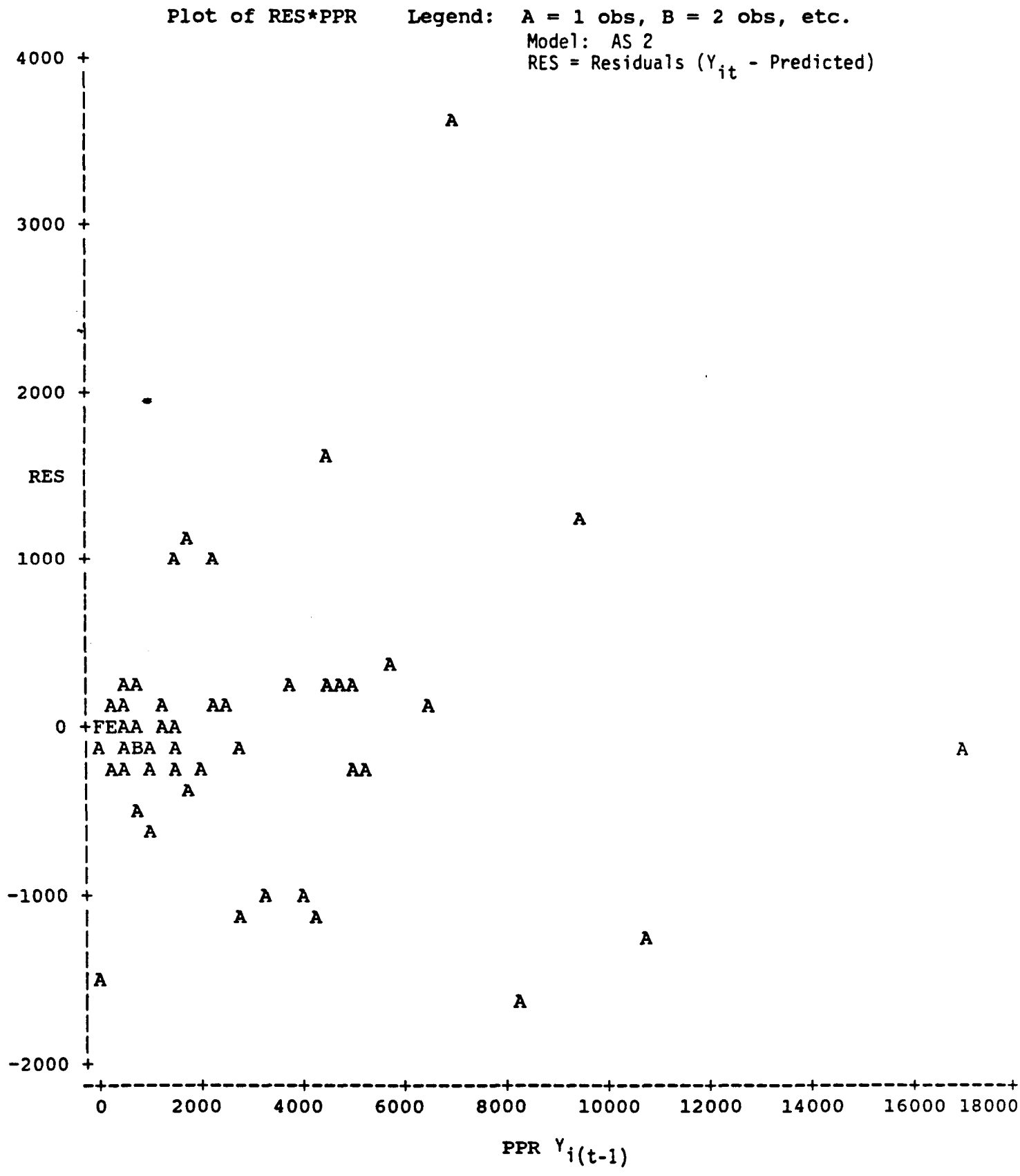


FIGURE 5.1b RESIDUAL PLOT FOR ANNUAL SURVEY 2304 - 1984

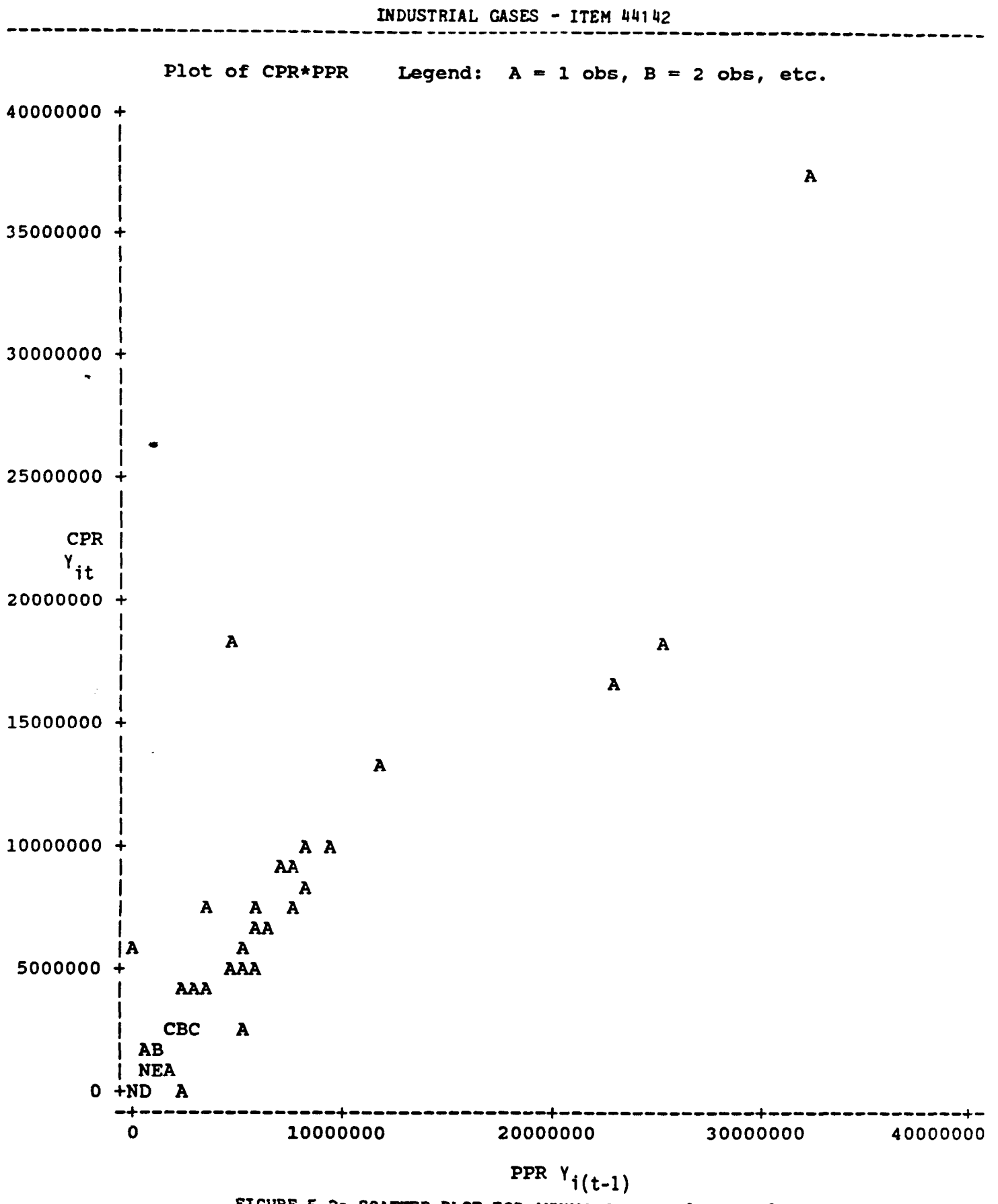


FIGURE 5.2a SCATTER PLOT FOR ANNUAL SURVEY 2802 - 1984

INDUSTRIAL GASES - ITEM 44142

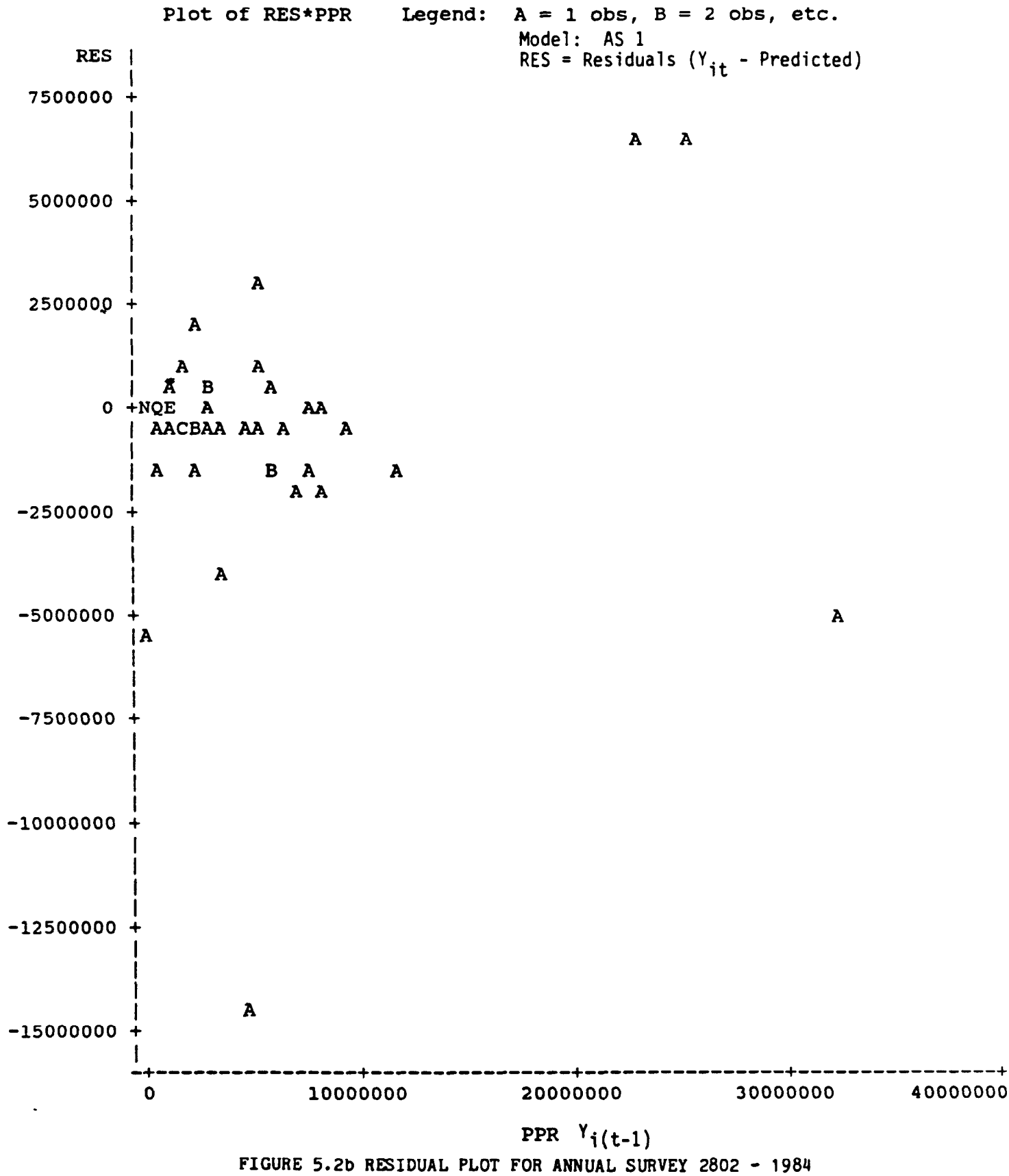


FIGURE 5.2b RESIDUAL PLOT FOR ANNUAL SURVEY 2802 - 1984

WIRING DEVICES AND SUPPLIES - ITEM 31291

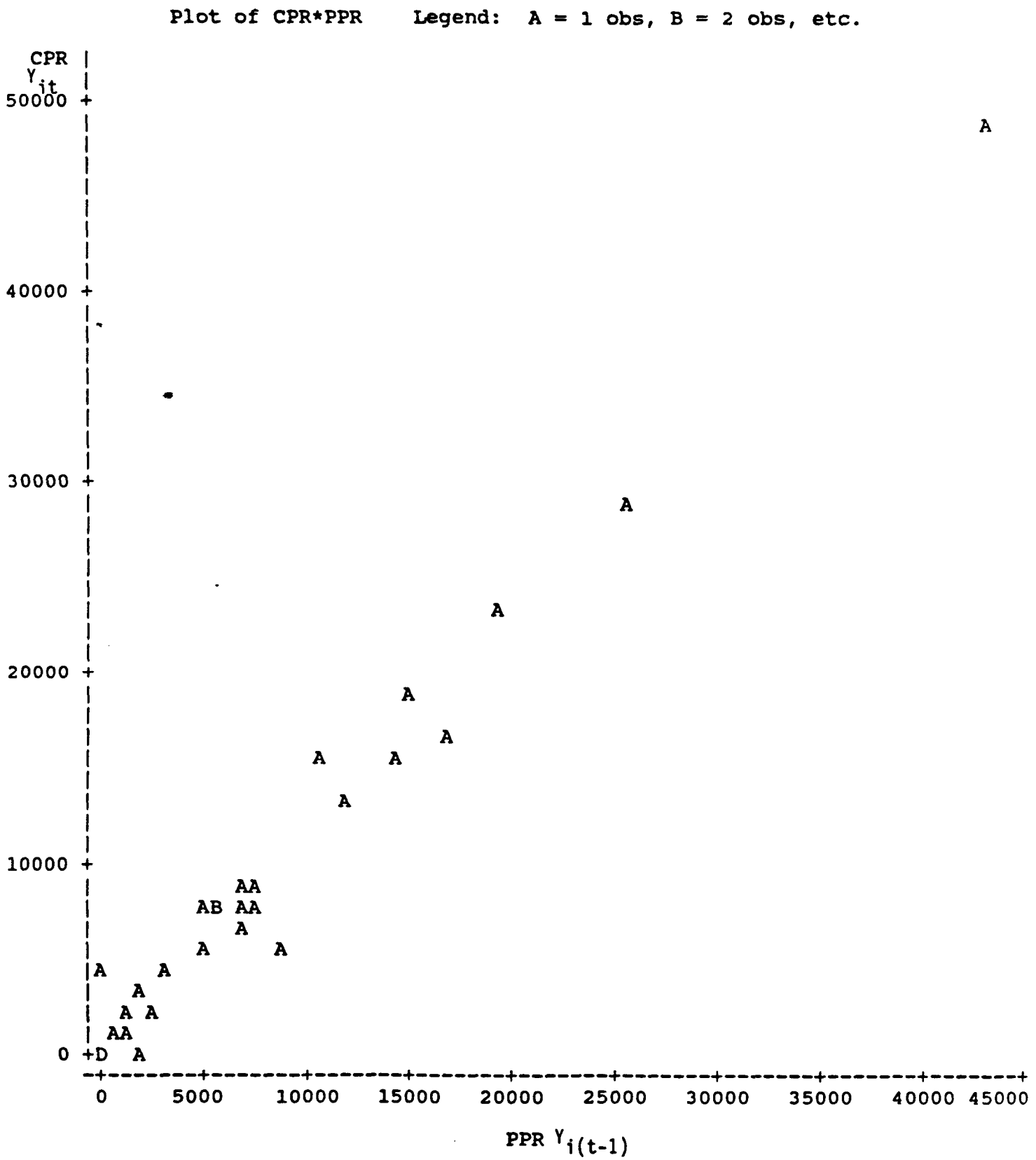


FIGURE 5.3a SCATTER PLOT FOR ANNUAL SURVEY 3611 - 1984

WIRING DEVICES AND SUPPLIES - ITEM 31291

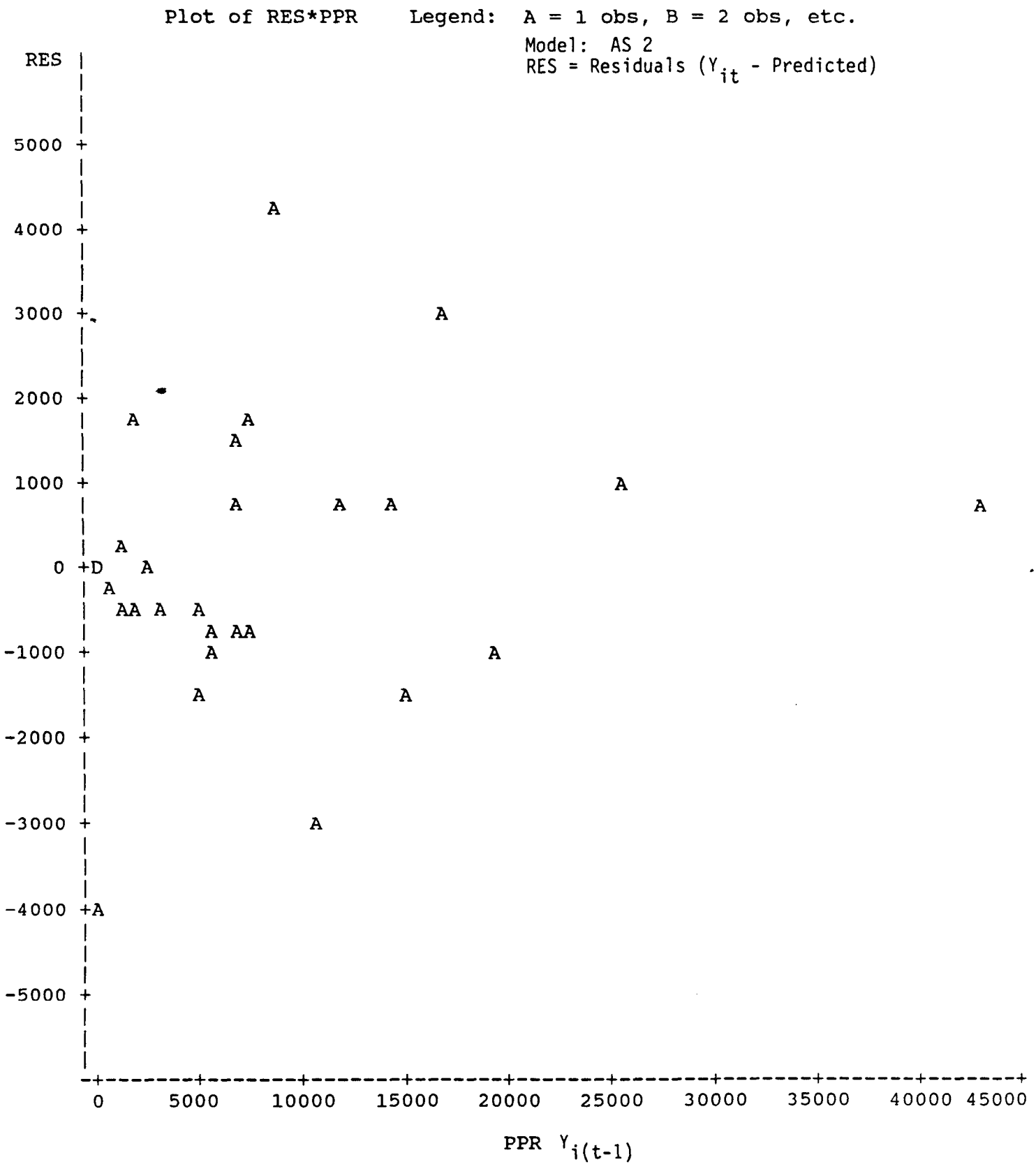


FIGURE 5.3b RESIDUAL PLOT FOR ANNUAL SURVEY 3611 - 1984