IMPROVING THE PLANT AND EQUIPMENT
EXPENDITURES SURVEY PANEL

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Improving The Plant and Equipment Expenditures (P&E) Survey

Executive Summary

This paper discusses the improvement of the mail panel of the P&E Survey. The mail panel of this survey is not based on a probability sample drawn from a universe frame. Therefore, improvements could not be guided by considerations of standard statistical estimates of variances.

A methodology was developed for allocating resources across the survey strata which are industries. This methodology enables us to identify industries that should receive high priority for improvement. Standard mail panel supplementation techniques then were used to add companies in the identified industries to the survey mail panel.

The methods used here are recognized as incomplete. In this paper, the need, or "demand," for accuracy is being considered. Since we cannot calculate the variance of an estimate from this panel, we cannot address the availablity, or "supply," of accuracy. We cannot say how much improvement was obtained as a result of applying the methods developed here. We only can say the estimates "should" be improved and that the improvement occurred in areas where it was needed most.

If sufficient resources are available, a universe frame can be developed and a properly stratified probability sample drawn from that frame. Since the P&E Survey has a scope of all nonfarm businesses in the United States, this will be a costly undertaking. It will be necessary not only to develop the frame initially but also to maintain it over time. The methodology developed here can be useful in that work if it enables us to determine when a high degree of accuracy is necessary and when it may not be as important.

INTRODUCTION

The P&E Survey is a quarterly survey conducted by the Bureau of the Census as the basis for estimates of actual and planned future spending on plant and equipment by U.S. nonfarm businesses. Estimates of this spending are published for detailed industries and for the total of those industries. This paper describes recent attempts to improve the mail panel of the P&E Survey. The improvement is complicated by the fact that the survey mail panel is not a random sample.

The P&E Survey is a survey of companies rather than establishments. When these improvements where undertaken, there was no universe frame of nonfarm companies in the United States available for our use.[1] Without a sample from a known frame, we cannot identify weaknesses in the panel by consulting standard statistical characteristics such as the variances of survey estimates. We must find some other criteria for choosing industries for improvement, and we must find ways to improve the panel for the chosen industries[2].

Since we could not examine estimate variances due to sampling as a guide to where our mail panel needed improvement, we began searching for an alternative guide. The guide we developed is based on considering the need for accuracy. In fact, this need could have been considered in conjunction with variances. That is, even if we could calculate the sample variance of each estimate, it would be legitimate to question whether the variances of all estimates should be treated as equally important.

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1. There is a project underway at the Census Bureau to construct a universe frame of nonfarm companies in the United States and to sample that frame for purposes of mailing an annual survey of investment in the United States. The improvements described in this study can be regarded as stopgap measures intended to do what is possible until the development of that survey makes resources needed for more extensive improvements available.

2. The P&E Survey produces estimates of planned as well as actual spending. Discrepancies between planned and actual spending are not appropriate measures of accuracy because they reflect the effects of changing economic conditions. There is no reason to suppose that inaccuracies in estimates of actual spending also are not present in estimates of planned spending.

We used a two-step process to choose industries for improvement. The first step was to identify "high-priority" industries. This was done on the basis of industries' contributions to accuracy. The accuracy of total spending across all industries, and the accuracy of spending by individual industries were considered separately. The second step was to specify "standards" for each level of priority. We could then identify industries that didn't meet the standards.

In the next section, we develop methodologies for prioritizing industries. In the third section, we specify "standards." These standards are characteristics of the mail panel that we think are desirable. Industries will be chosen for improvement when they are assigned a high priority but do not satisfy the standards for high-priority industries. Finally, in the fourth section, we discuss the specific steps taken to bring the mail panel of the P&E Survey up to standards for the chosen industries.

CHOOSING INDUSTRIES

If our resources were unlimited, we could take the straight forward approach of improving the accuracy of every industry. This also would result in improved estimates of total spending by all industries. Using this approach, would eliminate the need to prioritize industries. Unfortunately, our resources are not unlimited. Therefore, we must focus our efforts on industries where we will get the biggest payoff for investing our limited resources.

We also must decide whether to focus on estimates of levels of spending or changes in spending. Since, the P&E survey actually produces estimates of change which are then used to extrapolate "benchmark" estimates of levels, we will focus on changes in spending.

If we can identify industries that are most important in determining the change in total spending across all industries, we can argue that maintaining or improving the accuracy of these industries will best ensure the accuracy of that total change. Care must be taken, however, that we do not become fixated on the accuracy of the total because we also publish estimates of spending by detailed industries. We want any published estimate (both the total and the details) to be accurate enough to be useful to our data users.

We will use a combination of two approaches. First we will identify industries that are "important" in achieving accurate estimates of the change in total spending. We will assume that industries that are most important in determining this change should be estimated

with the highest degree of accuracy. Then we will identify
detailed industries that are the most variable over time.
We will assume that industries with more variability should
be estimated with more accuracy since their past changes
(which can be extrapolated to aid current estimation) are
less accurate indicators of their current value. We will
include both types of industries in our list of high-
priority industries.

We develop a basis below for identifying industries that
are the most important in explaining changes in total P&E
spending. The process we develop does not require us to
assume that survey respondents consititute a random sample
from a population. We then identify the industries that are
important because of their variability. These are the
industries with the largest coefficients of variation of
annual change.[1] Our highest priority for improvement will be
assigned to the most important industries in each group.

Importance to Change in Total Investment:

The universe of the P&E survey is total nonfarm
businesses in the United States. For publication purposes,
this universe is divided into 29 detailed industries.
Estimates actually are tabulated at a much more detailed
level. The more detailed estimates are not regarded as
reliable enough to release. We will delay consideration of
them until a later section. For now, all tabulations are
done at the level of the 29 most detailed published
industries shown in Table 1.

If X_t is the level of Total Nonfarm spending in
period t, then

$$X_t = \sum_{i=1}^{29} X_{i,t} \qquad \text{where,} \qquad (1)$$

$X_{i,t}$ is the level of spending of the ith industry in
period t.

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1. Annual change is used primarily for convenience. It does
have the added advantage of eliminating considerations of
seasonal adjustment.

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Period-to-period changes in X can be written,

$$\Omega X_t = \sum_{i=1}^{29} w_{i,t-1} \Omega X_{i,t} \quad \text{where,} \qquad (2)$$

$$\Omega X_t = \left(\frac{X_t}{X_{t-1}}\right), \qquad (2.1)$$

$$w_{i,t-1} = \frac{X_{i,t-1}}{X_{t-1}}, \quad \text{and} \qquad (2.2)$$

$$\Omega X_{i,t} = \left(\frac{X_{i,t}}{X_{i,t-1}}\right). \qquad (2.3)$$

Equation 2 shows the change in Total Nonfarm spending as the weighted sum of the changes in the individual industries where the weight of each industry is the proportion of total spending it accounted for in the previous period. This expression lets us note that changes in a detailed industry can affect changes in the total in two ways. First an industry that accounts for a large proportion of the total can affect total change significantly even if the change in the detailed industry is not very large. Second a detailed industry can affect the total change significantly if a large enough change occurs in the detail even if the industry does not account for a large proportion of the total.

We can use historic data as a guide to classifying industries by simplifying equation 2 and interpreting it in a different way. First note that equation 2 can be expanded to[1]:

$$\Omega X_t = \left[\sum_{i=1}^{29} w_i \Omega X_{i,t}\right] + \left[\sum_{i=1}^{29} (w_{i,t-1} - w_i) \Omega X_{i,t}\right] \quad \text{where,} \qquad (2.A)$$

$$w_i = (1/T) \sum_{t=1}^{T} w_{i,t}$$

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1. Richard Sigman pointed out this expansion after reviewing an earlier draft.

Now the change in Total Nonfarm spending is expressed as the sum of two terms. The left term is again the weighted sum of the changes in the individual industries, but now the weights are the average proportion of total spending accounted for by each industry during time periods 1, 2, through T. The right term is also a weighted sum of the same detailed changes, but the weights are the differences between the average proportion and the proportions associated with the time periods.

We would like to simplify equation 2.A by assuming the proportions of X accounted for by different industries are stable during the time periods being considered. If there is little change in the proportions across time periods, the differences serving as weights in the right term will be small. If the weights are small, the term will be small, and we can ignore it. This simplifies the algebra and our calculations.

The results of evaluating the assumption that the proportions are stable are discussed in the appendix. Although the assumption is weak, it is not overly troublesome, so we adopt it and drop the right term. We also assume that the change in an industry can be characterized as a random variable. Then we can interpret the equation as follows:

$$\Omega X_t = \sum_{i=1}^{29} w_i \Omega X_{i,t} \quad \text{where,} \tag{3}$$

$\Omega X_{i,t}$ is the observation in time t of a random variable ΩX_i that is normally distributed with mean x_i and variance σ_i^2, and w_i is the stable proportion of X accounted for by X_i.

Then ΩX_t is the observed value in period t of the random variable ΩX and the distribution of ΩX is normal with mean x and variance σ^2 where,

$$x = \sum_{i=1}^{29} w_i x_i, \quad \text{and}$$

$$\sigma^2 = \sum_{i=1}^{29} w_i^2 \sigma_i^2 \quad \text{if the } \Omega X_i\text{'s are independently distributed (covariances = 0).}$$

Note that an extra element has been added to the analysis. We have introduced σ_i^2 which reflects the variability over time of the changes in the industry.

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We now must consider both the size of the period-to-period changes in an industry and whether or not the size of those changes is stable! These two aspects of each industry are revealed by the industry's weighted mean change and squared weighted variance of change.

Selected statistics for the most detailed published industries are shown in Table 2. Chart 1 shows each industry's weighted mean change and squared weighted variance of change with the industries sorted in descending order by the size of their weighted mean changes. Thus industries on the left account on average for a large amount of the change in total nonfarm spending. Note that, in general, the weighted mean changes and the squared weighted variances both decline from left to right on the graph.

The graph can be divided into three sections (and the industries into three groups) by placing a vertical line between Industries 290 and 280 (line 1), and between Industries 331 and 340 (line 2). These lines are intended to separate the industries into three groups with substantially differing effects on the change in Total nonfarm spending. Every industry to the right of line 1 has a lower value of weighted mean change and of squared weighted variance then every industry to the left. If line 1 were drawn any further to the right, this would not be true. Line 2 almost has the same property as line 1. All industries to the right of line 2 have both a lower value of weighted mean change and a lower value of squared weighted variance, except Industry 372. Still the jump in squared weighted variance that occurs at Industry 372 is obviously less than the jump that occurs at Industry 450 so the placement of line 2 seems as good as can be achieved.

Having placed lines 1 and 2 in Chart 1, we now can identify the industries that are most significant, moderately significant, and least significant in explaining changes in total spending. This is done in Table 3. Industries to the left of line 1 have been called most significant. Industries to the right of line 2 have been called least significant. The industries between the lines have been called moderately significant. The highest ranked of the most significant industries is the Annual-only industry. This industry accounts, on average, for more than 12 percent of total spending and has an average annual change of over 1.07. Wholesale-and-retail trade accounts for slightly more than 10 percent of total spending on average and has an average change of 1.12. Electric utilities, Personal-and-business services, and Communications are the next highest ranked industries. Finance and insurance accounts for an average of 6 percent of total spending but has an average annual change of almost 1.16. Petroleum accounts for a substantial share of total spending and has significant annual changes but is even more

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important because its dramatic variability causes it to affect the variance of the change in total spending more than any other industry.

Variability of Individual Industries:

In addition to producing estimates of the level of spending and the change in the level of spending for Total nonfarm business, the P&E Survey also produces estimates for detailed industries. Table 2 shows the coefficient of variation of the annual change in each industry[1]. These coefficients can be used to identify relatively volatile industries. A better panel is needed to estimate changes in a volatile industry. Note that the industries with the largest coefficients of variation are not in the "Most Significant" category. We find a conflict here between our criteria for identifying candidates for improvement resources. Chart 2 shows the same industries as Chart 1 but now they are sorted from left to right in order of decreasing coefficients of variation. Clearly a different ranking is implied when we consider the accuracy of detailed estimates instead of the accuracy of the overall estimate.

Chart 2 has been divided into three regions by drawing lines A and B. The median coefficient is identified as a guide to drawing the lines, but their placement is ultimately arbitrary. Moving to the left of the median to divide the most volatile industries from those of moderate volatility, there is no clear separation. If Industry 290 is included in the most volatile, then Industries 260, 003, and even 401 should be included as well. To make the use of the word "most" more exclusive, line A was drawn between Industries 333 and 290. Moving to the right of the median, it is easier to identify the dip in the level of the coefficients to the right of Industry 340 as a division. Placing line B between Industries 340 and 016 results in eight least volatile industries but any separation further to the right would be questionable.

So we have Air transportation as the most volatile industry with a coefficient of variation of 33.76. Other industries in the most volatile group are Aircraft and other transportation equipment, Blast furnaces-steel works, Motor

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1. The coefficient of variation is the standard deviation of the annual changes divided by the mean annual change and then multiplied by 100. The division normalizes the standard deviations for differences in the magnitudes of the changes. The multiplication converts the ratio into a percentage.

vehicles, Rubber, and Nonferrous metals. These are the industries most in need of a good panel to produce accurate estimates of change.

Note that, except for Petroleum, all of the industries that are most significant in explaining the changes in total P&E are in the group with the lowest coefficients of variation. These are the Annual-only industries, Wholesale and retail trade, Electric utilities, Personal-and-business services, Communications, and Finance-and-insurance. The low volatility of these industries contributes to the P&E Survey's ability to produce accurate estimates.

Assigning Priorities:

By utilizing both Importance and Volatility, we can prioritize industries. The quality of the panel for the following industries will receive highest priority.

HIGH PRIORITY INDUSTRIES

Because of Importance to Total:
Annual-only industries
Wholesale and retail trade
Electric utilities
Personal and business services
Communication
Finance and insurance
Petroleum

Because of Volatility:
Air transportation
Aircraft manufacturing
Other transportation equipment manufacturing
Blast furnaces, steel works
Motor vehicle manufacturing
Rubber
Nonferrous metals

Having identified the industries that should receive high priority, we would like to separate the remaining industries into medium and low priority. Unfortunately, those that are indicated for low priority by significance in determining the change in total P&E are indicated for medium priority by volatility. And those indicated for low priority by volatility are indicated for medium priority by significance in determining the change in total P&E. We will resolve this dilemma by grouping them as medium priority. We will therefore have only two priority levels, high and medium.

MEDIUM PRIORITY INDUSTRIES:

Because of Importance to Total:
Electrical machinery
Chemicals
Machinery, except electrical
Gas and other utilities
Food and beverage
Mining
Paper
Other nondurables
Other durables
Railroad transportation
Other transportation
Because of Volatility
Fabricated metals
Stone, clay, glass
Textiles
Other metals

Having determined what priority should be placed on obtaining a "good" panel for each industry, we now turn to defining good.

ESTABLISHING STANDARDS

Our goal when improving the survey panel and increasing response is to obtain a set of responses that accurately represent the individual industries respondents are classified in and when taken together the entire economy.

The panel of the P&E Survey is segmented into tabulation groups (tabs) on the basis of company size (measured by assets). We can approach the goal of representing industries and the economy as a whole by first obtaining responses from companies in every industry and then obtaining responses from companies in each tab within each industry. When we have accomplished this, we can work to obtain more responses in the most important industries. Then we can work to obtain more responses in the less important industries.

The problem, of course, is that without standard statistical controls we have no way to know when we have worked "enough" on any type of industry. We will use the statistics shown in Table 4 to address this problem[1].

Table 4 shows the number of respondents to the fourth quarter 1990 survey in each industry and the percent of spending in each industry that was accounted for by those respondents. The industries are separated by the priorities developed above.

These two statistics are shown because they relate to both the quality of a panel and its improvability. Neither of these statistics would tell us much about the quality of a panel when viewed in isolation. However, when considered together, they do provide information about the panel.

The number of respondents is shown for two reasons. First, it provides a context for other statistics. If there are 2 respondents in one industry and 200 respondents in another, then we know something about the expected accuracy of estimates for these industries if all other statistics for those industries are the same. Second, the number of respondents is a practical indicator of the number of new respondents (and therefore the resources) needed to improve the panel for an industry. If there are already 2,000 respondents in an industry, it is doubtful that adding 10 more similar respondents will improve the estimates for that industry. If there are only 5 respondents, the industry may be improved without using the resources necessary to find hundreds of new respondents.

The percent of spending in each industry accounted for by survey respondents also tells us something about how well the panel represents the industry. A survey whose respondents account for all investment in an industry is a census. As such it can be expected to yield accurate estimates. As the portion of investment accounted for by respondents declines, the results of the survey become increasingly suspect unless proper statistical controls and checks can be shown to maintain accuracy. Since the

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1. Another concern is to improve the list of companies to which questionnaires are being mailed. As long as the list is not created by the process of "drawing a random sample," questions about its ability to represent the industry will remain. If the panel is selected from a known frame, issues of coverage and response can be separated. Coverage can be addressed by considering only the frame. Response can be addressed considering only the panel. Without a randomly selected panel, we must address both issues simultaneously or find some other framework within which to analyze representativeness.

P&E Survey panel lacks standard statistical controls and checks, we would like to maintain as large a portion of investment accounted for by the respondents as possible.

We can use these statistics to develop systematic standards for determining when an industry (or tab) has been improved "enough." We need to be aware when we consider such standards that the presence of skewness in the population may nullify the criteria we are developing. With the caveat that all of the "largest" firms in an industry should be in any panel representing that industry, the following approach will be adopted.

Published Industries:

A published industry is "acceptable" when either of the standards in the chart below are met. When all published industries meet at least one standard we can apply the same (or modified) standards to the detailed industries that are tabulated but not published[1]. When the standards are met by all industries that are tabulated, we can apply them to the tabs. When all tabs of all industries meet at least one standard, the standards can be made more rigorous.

Standards for Industry Acceptability

Industry Status	Alternative Standards	
	Number of Respondents	Percent of Spending Accounted for by Respondents
High Priority	400	50
Medium Priority	200	40

Our goal is to bring each detailed published industry into conformance with these panel standards. There are five high priority industries in Table 4 that do not meet the

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1. We can see in Table 4, except for Finance-and-insurance, that all the instances where neither suggested standard for high priority industries is met involve industries that need a strong panel because they are a published detail. The industries that need a strong panel because they are significant in determining the change in total spending already meet these standards. One way to "improve" the survey publication in the short term would therefore be to publish less detail.

panel standards. They are Finance and insurance (016), Other transportation Equipment (373), Blast furnaces-steel works (331), Rubber (300), and Nonferrous metals (333). Of these, the most obvious violator of the standards is Other transportation equipment. It has 55 respondents who account for only 3.8 percent of the industry's spending.

There are also six medium priority industries that do not meet the standards. They are Electrical machinery (360), Gas and other utilities (497), Mining (003), Fabricated metals (340), Textiles (220), and Other metals (339). None of these is as clearly deficient as Other transportation equipment was among the high priority industries.

Our strategy for improving our estimates will be to improve our estimates for these eleven industries. Three of these industries are composed of more detailed industries that are not published. These unpublished details are shown below.

Unpublished Industries:

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Finance and insurance (016)
      Federal reserve banks...........601
      Commercial banks................602
      Mutual savings banks............603
      Savings and loan institutions...612
      Farm credit and home loan banks.613
      Credit unions...................614
      Other credit agencies..........619
      All other finance..............670
      Life insurance carriers........631
      Other insurance carriers.......633
      Insurance agents and brokers....640
Gas and other utilities (497),
      Gas except pipelines...........492
      Gas pipelines..................498
      Other utilities................494
Mining (003),
      Metal mining...................102
      Oil and gas extraction.........130
      Coal...........................120
      Nonmetallic....................140
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We will discuss the handling of the unpublished details shown above before considering the eight published details.

It would be inappropriate to apply the same standards to unpublished detailed industries as we are applying to published industries. First, the unpublished detailed

industries vary widely in size and volatility, and, therefore, in importance in the estimation of the published detailed and of total spending. Second, since they are unpublished, it would be wasteful to expend scarce resources bringing an unpublished industry into compliance with a standard that is not yet met by all published industries. As was argued earlier,

> An industry is "acceptable" when ... the standards are met. When all published industries meet at least one standard we can apply the same (or modified) standards to the detailed industries that are tabulated but not published.

For each unpublished detailed industry listed above, Table 5 shows the number of respondents, the percent of industry spending accounted for by the respondents during the fourth quarter 1990 survey, and the mean proportion of Total nonfarm spending accounted for by each industry from 1963 to 1989. We will apply a simple, ad-hoc standard to these detailed industries. Each industry should have at least 50 respondents, or its respondents should account for at least 50 percent of the total industry spending.

These alternative standards are related to the alternatives chosen for the published industries. Each of these unpublished industries constitutes a portion of a published industry. If one of these industries has 50 respondents, those respondents will count toward the 400 respondent standard for the published industry. The choice of 50 percent of total spending is a duplication of the 50 percent standard for the published industry. If each detailed industry has 50 percent of total spending accounted for, the published industry will have 50 percent accounted for.

A quick examination of the table reveals that Industries 612, 619, 670, 631, 498, 494, 102, and 120 do not meet this standard. In addition, we will include Industries 602 and 130 because they are large relative to the others and their respondents account for less than 25 percent of their total spending. We will group these industries with the eight published detail industries already identified. Thus we arrive at the list below.

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<u>Industries chosen for improvement priority</u>
Commercial banks (602)
Savings and loan institutions (612)
Other credit agencies (619)
All other finance (670)
Life insurance carriers (631)
Gas pipelines (498)
Other utilities (494)
Metal mining (102)
Oil and gas extraction (130)
Coal mining (120)
Other transportation equipment (373)
Blast furnaces-steel works (331)
Rubber (300)
Nonferrous metals (333)
Electrical machinery (360)
Fabricated metals (340)
Textiles (220)
Other metals (339)

IMPROVING THE PANEL

We want to improve the survey panel for the chosen industries. Table 6 provides a snapshot view of the panel we are trying to improve. It shows, the number of forms mailed, the number of responses received, and the response rate in the 90:IV survey for each industry. The table shows that this is a heterogeneous group of industries. The number of forms mailed varies from 366 in Electrical machinery (360) to 15 in Gas pipelines (498). Response rates vary from 66.7 in Gas pipelines (498) to 38.1 in Oil and gas extraction (130).

The survey staff work constantly at maintaining the mail panel and improving response. Therefore, even while the methodologies used to prioritize industries were being developed, the staff were improving the panel. Their intuition concerning weak areas of the panel overlapped with the results of the prioritization so some industries had been brought up to standards by the time they were identified for improvement. This was not revealed until the data from the fourth quarter survey of 1991 was available for analysis. Table 7 shows the number of respondents and the percent of spending accounted for by respondents in the industries chosen for improvement during the fourth quarter survey of 1991. Several industries now met the standards for their priority level. Our list of industries became:

<u>Industries</u> <u>still</u> <u>needing</u> <u>improvement</u>
Savings and loan institutions (612)
Other credit agencies (619)
All other finance (670)
Gas pipelines (498)
Other utilities (494)
Metal mining (102)
Oil and gas extraction (130)
Coal mining (120)
Other transportation equipment (373)
Blast furnaces-steel works (331)
Rubber (300)
Other metals (339)

<u>Response Rates</u>:

One obvious way to increase the number of respondents is
to improve response rates. There are 210 forms mailed to
companies in Oil and gas extraction so an increase in the
38.1 percent response rate could increase the number of
forms received enough to satisfy the mail panel standards
outlined earlier.

We took several steps in 1990-91 to improve response
from companies on the survey panel. We procured a FAX
machine. Some companies prefer responding by FAX to
responding by mail. Having the FAX machine available also
helps us obtain "last minute" responses from important
companies. We requested and obtained authority from the
Office of Management and Budget to mail a separate annual
questionnaire to companies that do not respond to our
quarterly mailings. This annual questionnaire is mandatory.
We worked with the Research and Methodology (R&M) staff to
conduct a Respondent Opinion Survey designed to elicit
information on why companies choose not to respond and what
actions we can take to overcome their reticence. Finally,
we have increased the number of follow up telephone calls to
nonrespondents by continuing each quarter's calls for
2 weeks after the completion of the estimates for that
quarter. We focus our efforts during these 2 weeks on
obtaining data for later use and encouraging the companies
to become respondents so future response rates will be
higher.

While these efforts are underway to improve response
rates to the survey, it is reasonable to expect that other
improvements also will be required.

One reason that response to the survey is not higher is
that the timely release of the survey results requires the
compilation of estimates before all responses are received.

Table 8 shows the number of fourth quarter 1990 forms received during each half month from January 1 to August 31, 1991. These forms were mailed to respondents on December 31, 1990. The fourth quarter survey results were released on April 10, 1991. There were obviously a large number of responses that were received too late to be included in the compilation of those results. This conflict between timely release and higher response is not unique to the P&E Survey. It does make the improvement of response rates more difficult and expensive because all the improvement must be achieved during a short time period between the mailing of the forms and the release of the results.

Panel Expansion:

We also can increase the number of respondents by supplementing the current mail panel. We recognize that this is a "second-best" solution. Our rationalization is that with more resources we would construct a full-blown probability sample. Without more resources, we must wait until the Annual Capital Expenditure Survey project can provide a probability-based sample that we can subsample. In the mean time, if we think of our ultimate mail list as being composed of a "certainty" component and a "random" component, we can regard this work as an augmentation of the "certainty" component of the mail panel[1].

To enlarge the panel for an industry we need to 1) identify a source(s) of companies to add to the panel, and 2) choose specific companies to add to the panel. The desire to obtain responses from any large company in an industry that does not report will surely be irresistible, so we acknowledge that the companies almost certainly will be selected simply on the basis of size. This biases our results toward large companies within each industry. It biases the overall survey results less than the individual industry results because some of the industries chosen for priority improvement may be composed of firms that are small- to medium-sized in relation to the economy as a whole. Choosing the largest nonresponding companies within an industry composed of small companies need not bias the overall survey results toward large companies.

Sources of companies to add to the panel can be identified in several ways. We worked with the Research and Methodology (R&M) staff in the development of a list of all multi-unit companies represented on the Census Bureau's Standard Statistical Establishment List. The R&M staff then

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1. Easley Hoy pointed out this argument.

used this list of companies to provide us with a listing of the 10 largest multi unit companies in each of the 59 detailed industries that we survey each quarter. Each of these companies was checked against the P&E Survey panel and the 200 companies not already on the panel or already requesting exclusion were added.

In addition, we identified the Census File Number (CFN) of most of the companies in our panel. We are utilizing other Census Bureau staff to identify the CFNs of as many remaining companies as possible. Knowing the CFNs of the companies in our panel, will allow us to compare our panel with other Census Bureau mail lists in the future. This will allow us to utilize those lists more effectively as future sources of companies to add to the panel.

After industries were chosen for priority treatment, a special team was formed to locate and select companies in these industries to add to the mail panel. Our plan was to have the team identify companies in the chosen industries that were not on the mail panel and then rely on the analyst responsible for normal survey processing of each industry to obtain as many responses as possible from the companies. In addition to the SSEL-based list of multiestablishment companies already mentioned, company names and addresses were taken from, Moody's Public Company Information on Disc.[1] The list below shows the approximate number of companies to be added to the mail panel for each industry.

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1. Moody's Public Company Information on Disc, Moody's Investors Service, New York, New York, January 1992. This is a CD-ROM based system that includes both data files and retrieval software.

Numbers of Companies To Be Added To Mail Panel

Industry	Number of Companies
Savings and loan institutions (612)	65
Other credit agencies (619)	42
All Other Finance (670)	65
Gas pipelines (498)	12
Other utilities (494)	49
Metal mining (102)	30
Oil and gas extraction (130)	39
Coal mining (120)	14
Other transportation equipment (373)	101
Blast furnaces-steel works (331)	19
Rubber (300)	33
Other metals (339)	21

Industries for which the number of companies to be added to the mail panel seems small (e.g. Coal mining) were found to have very few identifiable large companies that were not already on the mail panel. For these industries, response rate improvement and probability sampling of a universe of small companies may be the only avenues to improved estimates.

Chart 1. Weighted Change and Variance of Change
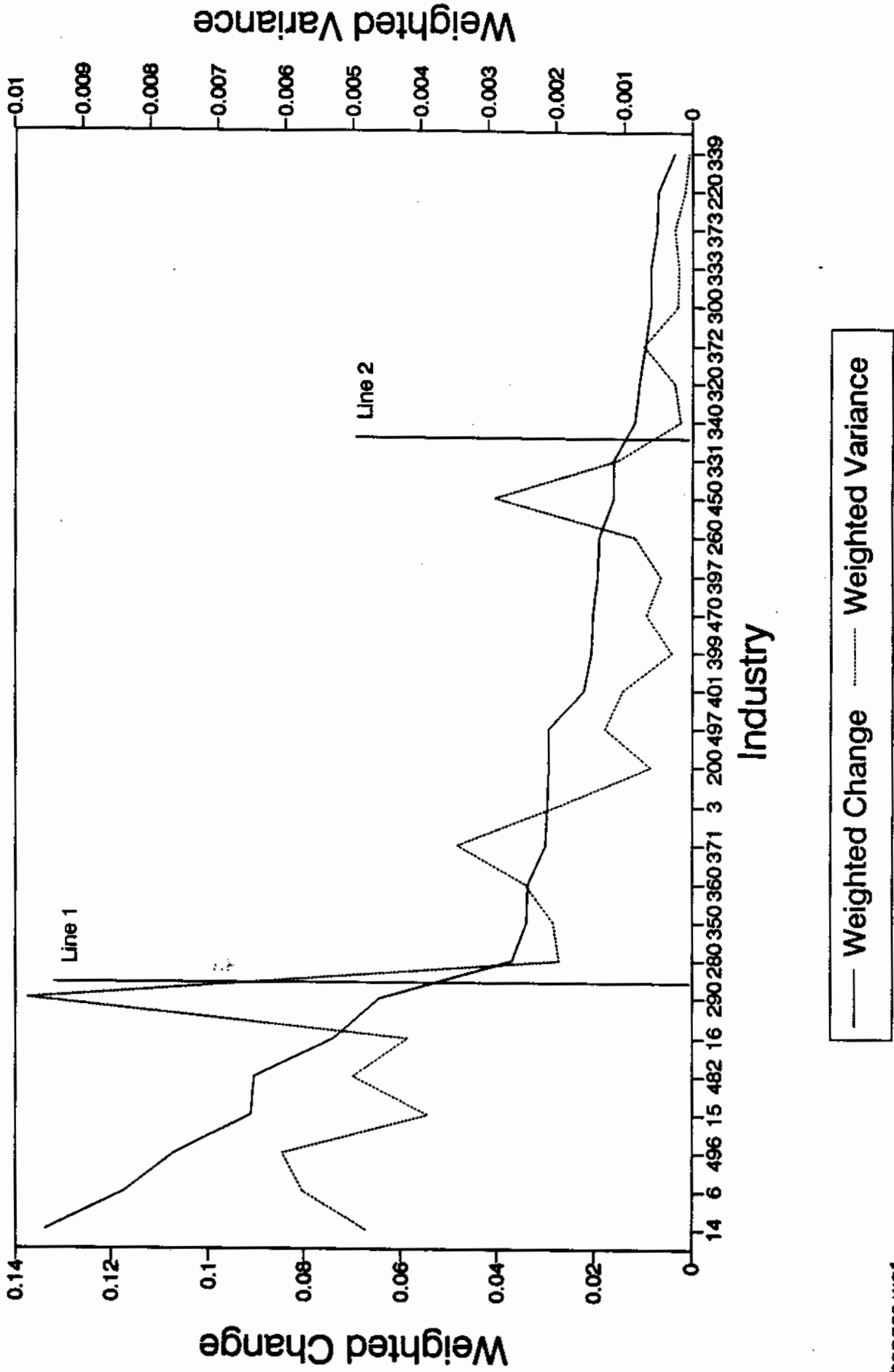Published Details Only, 1963-89

Weighted Change ——— Weighted Variance

Changes.wq1

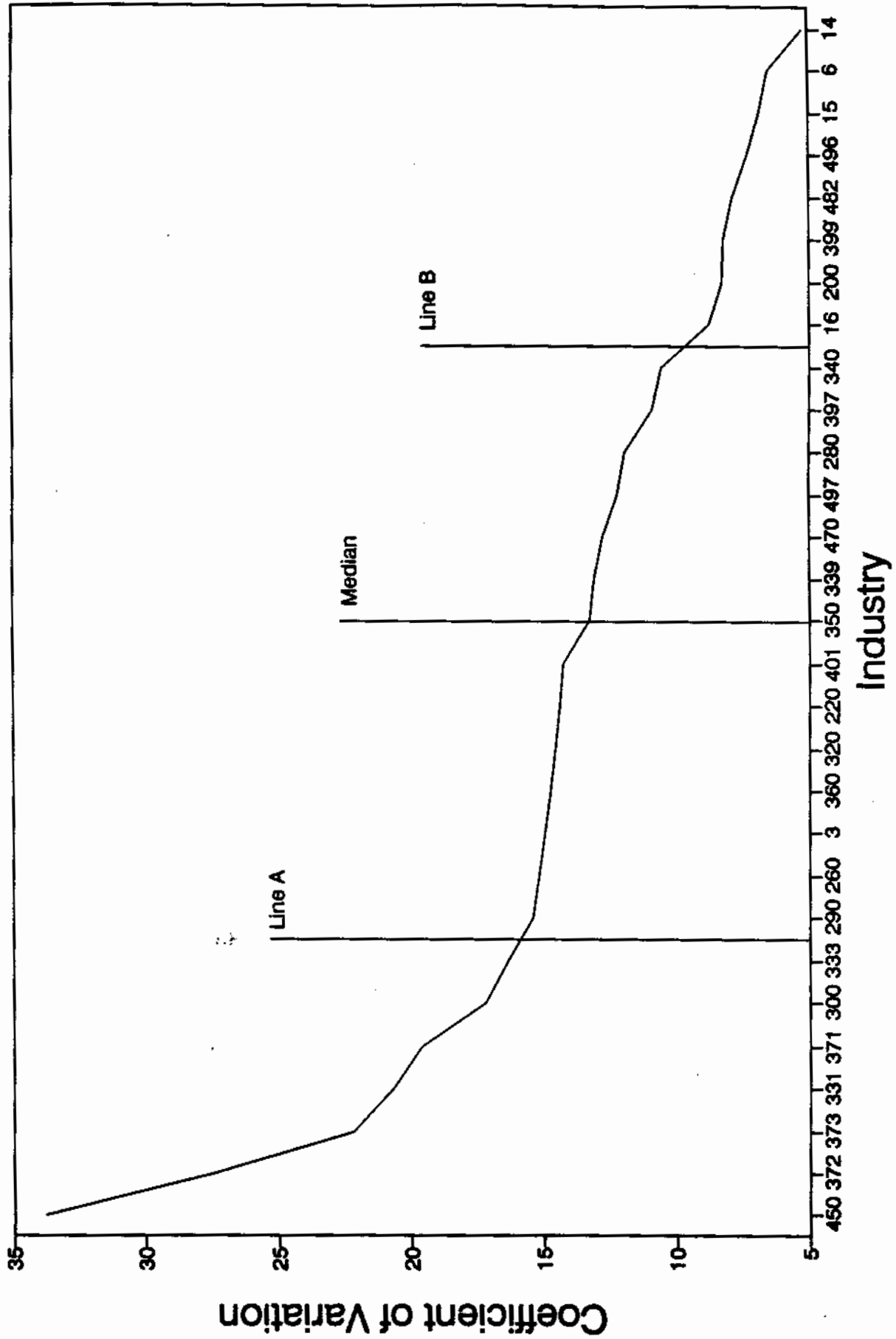# Chart 2. Coefficient of Variation of Annual Change, Most Detailed Pub'd Industries

Changes.wq1

Table 1. The Most Detailed Published Industries for the Plant and Equipment Expenditures Survey

Industry Name	Industry Number
Manufacturing details	
Blast furnaces, steel works.........	331
Nonferrous metals...................	333
Other metals........................	339
Fabricated metals...................	340
Electrical machinery................	360
Machinery, except electrical........	350
Motor vehicles......................	371
Aircraft............................	372
Other transportation equip.........	373
Stone, clay, and glass.............	320
Other durables......................	397
Food including beverage............	200
Textiles............................	220
Paper...............................	260
Chemicals...........................	280
Petroleum...........................	290
Rubber..............................	300
Other nondurables...................	399
Nonmanufacturing details	
Mining..............................	003
Railroad transportation............	401
Air transportation.................	450
Other transportation...............	470
Electric Utilities.................	496
Gas and other utilities............	497
Wholesale and retail trade.........	006
Finance and insurance..............	016
Personal and business services.....	015
Communication.......................	482
Surveyed annually..................	014

Table 2. Selected Statistics for Detailed Published Industries for 1963-89

Industry	W	X	Var(X)	WX	WWVar(X)	Coeff. of Variation of W	Coeff. of Variation of X
003	0.0273	1.0927	0.0266	0.0299	0.0020	36.7016	14.9160
006	0.1048	1.1181	0.0052	0.1172	0.0057	21.5924	6.4674
014	0.1251	1.0707	0.0031	0.1339	0.0048	19.0419	5.1798
015	0.0846	1.0767	0.0054	0.0911	0.0039	16.2880	6.8364
016	0.0638	1.1589	0.0103	0.0739	0.0042	46.9266	8.7588
200	0.0269	1.0989	0.0082	0.0295	0.0006	7.0059	8.2185
220	0.0065	1.0769	0.0240	0.0070	0.0001	34.4049	14.3848
260	0.0168	1.1402	0.0298	0.0191	0.0008	18.1902	15.1498
280	0.0337	1.1029	0.0172	0.0371	0.0019	11.4251	11.8879
290	0.0584	1.1048	0.0288	0.0645	0.0098	23.7685	15.3615
300	0.0077	1.1086	0.0363	0.0085	0.0002	21.5877	17.1957
320	0.0101	1.0805	0.0246	0.0109	0.0002	21.4034	14.5187
331	0.0144	1.1102	0.0527	0.0160	0.0011	32.5696	20.6851
333	0.0077	1.0842	0.0314	0.0084	0.0002	37.1679	16.3548
339	0.0033	1.0975	0.0206	0.0036	0.0000	20.6447	13.0938
340	0.0109	1.0779	0.0129	0.0118	0.0002	22.9881	10.5233
350	0.0307	1.1092	0.0216	0.0341	0.0020	11.9559	13.2589
360	0.0297	1.1346	0.0278	0.0337	0.0024	22.7135	14.6863
371	0.0274	1.0938	0.0461	0.0300	0.0035	22.5526	19.6326
372	0.0086	1.1263	0.0958	0.0097	0.0007	30.5061	27.4811
373	0.0061	1.1644	0.0668	0.0071	0.0003	39.7073	22.1924
397	0.0177	1.0888	0.0141	0.0193	0.0004	22.5583	10.9051
399	0.0184	1.1244	0.0084	0.0206	0.0003	17.4884	8.1655
401	0.0209	1.0618	0.0229	0.0222	0.0010	38.7754	14.2651
450	0.0136	1.1747	0.1573	0.0160	0.0029	42.6691	33.7642
470	0.0192	1.0603	0.0182	0.0203	0.0007	37.2037	12.7374
482	0.0826	1.0939	0.0073	0.0903	0.0050	9.6390	7.8314
496	0.0971	1.1003	0.0064	0.1068	0.0060	16.2877	7.2746
497	0.0262	1.1215	0.0186	0.0294	0.0013	21.0580	12.1771

Definitions of Variables:

W = the mean proportion of total nonfarm spending accounted for by this industry

X = the mean annual change in this industry

Var(X) = the variance of the annual changes in this industry

WX = the product of W and X

WWVar(X) = the product of the square of W and Var(X). The values shown also are multiplied by 100 for convenience in display.

Coeff. of Variation of W= the coefficient of variation of the proportion of Total Nonfarm accounted for by this industry. This is the standard deviation of the proportion as a percentage of the mean proportion.

Coeff. of Variation of X= the coefficient of variation of the annual change in this industry. This is the standard deviation of the change as a percentage of the mean change.

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Table 3. Most Detailed Published P&E Industries Classified By Importance In Determining Changes In Total Nonfarm P&E

Classification and Industry		Mean Proportion of Total Nonfarm P&E for 1963-89	Mean Annual Change, 1964-89
Most Significant			
Annual-only industries	014	0.1251	1.0707
Wholesale and retail trade	006	0.1048	1.1181
Electric utilities	496	0.0971	1.1003
Personal and business services	015	0.0846	1.0767
Communication	482	0.0826	1.0939
Finance and insurance	016	0.0638	1.1589
Petroleum	290	0.0584	1.1048
Moderately Significant			
Chemicals	280	0.0337	1.1029
Machinery, except electrical	350	0.0307	1.1092
Electrical machinery	360	0.0297	1.1346
Motor vehicles	371	0.0274	1.0938
Mining	003	0.0273	1.0927
Food and beverage	200	0.0269	1.0989
Gas and other utilities	497	0.0262	1.1215
Railroad transportation	401	0.0209	1.0618
Other nondurables	399	0.0184	1.1244
Other transportation	470	0.0192	1.0603
Other durables	397	0.0177	1.0888
Paper	260	0.0168	1.1402
Air transportation	450	0.0136	1.1747
Blast furnaces, steel works	331	0.0144	1.1102
Least significant			
Fabricated metals	340	0.0109	1.0779
Stone, clay, glass	320	0.0101	1.0805
Aircraft	372	0.0086	1.1263
Rubber	300	0.0077	1.1086
Nonferrous metals	333	0.0077	1.0842
Other transportation equip	373	0.0061	1.1644
Textiles	220	0.0065	1.0769
Other metals	339	0.0033	1.0975

Table 4. The Number of Respondents and the Percent Of Spending In Each Industry Accounted For By Respondents To The 1990:IV Survey

Classification and Industry		Number of Respondents (1990:IV)	Percent of Spending Accounted for by Respondents

HIGH PRIORITY INDUSTRIES

Because of Importance to Total:

Annual-only industries	014	2843	10.8
Wholesale and retail trade	006	499	12.3
Electric utilities	496	162	50.3
Personal and business services	015	417	26.8
Communication	482	60	65.3
Finance and insurance	016	317	23.6
Petroleum	290	52	58.2

Because of Volatility:

Air transportation	450	19	97.3
Aircraft	372	41	88.9
Other transportation equip	373	55	3.8
Blast furnaces, steel works	331	50	47.9
Motor vehicles	371	48	98.9
Rubber	300	89	39.7
Nonferrous metals	333	36	39.9

MEDIUM PRIORITY INDUSTRIES:

Because of Importance to Total:

Electrical machinery	360	178	33.3
Chemicals	280	118	73.8
Machinery, except electrical	350	201	51.2
Gas and other utilities	497	70	36.0
Food and beverage	200	138	44.9
Mining	003	169	24.6
Paper	260	66	44.6
Other nondurables	399	259	30.4
Other durables	397	327	65.9
Railroad transportation	401	12	48.3
Other transportation	470	514	46.2

Because of Volatility:

Fabricated metals	340	178	19.1
Stone, clay, glass	320	74	41.1
Textiles	220	78	31.4
Other metals	339	80	30.8

Table 5. The Number of Respondents and the Percent Of Spending
          In Each Industry Accounted For By Respondents
          To The 1990:IV Survey: Annual Data

Industry	Number	Number of Respondents	Percent of Spending Accounted for by Respondents	Mean Proportion of Total Nonfarm P&E for 1963-89 (X 100)
Finance and insurance (016)				
Federal reserve banks...........601		na	na	.03
Commercial banks................602		85	12.91	3.23
Mutual savings banks............603		21	60.81	.06
Savings and loan inst...........612		40	47.73	.35
Farm credit and home loan banks.613		na	na	.01
Credit unions...................614		na	na	.09
Other credit agencies...........619		19	33.10	.62
All other finance...............670		27	6.53	.59
Life insurance carriers........631		39	40.83	.76
Other insurance carriers.......633		57	16.31	.48
Insurance agents and brokers....640		na	na	.17
Gas and other utilities (497),				
Gas ex pipelines................492		42	52.05	.89
Gas pipelines...................498		10	22.15	1.24
Other utilities................494		10	6.80	.45
Mining (003),				
Metal mining....................102		12	7.09	.32*
Oil and gas extraction.........130		80	21.90	1.59*
Coal...........................120		16	14.59	.61
Nonmetallic....................140		36	85.60	.21

Notes:
  The mean proportions of Total Nonfarm have been multiplied by 100 for
     convenience.
  "na" indicates that an alternative methodology is used to estimate
     this industry. The estimates are not based on responses from
     companies in this industry.
  * Industries 492 and 498 have been estimated separately since 1972
     so the mean shown for those industries is for 1972-89.

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Table 6. Number Mailed, Number Responding And Response Rates For
 Priority Improvement Industries: 1990:IV Annual Survey Data

Classification and Industry	Number of Forms Mailed	Number of Respondents	Response Rate
Commercial banks.................602	205	85	41.5
Savings and loan inst...........612	103	40	38.8
Other credit agencies...........619	41	19	46.3
All other finance...............670	69	27	39.1
Life insurance carriers.........631	83	39	47.0
Gas pipelines...................498	15	10	66.7
Other utilities.................494	20	10	50.0
Metal mining....................102	26	12	46.2
Oil and gas extraction..........130	210	80	38.1
Coal............................120	39	16	41.0
Other transportation equip 373	112	55	49.1
Blast furnaces, steel works 331	83	50	60.2
Rubber 300	158	89	56.3
Nonferrous metals 333	68	36	52.9
Electrical machinery 360	366	178	48.6
Fabricated metals 340	326	178	54.6
Textiles 220	162	78	48.1
Other metals 339	152	80	52.6

Table 7.   The Number of Respondents and the Percent Of Spending In Each
           Industry Accounted For By Respondents To The
                    1991:IV Annual Survey Data

Classification and Industry	Number of Respondents	Percent of Spending Accounted for by Respondents
Commercial banks.................602	124	12.3
Savings and loan inst...........612	49	27.2
Other credit agencies...........619	24	53.6
All other finance...............670	39	18.1
Life insurance carriers.........631	58	82.9
Gas pipelines...................498	11	29.8
Other utilities.................494	53	28.2
Metal mining....................102	22	19.8
Oil and gas extraction..........130	109	27.5
Coal............................120	31	28.3
Other transportation equip 373	76	11.4
Blast furnaces, steel works 331	60	45.4
Rubber 300	102	45.4
Nonferrous metals 333	45	73.9
Electrical machinery 360	239	34.2
Fabricated metals 340	223	28.1
Textiles 220	97	41.6
Other metals 339	97	33.7

Table 8. Numbers of 1990:IV Forms Received in Half Month Intervals During 1991

Time Interval	Number of Forms Received
Jan. 1 - Jan. 15	637
Jan. 16 - Jan. 31	1104
Feb. 1 - Feb. 15	959
Feb. 16 - Feb. 28	1011
Mar. 1 - Mar. 15	447
Mar. 16 - Mar. 31	207
Apr. 1 - Apr. 15	75
Apr. 16 - Apr. 30	50
May 1 - May 15	34
May 16 - May 31	18
Jun. 1 - Jun. 15	17
Jun. 16 - Jun. 30	10
Jul. 1 - Jul. 15	5
Jul. 16 - Jul. 31	8
Aug. 1 - Aug. 15	5
Aug. 16 - Aug. 31	4
After Aug. 31	13

Appendix: Evaluating the assumption that the proportions of total spending accounted for by various industries are stable over time.

We evaluated this assumption in three ways. First, we tabulated the coefficients of variation (CV) of the proportions of Total nonfarm spending accounted for by each of the 29 detailed industries. Table 2 shows these CV's. The CV of the proportions of any industry is the standard deviation of the proportions observed for that industry from 1963 to 1989 expressed as a percentage of the mean of those proportions. All other things the same, a smaller CV indicates a more stable data series. The CV of these proportions range from a maximum of 46.9 for Industry 016 to a minimum of 7.0 for Industry 200. This result is regarded as inconclusive.

The second check on the validity of assuming stable proportions was to calculate what the annual percent change in Total nonfarm spending would have been if the proportions accounted for various detailed industries were fixed. Table A1 shows the actual annual percentage change in Total nonfarm spending and the annual percentage change in Total nonfarm spending implied by fixed weights of detailed industries. Chart A1 displays these total changes. The annual percentage change implied by fixed weights is calculated as the weighted sum of the changes in the detailed industries when the average proportion of Total nonfarm accounted for by each industry is used as its fixed weight.

We can see that any substantial changes in individual industry weights are canceling out because the annual changes in the total implied by an assumption of fixed weights is almost identical to the actual annual changes in the total. This implies the assumption of stable proportions is acceptable.

Our third and final approach was to examine some specific industries. Chart A2 shows the proportion of Total nonfarm spending accounted for by each of six industries from 1963 to 1989. It is clear that there have been systematic shifts, with Industry 014 decreasing as a proportion of the total while Industries 006, and 016 have increased.

Obviously, there are changes in the proportions. However, the changes are accounting for a small part, if any, of the change in the total. Assuming the proportions are stable, we dropped the right term in equation 2.A.

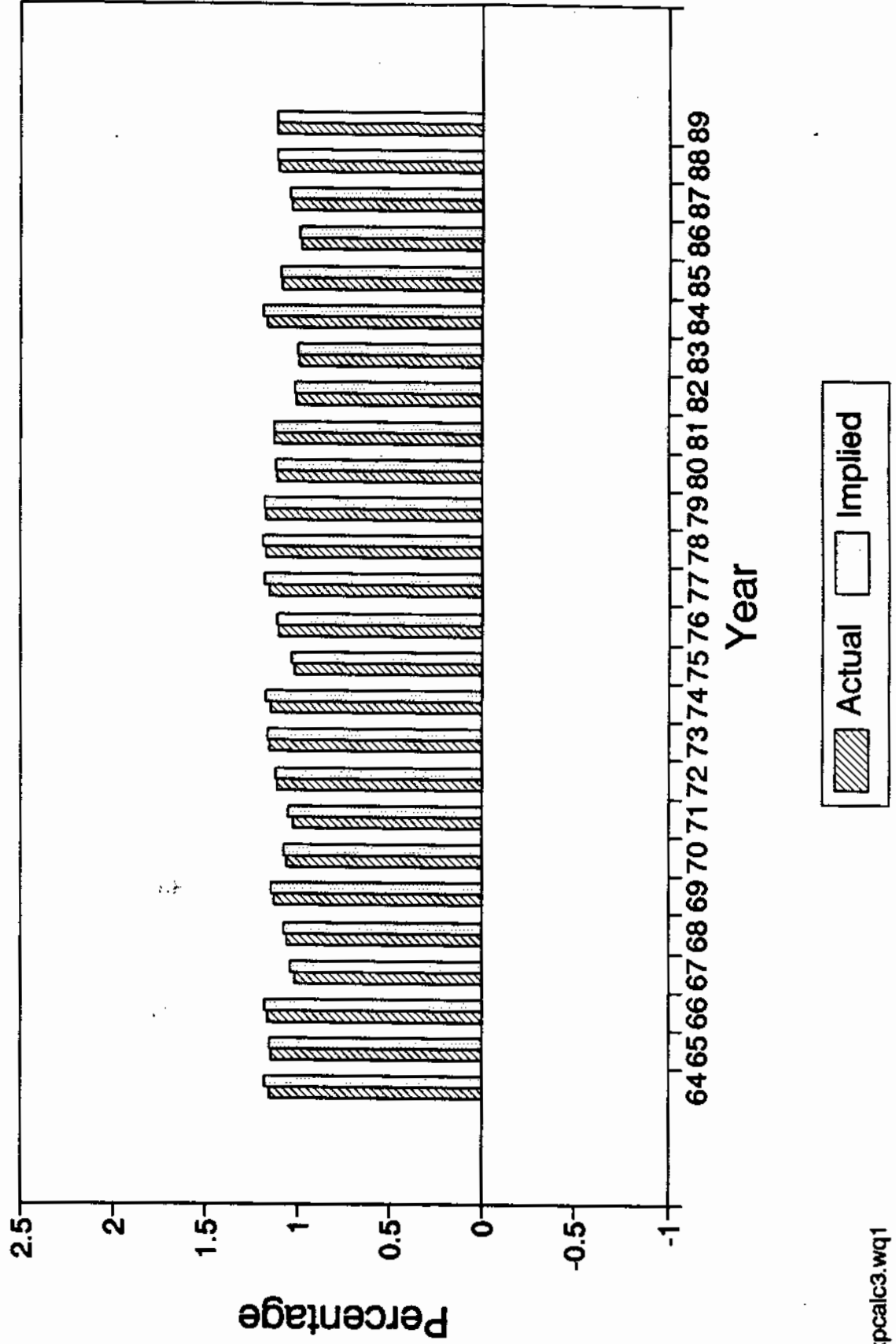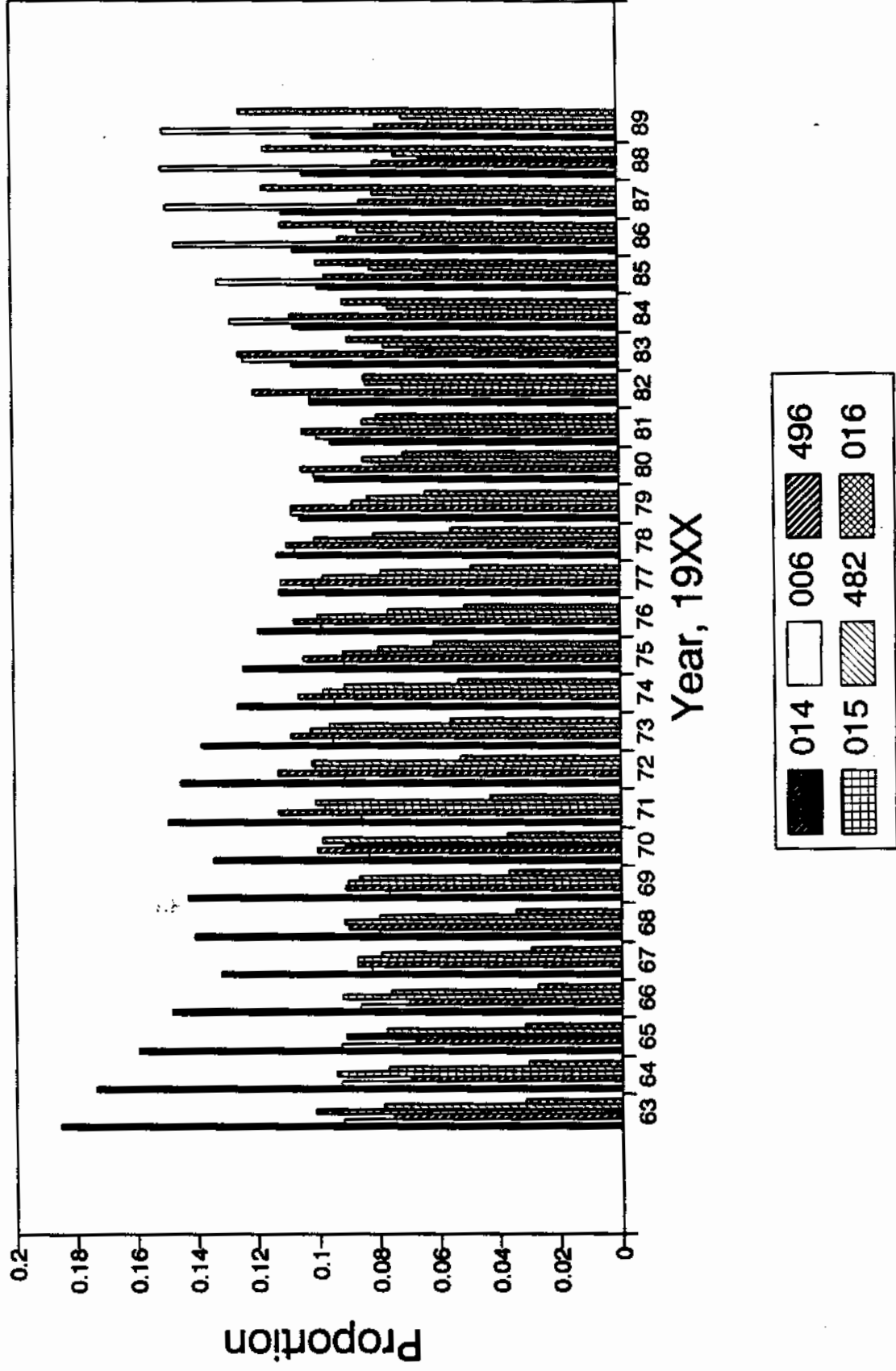# Chart A1. Annual Percent Change in Total Nonfarm (Actual and Implied by Fixed Weights)

Percentage

Year

64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

▨ Actual   ☐ Implied

expcalc3.wq1

Chart A2. Proportions of Total Nonfarm Accounted For By Most Significant Industries

Year, 19XX

Proportion

014 006 496
015 482 016

Annprop.wq1

Table A1. Annual Percentage Change in Total Nonfarm: Actual Change and Change Implied By Fixed Weights

Year	Actual Change	Implied Change	Difference
1964	1.1573	1.1798	-0.0225
1965	1.1414	1.1571	-0.0157
1966	1.1671	1.1789	-0.0119
1967	1.0145	1.0387	-0.0242
1968	1.0609	1.0802	-0.0193
1969	1.1248	1.1468	-0.0220
1970	1.0613	1.0792	-0.0179
1971	1.0286	1.0485	-0.0200
1972	1.1075	1.1237	-0.0162
1973	1.1517	1.1647	-0.0129
1974	1.1477	1.1749	-0.0271
1975	1.0173	1.0302	-0.0129
1976	1.1064	1.1124	-0.0060
1977	1.1570	1.1793	-0.0223
1978	1.1742	1.1920	-0.0178
1979	1.1671	1.1818	-0.0147
1980	1.1151	1.1215	-0.0064
1981	1.1279	1.1268	0.0011
1982	1.0120	1.0170	-0.0050
1983	0.9908	1.0034	-0.0126
1984	1.1630	1.1857	-0.0227
1985	1.0874	1.0942	-0.0069
1986	0.9828	0.9931	-0.0103
1987	1.0322	1.0392	-0.0070
1988	1.1012	1.1076	-0.0064
1989	1.1096	1.1110	-0.0014