PUBLISHED VERSUS SAMPLE STATISTICS FROM THE ASM: IMPLICATIONS FOR THE LRD

by

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Abstract

In principle, the Longitudinal Research Database (LRD) which links the establishments in the Annual Survey of Manufactures (ASM) is ideal for examining the dynamics of firm and aggregate behavior. However, the published ASM aggregates are not simply the appropriately weighted sums of establishment data in the LRD. Instead, the published data equal the sum of LRD-based sample estimates and nonsample estimates. The latter reflect adjustments related to sampling error and the imputation of small-establishment data. Differences between the LRD and the ASM raise questions for users of both data sets. For ASM users, time-series variation in the difference indicates potential problems in consistently and reliably estimating the nonsample portion of the ASM. For LRD users, potential sample selection problems arise due to the systematic exclusion of data from small establishments. Microeconomic studies based on the LRD can yield misleading inferences to the extent that small establishments behave differently. Similarly, new economic aggregates constructed from the LRD can yield incorrect estimates of levels and growth rates. This paper documents cross-sectional and time-series differences between ASM and LRD estimates of levels and growth rates of total employment, and compares them with employment estimates provided by Bureau of Labor Statistics and County Business Patterns data. In addition, this paper explores potential adjustments to economic aggregates constructed from the LRD. In particular, the paper reports the results of adjusting LRD-based estimates of gross job creation and destruction to be consistent with net job changes implied by the published ASM figures.

Keywords: Longitudinal data, Annual Survey of Manufactures, gross job flows

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I. Introduction

The Longitudinal Research Database (LRD) maintained by the Center for Economic Studies at the U.S. Bureau of the Census is a vital source of annual and quarterly data on the manufacturing sector between 1972 and 1986. By linking successive Annual Surveys of Manufactures (ASM) at the establishment level, the LRD affords a unique opportunity to study the time-series behavior of a large, national probability sample of manufacturing establishments. The LRD has been used to study mergers (McGuckin, Nguyen, and Andrews 1990), diversification (Streitwieser 1990), productivity (Lichtenberg & Siegel 1990), and firm growth (Dunne, Roberts, Samuelson 1989a, 1989b, and Pakes and Olley 1990). Moreover, the LRD includes sample weights that, in principle, allow estimation of new industry and sector aggregates that exploit the longitudinal establishment linkages. Davis and Haltiwanger (1989,1990) exploit these linkages to measure and study annual and quarterly gross job flows.

Despite broad coverage, the LRD does not sample the entire manufacturing universe. The ASM estimates published by the Census Bureau (hereafter, published or ASM) equal the sum of nonsample estimates and LRD-based sample estimates. The nonsample portion of the published ASM figures reflect adjustments related to sampling error and the imputation of small-establishment data. These nonsample components of the published ASM figures have previously been unavailable to LRD users. Although the LRD data are by far the largest component of the ASM figures, marked cross-sectional and time-series differences exist between the ASM and LRD.

Differences between the ASM and LRD raise questions for users of both data sets. For ASM users, time-series variation in the difference indicates potential problems in consistently and reliably estimating the nonsample portion of the ASM. For LRD users, potential sample selection problems arise. Since the nonsample component of the ASM primarily reflects the behavior of very small establishments, systematic differences between movements in the sample and nonsample components presumably reflect differences in the behavior of large and small plants. Thus, microeconomic studies based on the LRD can yield misleading inferences to the extent that small establishments behave differently and are systematically excluded from the sample. By the same token, new economic aggregates constructed from the LRD can yield incorrect estimates of levels and growth rates.

This paper documents cross-sectional and time-series differences between ASM and LRD estimates of levels and growth rates of total employment, and compares them with employment estimates provided by Bureau of Labor Statistics (BLS) and County Business Patterns (CBP) data. For total manufacturing, employment level and growth rate estimates display a high degree of similarity across all four data sources. Similarities diminish markedly for two- and four-digit industries dominated by small establishments. In addition, the correspondence between the ASM and LRD deteriorated after 1979, when ASM sampling procedures changed. Perhaps most troublesome, discrete changes in the divergence between ASM and LRD-based estimates occur in the first year of each panel and in census years. This pattern reflects cumulative multi-year employment changes that are first reflected in the published ASM figures in census years and first reflected in the LRD at the commencement of a new five-year panel. Although ASM figures typically correspond more closely to BLS and CBP figures, the LRD appears to provide superior growth rate estimates in certain years. In any case, further analysis of ASM-LRD differences seems warranted.

Beyond documenting ASM-LRD differences, this paper explores potential adjustments to economic aggregates constructed from the LRD. In particular, the paper reports the results of adjusting the

LRD-based estimates of gross job creation and destruction calculated by Davis and Haltiwanger (1989, 1990) to be consistent with the net job changes implied by published ASM figures. LRD-based estimates of gross job flows represent lower bounds on true (ASM) gross job flows, because they fail to capture job creation and destruction among manufacturing establishments outside the sampling frame of the LRD. A more important concern regarding the LRD-based measures of gross job flows is that, by neglecting the behavior of very small establishments, they possibly provide a distorted picture of time-series and cross-sectoral patterns of covariation between gross job creation and gross job destruction.

In practice, the adjustment of LRD-based gross job flow measures for consistency with the ASM measure of net job flows raises difficult problems. This paper implements and evaluates a simple methodology that treats the difference between the ASM and LRD at the four-digit level of disaggregation as a pseudo-establishment. Job creation and destruction among pseudo-establishments are calculated and added to the LRD-based figures to obtain adjusted gross flows. This procedure understates true gross flows from the nonsample portion of the ASM but potentially improves upon the unadjusted measures. Unfortunately, in census years and in the first year of each panel, the nonsample portion exhibits discrete employment changes that distort adjustments to the gross flows. In other years, the adjustment procedure appears to work well but have little impact.

We draw two conclusions from our adjustment exercise. First, the simple adjustment procedure yields estimates of gross job flow rates that are inferior to their counterparts based solely on the LRD. Second, we find no evidence that inferences based on the time-series properties of the LRD-based gross job flow measures are distorted by a sampling frame that excludes very small establishments.

II. ASM Sampling Procedure

A. LRD Background

The LRD is a comprehensive collection of establishment-level economic data on U.S. manufacturing firms between 1972 and 1986. The annual portion contains about 860,000 observations on 160,000 plants on many aspects of production: shipments, employment, capital expenditures and assets, raw material inputs, inventories, payroll, and many other variables. The LRD also contains detailed classification data such as geography, industry, ownership, and plant type. For details of the LRD's specific contents, see McGuckin and Pascoe (1989).

The annual portion of the LRD comprises the linked sample data from the ASM. Conducted since 1949, the survey tracks for five years a panel of establishments selected from a size-weighted probability sample. Sampled establishments represent about one-sixth of manufacturing plants and three-fourths of employment. The sampling frame encompasses all but the smallest establishments, typically those with five or fewer employees. Large establishments are sampled with certainty. A new panel of establishments is selected in years ending in 4 and 9 (e.g., 1974, 1979) from the universe of manufacturing establishments identified by the quinquennial Census of Manufactures (CM), which occurs in years ending in 2 and 7 (e.g., 1982, 1987). The annual LRD contains four panels: 1969-73, 1974-78, 1979-83, and 1984-88. (Data for 1969-71 are not available; data for 1987 and later years will be added as they become available.) New establishments are added to ongoing panels to incorporate births and preserve the representative character of the panel.

B. Published ASM Estimates

Published aggregate ASM statistics reflect additional information beyond that contained in the LRD. In particular, the published data include two additive adjustments representing sampling error and small-establishment imputation. Let X represent an ASM data item (in this paper X is total employment). Then published ASM X is

$$X^{A}(st) = X^{L}(st) + X^{F}(st) + X^{I}(st) , \qquad \textbf{(1)}$$

where the superscript A denotes ASM, L denotes LRD, F denotes fixed-base difference (sampling error), I denotes imputed data, s refers to sector (e.g., industry), and refers to time (year). The empirical section shows that these two nonsample components, though small relative to the sample component, can be important influences on the published levels and growth rates.

During the period covered by the LRD, the methodology used to estimate the components of equation (1) underwent significant changes, thereby affecting the relationship between the published ASM and sample LRD data. To understand the behavior of these components, it is important to understand the development of the ASM sampling procedure, so the remainder of this section describes each component in more detail. Complete descriptions of these sampling issues can be found in Ogus and Clark (1971) and Waite and Cole (1980).

C. Sample Estimates

In selecting an ASM sample of establishments from the CM universe, the Census Bureau uses a sampling technique that defines independent sampling units and uses a probability proportional to size (PPS) method to assign selection probabilities to each unit. These probabilities are independent of the selection outcome of all other sampling units or groups of units. A linear unbiased estimate of, for example, total employment of all sampling units (u) at time t is

$$X^{L}(st) = \sum_{u} W(ut)\ X^{L}(ust)\ , \qquad \textbf{(2)}$$

where W(ut), the sample weight, is the reciprocal of the sampling probability. A sampling probability of 0.25 implies a sample weight of 4 and the sampling unit's data represents that of four units. The variance of the estimate (2) is minimized when the selection probability is a constant fraction of sampling unit size. In principle, a separate selection probability should be assigned for each data item, but, in practice, a common size measure determines the sample weight for all data items. The current size measure for the ASM weights is total value of shipments within a product class. An advantage of this sampling procedure is the independence of selection probabilities because it permits arbitrary assignment of certain probabilities, such as one (certain inclusion) for large establishments.

Two significant changes in the sample selection procedure occurred during the LRD period. The first change pertained to the definition of the sampling unit. Before 1979, the company (the group of establishments legally attached to a single manufacturing organization) served as the sampling unit. If a company was selected (using probabilities derived from company size), then all establishments belonging to that company were included in the panel. Since 1979, however, the establishment has been the sampling unit. Only establishments selected (using probabilities derived from establishment size) are included in the panel. The Bureau switched to an establishment-based sampling scheme because it requires fewer establishments to achieve the same estimation efficiency.

The second major sampling change altered the nature of the sample weights. Since 1963, the CM has excused certain very small single-unit (SU) establishments from completing the survey to reduce respondent burden (i.e, they were given sample weights of zero). During the LRD period these establishments, known as administrative records (ARs), represented about one- third of the total manufacturing universe of approximately 350,000 establishments. From 1972-78, the sample weights generated for the remaining non-AR establishments took account of the existence of the AR establishments, in which case (2) is a suitable estimate of the aggregate quantity. Beginning in 1979, however, the sample weights did not account for AR establishments, and so it became necessary to independently estimate AR establishment data and add it to the weighted sample estimate (2). This independent estimate is the imputed component of (1) and is described in the next subsection.

To maintain the representativeness of the sample, the Census Bureau adds births of new establishments to the panel each year. Three types of establishments are added to a panel. Multi-unit births are identified from the Bureau's annual Company Organization Survey (COS), in which multi-unit companies describe their organizational status. Single-unit births are identified from periodic listings of Social Security Administration (SSA) issues of new Employer Identification (EI) numbers. (Since many births are very small or related to non- ASM companies, not all are added to the panel.) Finally, during the company-based survey period, many establishments were added due to corporate reorganization.

Timing difficulties arise regarding births. Nearly all births appear in the ASM panel for the first time in the year following the actual birth year. Consequently, both ASM and LRD estimates reflect measurement errors generated by the mistiming of births. Davis and Haltiwanger (1989, 1990) discuss procedures for adjusting the employment data to address this problem. By focusing on March total employment in the analysis below, the extent of timing mismeasurement is mitigated, because births that occur after March 12 are properly timed with respect to March employment figures. (There are related but less severe difficulties for deaths; see Davis and Haltiwanger (1989,1990)).

D. Nonsample Estimates

Two nonsample components also enter into the published ASM estimates. These nonsample estimates are: 1) constant (within panel) estimates of the sampling error called the fixed-base difference (FBD); and 2) imputed data for the ARs and births not included in the panel, a total called the impute (or small) block (IB).

The FBD represents an adjustment of the LRD estimates for sampling error using estimates from the most recent previous CM. The FBD is

$$X^F(st) = \sum_{i \in CM(s,t-2)} X^L(is,t-2) - \sum_{i \in ASM(st)} W(ist)\ X^L(is,t-2) \tag{3}$$

for the period t representing the first year of a panel. CM(st) and ASM(st) denote the sample of establishments in the respective survey. The FBD remains at this level through the third year of the panel. (In the fourth panel year, the CM estimate is used in generating the published ASM figure.) If the panel-based weighted estimates equaled the CM figure, the FBD would be zero (abstracting from the impute block). Minimizing the FBD is one panel selection criterion. Notice that during the panel another CM occurs so that any error accumulated during the first three panel years is eliminated by recalculating the FBD. This recalculation is done and applied to the fifth panel year sample estimate analogously to (3).

The imputed estimates for establishments outside the panel (ARs and small births) are derived from payroll and employment information obtained by the Bureau from IRS data. For each impute-block establishment, the Bureau receives March total employment and quarterly payroll (PAY) information from which it imputes estimates of all other CM data items. Next, the impute-block employment and payroll data are tabulated to four-digit SIC industry by state by metropolitan statistical area (MSA) cells. Then the imputed data for that cell is

$$X^I(st) = \left[\frac{\sum_{i \in ASM(st)} X^L(ist)}{\sum_{i \in ASM(st)} PAY^L(ist)}\right]\left[\sum_{i \in IB(st)} PAY(ist)^I\right]. \quad \textbf{(4)}$$

That is, the imputed value of the data item equals the industry average ratio of the item to payroll times cell payroll.

III. Empirical Evidence

A. Data Description

The data will be described using the following notation: A stands for ASM, L for LRD, D for the difference A-L, F for FBD, and I for IB, B for BLS, and C for CBP. In census years the CM estimate is the published number but for simplicity we use ASM (A). Exceptions are noted. The variables used are total employment (TE), production worker employment (PW), and other employment (OE). Sector and time subscripts are suppressed unless necessary for expositional clarity.

Because the definitions and timing of employment vary across data sources, it is necessary to consider different types and periods of employment measures. ASM and LRD quarterly PW estimates represent employment on the 12th of March, May, August, and November, and OE is collected for March 12. Annual TE is

$$TE = \sum_{q=1}^{4} PW(q)/4 + OE , \quad \textbf{(5)}$$

where q indexes quarters. March LRD TE is

$$TE = PW(1) + OE \quad \textbf{(6)}$$

Since published ASM data do not include an analogue of (6), we estimate published ASM March TE by multiplying annual ASM TE by the ratio of annual ASM TE to annual LRD TE.

The CBP data are only available for March, and BLS March employment is that observed from the monthly establishment survey data. (An annual BLS analogue of (5) can be calculated.) The BLS data also contain the employment of auxiliary manufacturing establishments, which are owned by and support manufacturing enterprises but are not directly involved in manufacturing. The ASM, LRD, and CBP data exclude auxiliary establishments, whose employment amounts to approximately one million. We concentrate on the March employment data in the remainder of this section.

Historical FBD and IB data are not included in the LRD data. In principle, it is possible to use the LRD and CM data available at the Center for Economic Studies to recreate the FBD using equation (3) and derive the IB (impute block) from 1979 forward using the formula ITE=ATE- LTE-FTE. Attempts to execute this procedure have been unsuccessful thus far, though we are still investigating the problem.

Fortunately, we obtained unpublished industry level FBD and IB data on actual FTE and ITE for 1982, 1983, and 1984. Given the constancy of FTE, a derived ITE, ITE^d, for 1979 to 1986 may be calculated from the formula

$$ITE^{d} = ATE - LTE - FTE . \tag{7}$$

There are thus two versions of the difference between ASM and LRD employment:

$$
\begin{aligned}
DTE &= FTE + ITE^{d} \\
DTE* &= FTE + ITE ,
\end{aligned}
\qquad \textbf{(8)}
$$

where ITE=ITE^d in the missing years, 1979-81 and 1985-86.

B. Comparisons of Levels and Growth Rates

Figures 1 and 2 plot the level and growth rate of total manufacturing employment estimated via a number of different methods and sources. The plots indicate that published ASM and LRD sample estimates follow the same basic time-series pattern. However, three sources of divergence stand out. First, the divergence between the levels of the ASM and the LRD estimates are much larger after 1979. This change reflects the effects of the switch to an establishment-based sample frame in 1979 and the tendency of ITE to grow over time. The effect of the change on growth rates is much less pronounced.

Second, there is a deterioration in the correspondence between the LRD and ASM that occurs within each panel. This is evidenced by a growing divergence in the levels within each panel and a sharp divergence in the growth rates between the ASM and the LRD in the first year of each panel. The latter reflects the correction incorporated into the LRD from the cumulative divergence that occurred in the previous panel.

Third, there is an increased divergence between the published and LRD levels and growth rates in census years (1977 and 1982). This is due to a cumulative intercensus distortion. Recall that published estimates reflect the entire manufacturing universe in census years. Accordingly, in census years reported one-year changes reflect cumulative changes since the previous census that were not previously incorporated into the published ASM figures.

Comparison with other data sources indicates that all of the estimates follow the same basic pattern in both levels and growth rates. BLS employment levels are higher for the entire period, reflecting the inclusion of auxiliary administrative establishments. The ASM estimates track the CBP and BLS estimates better than do the LRD estimates.

Quantitative evidence on growth rates for total manufacturing and 2-digit industries is presented in Table 1 (total manufacturing in this and all succeeding tables is denoted as industry 00). Several patterns emerge from Table 1. For total manufacturing, the mean growth rates across the published, weighted sample, BLS, and CBP measures are reasonably similar in magnitude, and the time-series standard deviations are highly similar. Thus, the table confirms the basic message of Figure 1 that, in terms of growth rates for total manufacturing, ASM-LRD differences are small.

There is considerable heterogeneity across industries in terms of the differences among published ASM, LRD, BLS, and CBP estimates of growth rates. Since small establishments dominate the behavior of the nonsample portion of the ASM, an obvious source of heterogeneity is differences in the size distribution of establishments. The mean establishment size is reported in the rightmost column of Table 1. For industries in which the establishment mean is relatively large (e.g., SIC 21-Tobacco, SIC 33-Primary Metals, SIC 37-Transportation Equipment), the mean and standard deviation of growth rates from the ASM and LRD are very similar. In contrast, for industries in which the establishment mean is relatively small (e.g., SIC 24-Lumber, SIC 27-Printing, SIC 39-Miscellaneous), the differences between the ASM and LRD growth rates in terms of means and/or standard deviations are large.

Time-series correlations of the employment growth rate estimates are reported in Table 2. For total manufacturing, the time-series pairwise correlations across all of the alternative growth rate series is quite high. However, the correlations between the ASM and either BLS or CBP are slightly higher than the correlations between the LRD and either BLS or CBP.

The diversity across industries in means and standard deviations indicated in Table 1 carries over to the correlations, shown in Table 2. Again, the industry size distribution is important. Industries dominated by large establishments (e.g., 33 and 37) have very high pairwise correlations. Industries dominated by smaller establishments (e.g.,20, 27, and 39) have substantially lower pairwise correlations, especially between the LRD and the ASM.

Figures 3 and 4 depict the substantial heterogeneity across industries. For Primary Metals (33), the time-series pattern of growth rates across the ASM, LRD, BLS and CBP is very similar. In contrast, for Food (20) there are sharp differences in the patterns of growth rates, especially between the LRD and the ASM.

While there is considerable diversity across industries, for most industries there is a high correlation between the LRD and ASM growth rates. This can be clearly seen from Figure 5 which plots a histogram of the correlations between LRD and ASM growth rates by 4-digit industry. The vast majority of 4- digit industries have a correlation in excess of 0.70. The non- trivial minority of 4-digit industries with low correlations are industries that present researchers with potentially severe sample selection problems.

As is apparent from Figure 1, the nature of the divergence between the ASM and the LRD varies across panels. Table 3 presents means and standard deviations of growth rates for the 1974-78 panel and the 1979-83 panel. Two observations stand out from Table 3. First, even for total manufacturing, the LRD estimates deviate substantially from the ASM
and other estimates to a far greater extent during the 1979-83 panel than during the 1974-78 panel. Second, even for industries characterized by small establishments (e.g, 27), the
divergence between the LRD estimates and the ASM estimates is relatively small for the 1974-78 period. These comparisons of levels and growth rates highlight several messages that emerge from

this analysis. First, the correspondence between the behavior of the LRD and ASM estimates is reasonably high for total manufacturing and very high for industries dominated by large establishments. Second, the correspondence between the LRD and ASM is better prior to 1979. Third, discrete changes in the divergence between the ASM and the LRD occur in the first year of each panel and in census years. Both of the latter effects reflect cumulative five-year changes that are concentrated in those respective years.

C. Decomposition of ASM Estimate

The behavior of the difference (DTE) between LTE and ATE is by construction driven by the behavior of FTE and ITE^d (or ITE). This section analyzes the decomposition of ATE in terms of its three true components, LTE, FTE, and ITE, rather than using ITE^d. Since FTE and ITE data are only available since 1979, we accordingly focus on the 1979-86 period.

Figure 6 plots the decomposition of ATE between 1979 and 1986. From 1979 to 1981, the difference between ATE and LTE grows very slightly. In 1982, the difference between ATE and LTE increases discretely. The difference between ATE and LTE remains large in 1983 and then falls substantially in 1984. From 1984 to 1986 the difference is relatively constant. The basic pattern is that the difference is relatively constant except in census years and in the first year of each panel.

Figure 7 shows that the most striking feature of DTE behavior is the discrete jump in 1982. Moreover, it is clear that much of the increase cannot be attributed to either an increase in ITE or FTE. This apparent contradiction of the identity linking the three components of ATE is reflected in the distinction between DTE and DTE^*. The latter represents what the difference in 1982 would have been if the published total had simply reflected the sum of the three components, LTE, FTE and ITE. However, published totals in a census year are based on the census totals rather than the sum of the three components. In 1982, we see that there is a large discrepancy between the sum of the three components and the census total.The other discrete change in DTE occurs in 1984. DTE drops substantially from 1983 to 1984. This decrease is attributable to a decline in both ITE and FTE between 1983 and 1984. This discrete change reflects the change in panels between 1983 and 1984.

Additional quantitative evidence on the relationship between the components of ATE is provided in Table 4. The striking finding from Table 4 is that while the growth rate correlation between ATE and LTE is quite high for total manufacturing and most 2-digit industries, the correlation between ATE and ATE^* is surprisingly low. ATE^* represents the sum of LTE, FTE and ITE, which equals ATE except in 1982-1984. The discrepancy in these years is apparently large enough to drive the correlation between the growth rates of ATE and ATE^* down substantially.

These results suggest that the discrete changes observed in published estimates in census years are due to factors other than discrete changes in FTE and ITE. Apparently, published totals in census years incorporate changes that have occurred between censuses but have not been reflected in the intervening published ASM estimates. These changes come from the discovery of births not identified in the prior five years, more accurate estimation of AR data, reclassification of nonmanufacturing establishments as manufacturing, and other sources. This implies that while census-year levels are undoubtedly accurate, estimating one-year changes from the difference between a census-year published total and a previous-year published total is apt to generate a biased estimate of the change. This raises doubts about how to interpret the time series behavior of ATE over intervals that include census years.

In contrast to the discrete change in 1982, the discrete change in DTE in 1984 does not raise questions about estimating changes from published ASM estimates. Rather, the discrete change in 1984 reflects a change in the relative importance of each of the components of ATE, with DTE becoming smaller and LTE becoming larger. This does, however, suggest that estimates of changes using LRD estimates are apt to be particularly unreliable in the first year of each panel. Similarly, using changes in DTE to represent changes in the behavior of AR cases and small births is apt to be unreliable in the first year of each panel. Both of these latter problems cause difficulties in developing procedures for adjusting LRD estimates to be consistent with published totals (as will become apparent in the next section).

D. Summary of Basic Findings

A summary of the relationship between ASM and LRD estimates is illustrated in Figure 8, which depicts the simplified development of a hypothetical ASM panel. In most years, the levels and growth rates of employment are more accurately estimated by the published ASM data. Exceptions to this conclusion follow.

In terms of employment levels, the sample LRD data are never superior to the published ASM data. In the first panel year the two estimates are the closest, but the sample LRD data deviate from the published data by a small FBD and (from 1979 forward) an impute block, which is at its smallest value. As the panel progresses, the sample LRD employment level increasingly deviates from the published ASM data (exhibited by the different slopes) because the impute block is growing and because the weighted sample estimate becomes biased over time. The latter effect occurs as establishment sizes change over time. Notice that the published ASM employment level is also biased and requires the large adjustment that occurs in the census year. This bias may come from births not detected between CMs, for example.

In terms of growth rates, the published ASM and sample LRD estimates are likely to be very similar in the second, third, and fifth panel years. However, the ASM estimate is preferable in the first year and the LRD estimate in the fourth (census) year for related reasons. In the census year, the ASM (CM) estimate jumps discretely, imposing the cumulative (undetected) changes from the previous four years. This potentially large growth rate probably overstates the true change, which the LRD -- because it doesn't impose the correction -- more accurately captures. The reverse occurs in the first panel year. The selection of a new panel, new sample weights, new IB, and new FBD discretely adjust the sample LRD level, causing a large and likely biased growth rate estimate. The first panel year problem with the sample LRD growth rate seems to be empirically larger than that for the published ASM data in the census year.

IV. Application to Gross Employment Flows

A. Motivation for Measuring Gross Flows

Considerable attention in both the data and research community has been devoted to estimating and studying gross worker flows across labor market states (i.e., employment, unemployment, not in the labor force, etc.). While these flows are clearly of interest, it is equally important to estimate and analyze gross job flows. In the absence of evidence from longitudinal establishment data on gross job flows, it has been difficult to determine whether observed large gross worker flows primarily reflect temporary layoffs and recalls plus continual sorting and resorting of workers across a given set of jobs, or alternatively, whether a large portion of worker turnover reflects gross job reallocation across establishments.

The LRD is well-suited to the measurement of high frequency (annual and quarterly) gross job flows. The LRD allows for careful treatment of births and deaths so that spurious entry and exit due to ownership change and other forms of reorganization can be controlled for. Further, the LRD provides detailed information that permits estimation of gross job flows across numerous key establishment characteristics. As such, the LRD offers substantial advantages over alternative data sources that can be used for this purpose (see, e.g., Leonard (1987), Birch (1981), and Armington and Odle (1982)).

Davis and Haltiwanger (1989,1990) report research on the cyclical properties and implications of gross job creation and destruction using gross job flows estimated from the LRD. In these studies, the impact of the nonsample portion of the ASM on gross job flows is neglected. In what follows, the role of the nonsample portion of the ASM on gross job flows is investigated. Procedures for incorporating the nonsample portion in gross job flow estimates are discussed and a crude version of these procedures is implemented. In the analysis, the focus is on annual gross job flows but the issues and procedures discussed apply to the quarterly job flow estimates as well.

B. Gross Job Creation and Destruction

The measures of gross job creation and destruction used here are those of Davis and Haltiwanger (1989, 1990). Creation is the sum of all new jobs in expanding establishments and destruction the sum of all lost jobs at contracting establishments. Expressed as rates relative to sector size, these measures are

$$POS = \sum_{i \in E+} \left(\frac{x(i)}{X} \right) g(i) \qquad \textbf{(9)}$$

$$NEG = \sum_{i \in E-} \left(\frac{x(i)}{X} \right) |g(i)| \ , \qquad \textbf{(10)}$$

where g(i) is the growth rate of establishment i at t, E+ is the set of establishments with positive and E- with negative growth rates, , x(i) is establishment size, and X is sector size. Size is measured as the average of employment at time t and t-1, i.e., x(it) = 0.5(x(it) + x(i,t-1)), and g(it) is the change in establishment employment divided by establishment size.

POS and NEG represent lower bounds on total creation and destruction because individual jobs within establishments cannot be distinguished. Thus a net establishment level job change of zero may include creation and destruction that merely alters the composition of types of jobs within establishments. To interpret POS and NEG, note that net employment growth is

$$NET = POS - NEG \ . \qquad \textbf{(11)}$$

Hence, POS and NEG represent the gross changes across establishments that underlie the observed net change. A summary measure of gross job reallocation is

$$SUM = POS + NEG \ . \qquad \textbf{(12)}$$

There are numerous interpretations of SUM. First, X times SUM represents the gross change in the number of employment positions at establishments. Second, X times SUM is an upper bound on the number of workers who must switch jobs and/or employment status to accommodate the redistribution of employment positions across establishments. Third, SUM is the size-weighted mean absolute deviation of establishment growth rates around zero. Accordingly, it has a formal statistical interpretation as a measure of dispersion.

C. Measurement Methodology

To obtain empirical estimates of the creation, destruction, and reallocation measures from the LRD, it is necessary to calculate creation and destruction for each establishment at each time t. If measured employment in the current and prior years are both positive, measurement proceeds as in (9) and (10). But, if measured employment is positive in one year but zero in the other, then additional information is used to determine whether a true birth or death occurred. For the purposes of computing POS, a birth is recorded only if the establishment had zero employment in prior years of the panel and if the LRD coverage code, which provides information on organizational changes, indicates that a new establishment is born. Likewise, for the purposes of computing NEG, a death is recorded only if the establishment had an appropriate coverage code.

The reselection of a new panel of ASM establishments every five years generates difficulties in measuring gross flows in the first year of each panel. Since only about one-third of the establishments in the previous panel continue into the current panel, simple calculation of gross employment change will mistakenly overestimate the change by attributing panel entry and exit to creation and destruction. However, information on gross job creation and destruction for continuing establishments across panels can be used to impute total gross job creation and destruction for the first period of each panel. An imputation based upon simple bivariate regressions is used in the results that follow. Since the imputation used is crude, considerable caution should be used in interpreting results for 1974, 1979 and 1984.

D. Adjusting the Gross Flows

In Davis and Haltiwanger (1989,1990) the creation and destruction measures were calculated using only the sample portion (i.e., LRD) of the data that underlie the published ASM figures. In principle, it is desirable to incorporate the nonsample portion of the ASM into the estimates of the gross flows. However, in practice, there are numerous difficulties given the nature of the nonsample portion of the ASM and the discrete changes in the nonsample portion that occur in census years and the first year of each panel.

Unfortunately, establishment-level data for the nonsample portion of the ASM are unavailable. The nonsample portion of the estimate is available at the four-digit level of disaggregation. Given this limitation, we implement a simple procedure for adjusting the LRD-based gross flows to incorporate information on the nonsample portion of the ASM. Essentially, the nonsample portion of each four-digit industry is treated as a pseudo-establishment. That is, the entire difference between published ASM and LRD estimates, DTE, is the pseudo-establishment from which additional creation or destruction can be calculated to add to the LRD based measures. Using this pseudo-establishment method, the adjusted (*) POS and NEG are

$$POS^{*} = \sum_{i \in E^{+} \cup D^{+}} \left(\frac{x(i)}{X} \right) g(i) \tag{13}$$

$$NEG^{*} = \sum_{i \in E^{-} \cup D^{-}} \left(\frac{x(i)}{X} \right) |g(i)| \ , \qquad \textbf{(14)}$$

where D+ (-) is the set of pseudo-establishments with growing (shrinking) employment.

Treating the nonsample portion as a pseudo-establishment generates gross flow estimates that are consistent with net changes in the published ASM figures. However, this procedure understates the gross flows associated with the nonsample portion, because net changes at the four-digit level mask offsetting establishment-level net changes within the nonsample portion of four-digit industries.

A second problem with this procedure is that the nonsample portion of the ASM exhibits discrete changes in census years and in the first year of each panel. These discrete changes will be reflected in the adjustment of the gross flows and thus generate distortions in those years.

An alternative to the pseudo-establishment method is to use the information available from the LRD regarding the relationship between gross and net flows for small establishments. This relationship could be used to impute gross flows for the nonsample portion based upon the actual net changes for the nonsample portion. Further, an adjustment could be made in the census years and the first year of each panel to spread the observed discrete changes appropriately over the course of the panel. Development of an imputation procedure along these lines will be considered in future work.

E. Results Using the Pseudo-Establishment Method

The effect of using the pseudo-establishment method on total manufacturing POS and NEG are shown in Figures 9 and 10. In years other than census years and the first year of each panel, the adjustment generates sensible results. The adjustment in such years tends to increase POS and NEG but the magnitude of the adjustment is marginal. For these years, means (standard deviations) are: POS - 9.03% (0.033), POSA - 9.35% (0.031), NEG - 11.15% (0.047), and NEGA - 11.26% (0.044).

In contrast, Figures 9 and 10 suggest that the discrete changes in the nonsample estimates generate distorted adjustments in census years and in the first year of each panel. Combined with the results of section III, this pattern indicates that the method fails to deliver a satisfactory adjustment in census years and in the first year of each panel.

Additional evidence on the relationship between adjusted and unadjusted gross flows appears in Table 5. Time-series correlations of the adjusted and unadjusted series are reported, excluding the first year of each panel and census years. For total manufacturing, correlations between adjusted and unadjusted series are quite high for POS, NEG, NET and SUM. The cross correlation between POS and NEG for total manufacturing is negative and about the same magnitude for adjusted and unadjusted series, and the same holds for the negative cross correlation between NET and SUM.

The same general patterns hold for the two-digit industry data. Not surprisingly, the adjusted and unadjusted series behave very similarly for industries with primarily large establishments (e.g., 33 and 37), while the series are less similar for industries dominated by small establishments (e.g., 27 and 39). However, even for the latter industries, the behavior of the adjusted and unadjusted is quite similar.

Overall, this pseudo-establishment adjustment method works reasonably well in years other than census years and the first year of each panel. However, in such years, the adjustment makes little difference to magnitudes or time-series properties of the gross flows. For census years and the first year of each panel, the current adjustment procedure is inappropriate. Since the adjustment makes little difference in years in which it is successful, these results supports the integrity of LRD-based estimates of gross flows. Further, given the difficulties with the adjustment procedure in other years, the LRD-based estimates of gross flows are at present a more reliable, internally consistent time series. Refinements to the adjustment procedure to incorporate the nonsample portion must be developed before reliable adjustments can be generated.

V. Conclusion

The imperfect relationship between published ASM and sample LRD data has potentially important implications for researchers using the LRD. LRD users should take this imperfect relationship into account in the selection of industries, sectors and time period of analysis.

Three main conclusions emerge with respect to the time-series and cross-sectional characteristics of the published ASM and sample LRD data. First, at high levels of aggregation employment levels and growth rates generated from the two data sets correspond closely. At the industry level, the quality of the correspondence is high for industries dominated by large establishments and lower for industries dominated by smaller establishments. Second, the correspondence between published and sample data deteriorates over the life of a panel due to sampling and imputation errors. Third, the rotation scheme for ASM panels leads to cumulative multi-year errors that show up in the published figures during census years and in the LRD figures during the first year of a new panel. The correction of cumulative errors leads to a biased growth rate calculation in these years.

This paper also implemented an adjustment designed to reconcile LRD-based estimates of gross job creation and destruction with published ASM figures on net job changes. Our procedure, which treats the ASM-LRD difference at the four-digit industry level as a pseudo-establishment, proved unsatisfactory because of the discrete changes in LRD and ASM employment figures associated with corrections of cumulative estimation errors. These corrections cause large changes in the ASM-LRD difference that induce spurious movements in the adjusted gross job flow figures. We proposed two alternative ways of handling these discrete changes in future research. We conclude that there is no simple and satisfactory method of reconciling the published and sample data.

References

Armington, Catherine and Marjorie Odle (1982), "Small Business -- How Many Jobs?" Brookings Review, 1 (Winter), pp. 14-17.

Birch, David L. (1981), "Who Creates Jobs?" Public Interest, 65 (Fall), pp. 3-14.

Davis, Steve J. and John Haltiwanger (1989), "Gross Job Creation, Gross Job Destruction, and Employment Reallocation," University of Maryland Working Paper No. 89-31.

Davis, Steve J. and John Haltiwanger (1990), "Gross Job Creation and Gross Job Destruction: Microeconomic Evidence and Macroeconomic Implications," NBER Macro Annual 1990, forthcoming.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson (1989a), "The Growth and Failure of U.S. Manufacturing Plants," The Quarterly Journal of Economics, Vol. 104, No. 4 (November), pp. 671-698.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson (1989b), "Plant Turnover and Gross Employment Flows in the U.S. Manufacturing Sector," Journal of Labor Economics, Vol. 7, No. 1 (January), pp. 48-71.

Leonard, Jonathan (1987), "In the Wrong Place at the Wrong Time: The Extent of Frictional and Structural Unemployment," in Unemployment & the Structure of Labor Markets, Kevin Lang and J. Leonard eds., Basil Blackwell: New York.

Lichtenberg, Frank R. and Donald Siegel (1989), "Using Linked Census R&D-LRD Investment on Total Factor Productivity Growth," Center for Economic Studies Working Paper No. 89-2.

McGuckin, Robert H. and George A. Pascoe, Jr. (1988), "The Longitudinal Research Database: Status and Research Possibilities," Survey of Current Business, Vol. 68, No. 11 (November), pp. 30-37.

McGuckin, Robert H., Sang V. Nguyen, and Stephen H. Andrews (1990), "The Relationships Among Aquiring and Acquired Firms' Product Lines," Working Paper.

Olley, G. Steven and Ariel S. Pakes (1990), "Dynamic Behavioral Responses in Longitudinal Data Sets: The Telecommunications Equipment Industry," Working Paper.

Ogus, Jack L. and Donald F. Clark (1971), The Annual Survey of Manufactures: A Report on Methodology, Technical Paper No. 24, U.S. Department of Commerce, Bureau of the Census.

Streitweiser, Mary L. (1990), "The Extent and Nature of Establishment Level Diversification in Sixteen U.S. Manufacturing Industries," Working Paper.

Waite, Preston J. and Stacey J. Cole (1980), "Selection of a New Sample Panel for the Annual Survey of Manufactures," presented at the annual meetings of the American Statistical Association, Houston, TX.

Figure 1

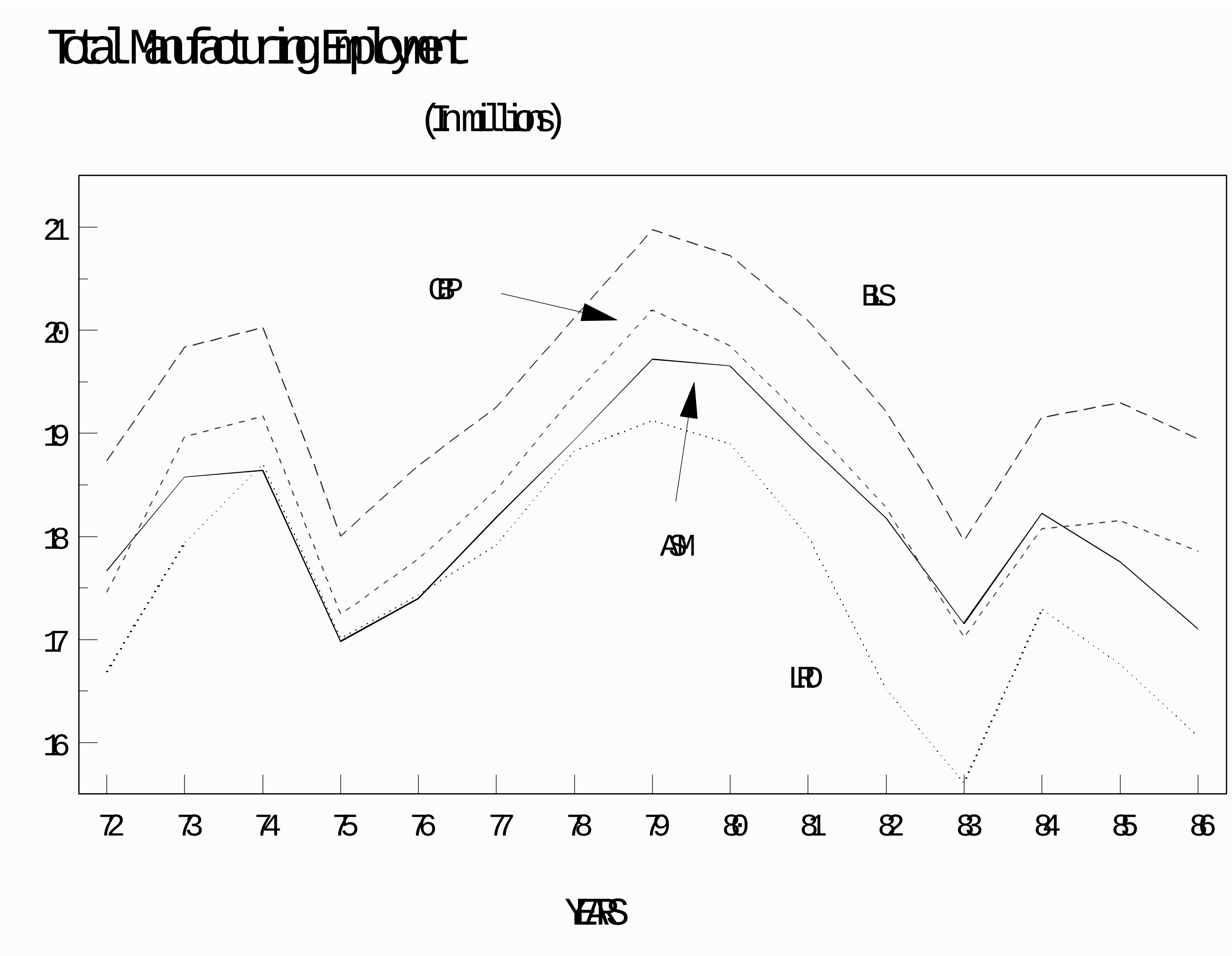

Total Manufacturing Employment
(In millions)
21
20
19
18
17
16
CBP
BLS
ASM
LRD
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS

Figure 2

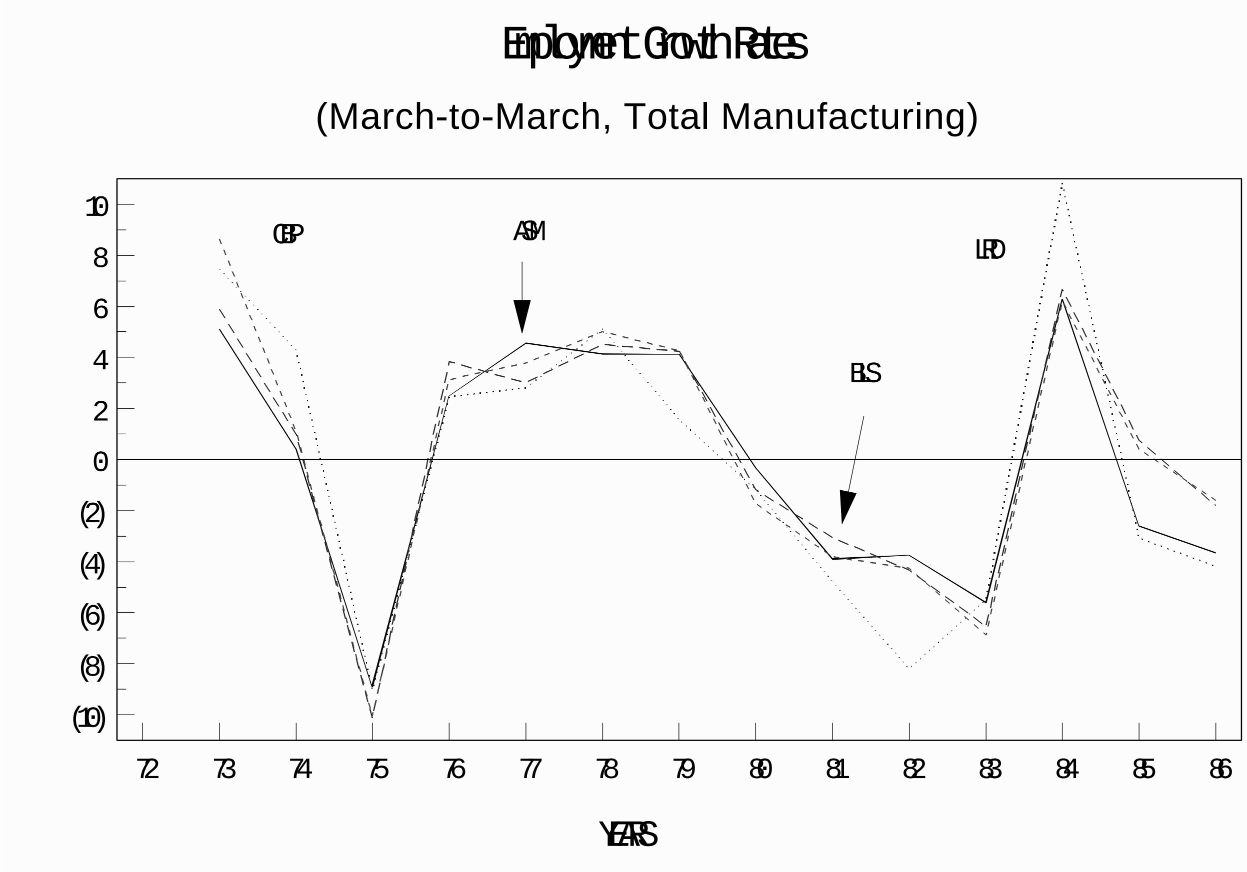
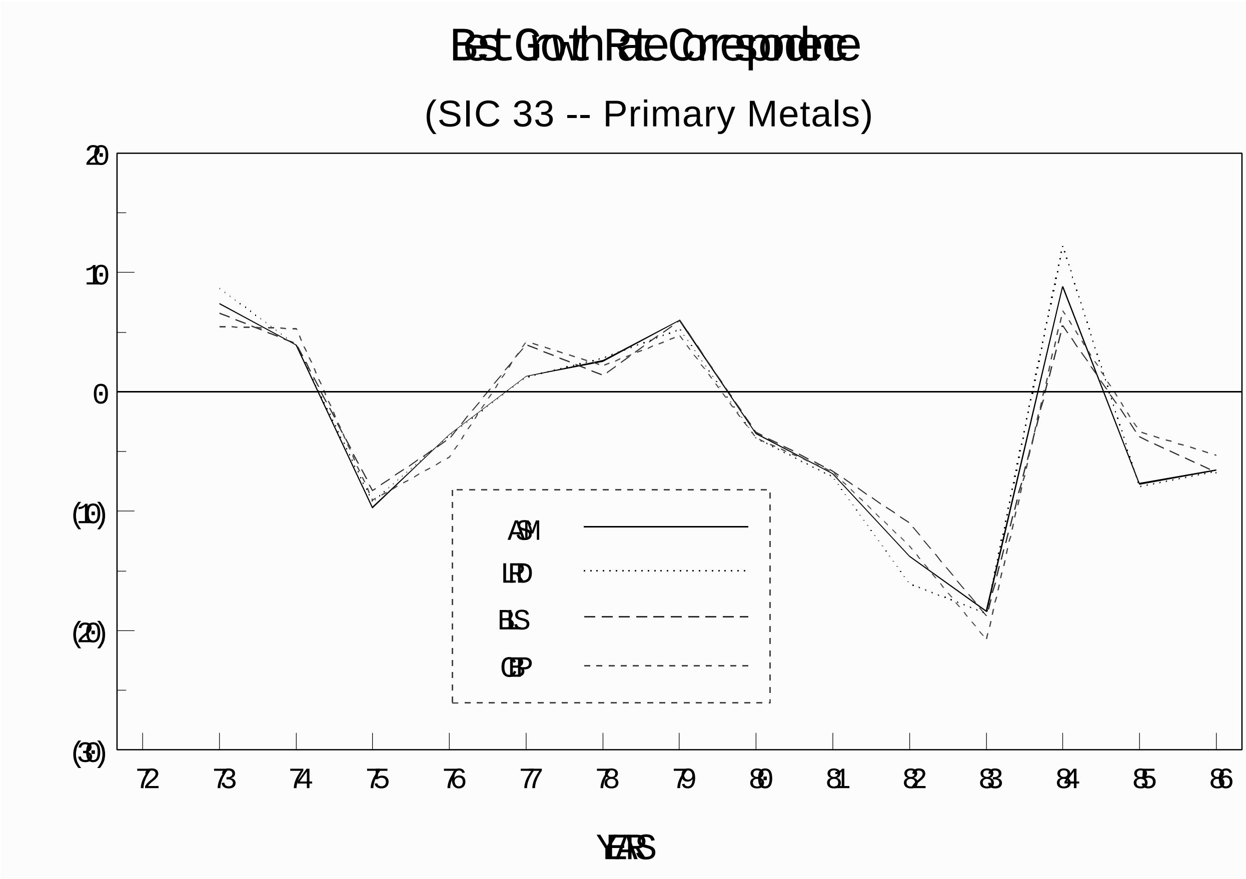

Employment Growth Rates
(March-to-March, Total Manufacturing)
CBP
ASM
LRD
BLS
10
8
6
4
2
0
(2)
(4)
(6)
(8)
(10)
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS

Figure 3



Best Growth Rate Correspondence
(SIC 33 -- Primary Metals)
20
10
0
(10)
(20)
(30)
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS
ASM
LRD
BLS
CBP

Figure 4

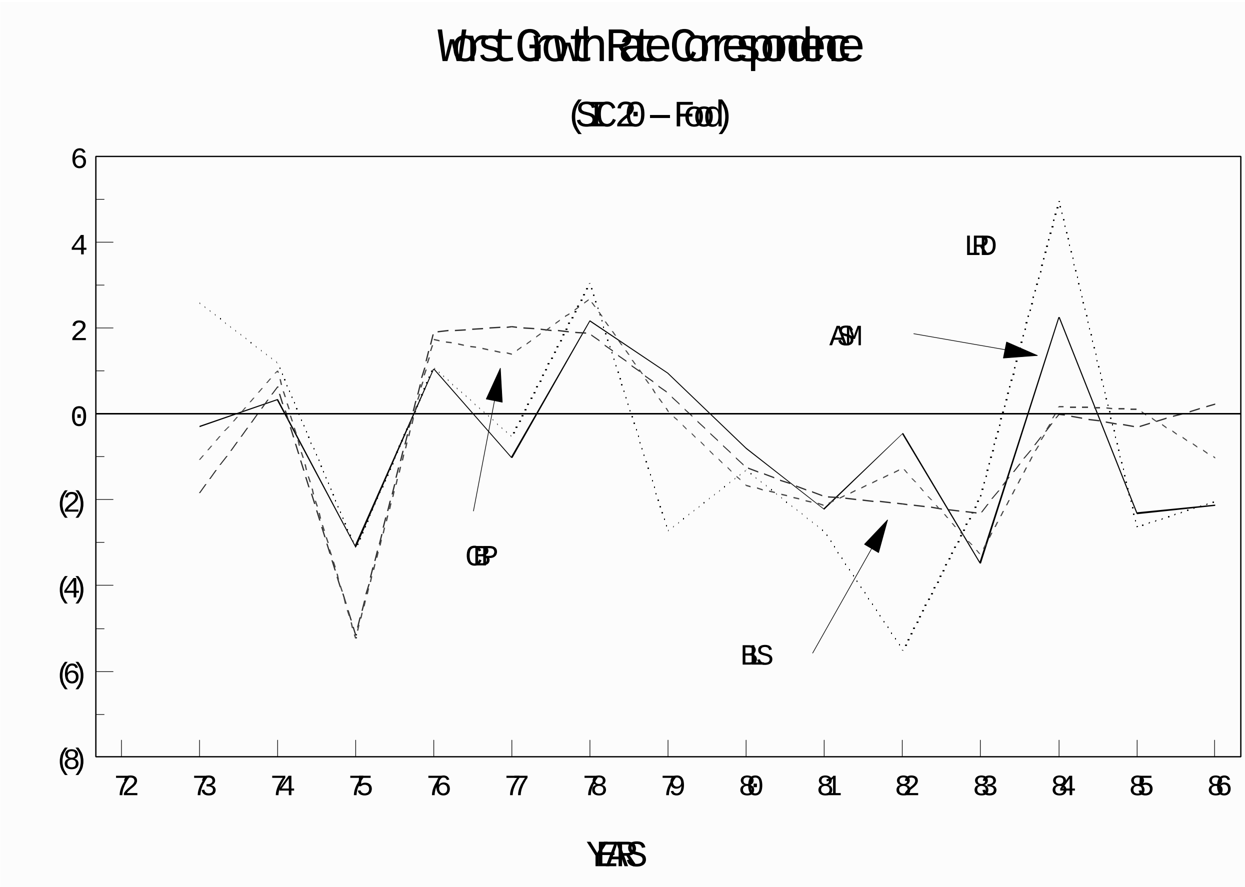
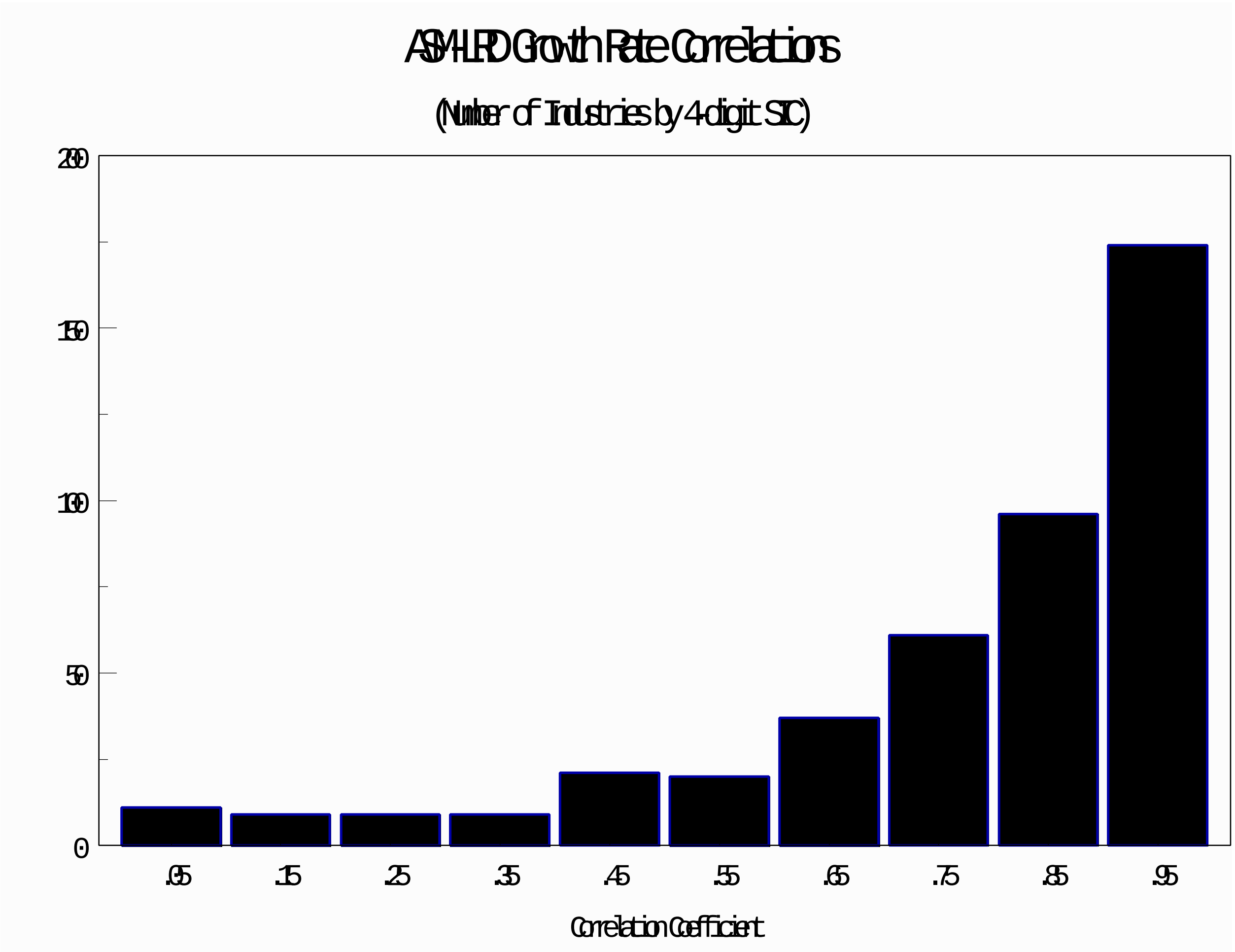

Worst Growth Rate Correspondence
(SIC 20 – Food)
6
4
2
0
(2)
(4)
(6)
(8)
LRD
ASM
GSP
BLS
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS

Figure 5



ASM-LRD Growth Rate Correlations
(Number of Industries by 4-digit SIC)
200
150
100
50
0
.05
.15
.25
.35
.45
.55
.65
.75
.85
.95
Correlation Coefficient

Figure 6

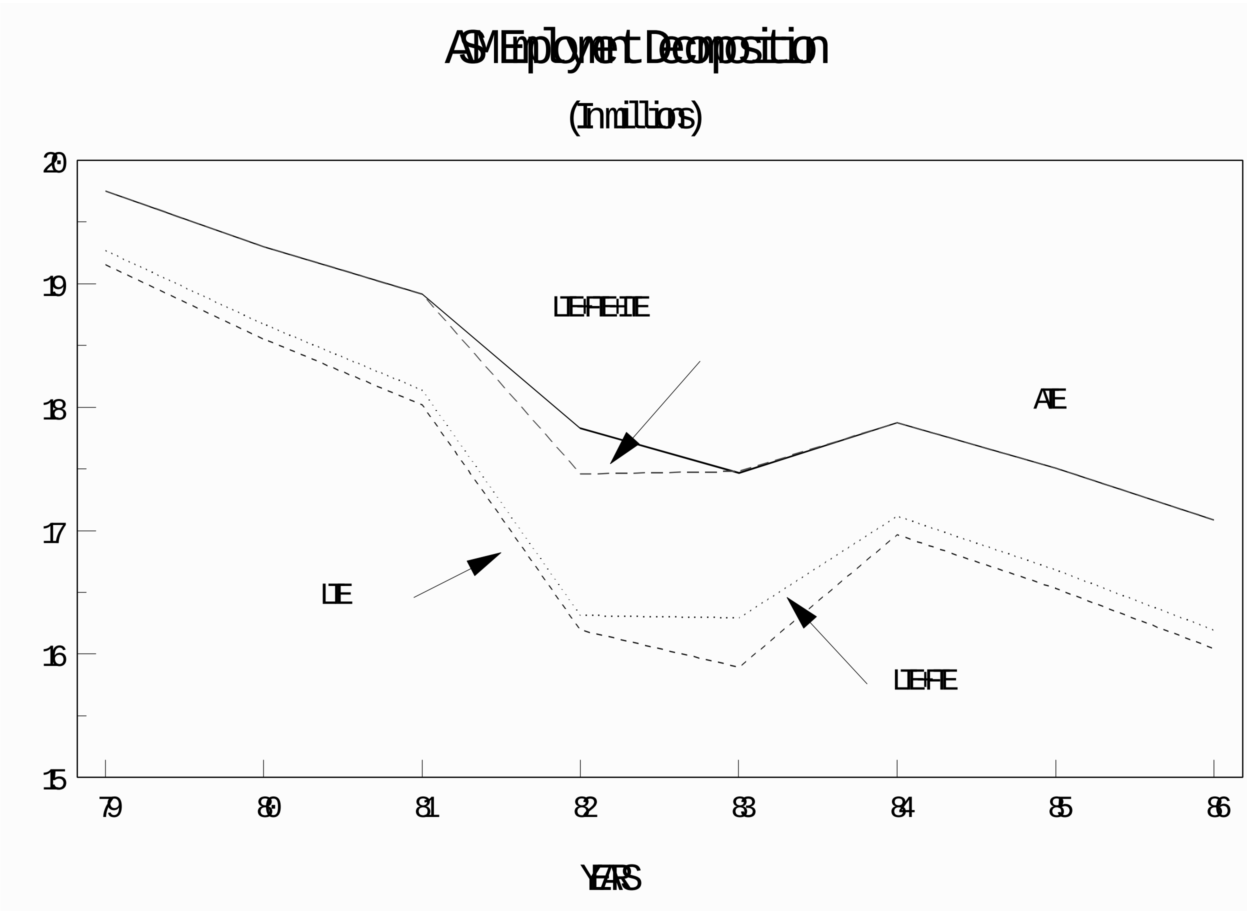

ASM Employment Decomposition
(In millions)
20
19
18
17
16
15
79
80
81
82
83
84
85
86
YEARS
LE+FE+IE
AE
LE
LE+FE

Figure 7

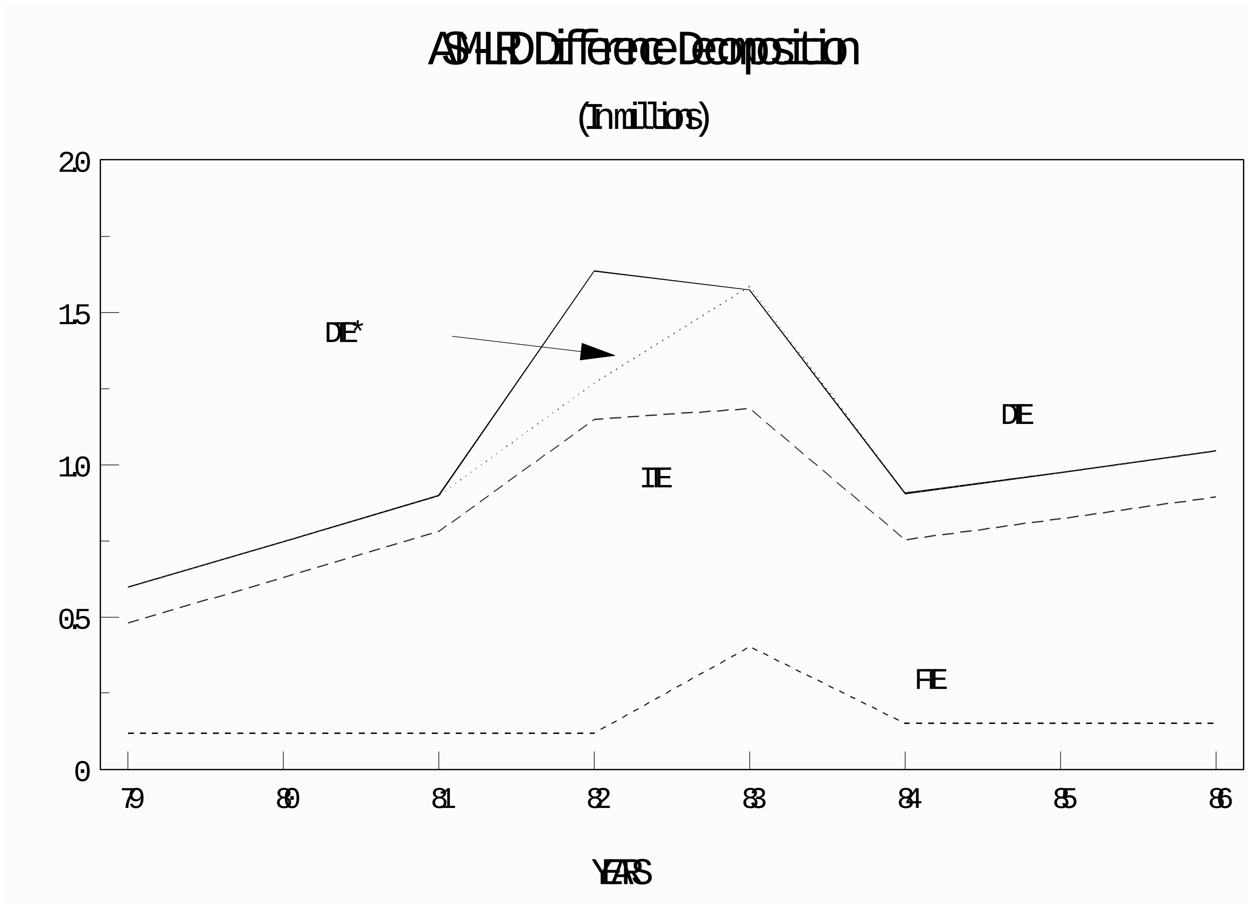
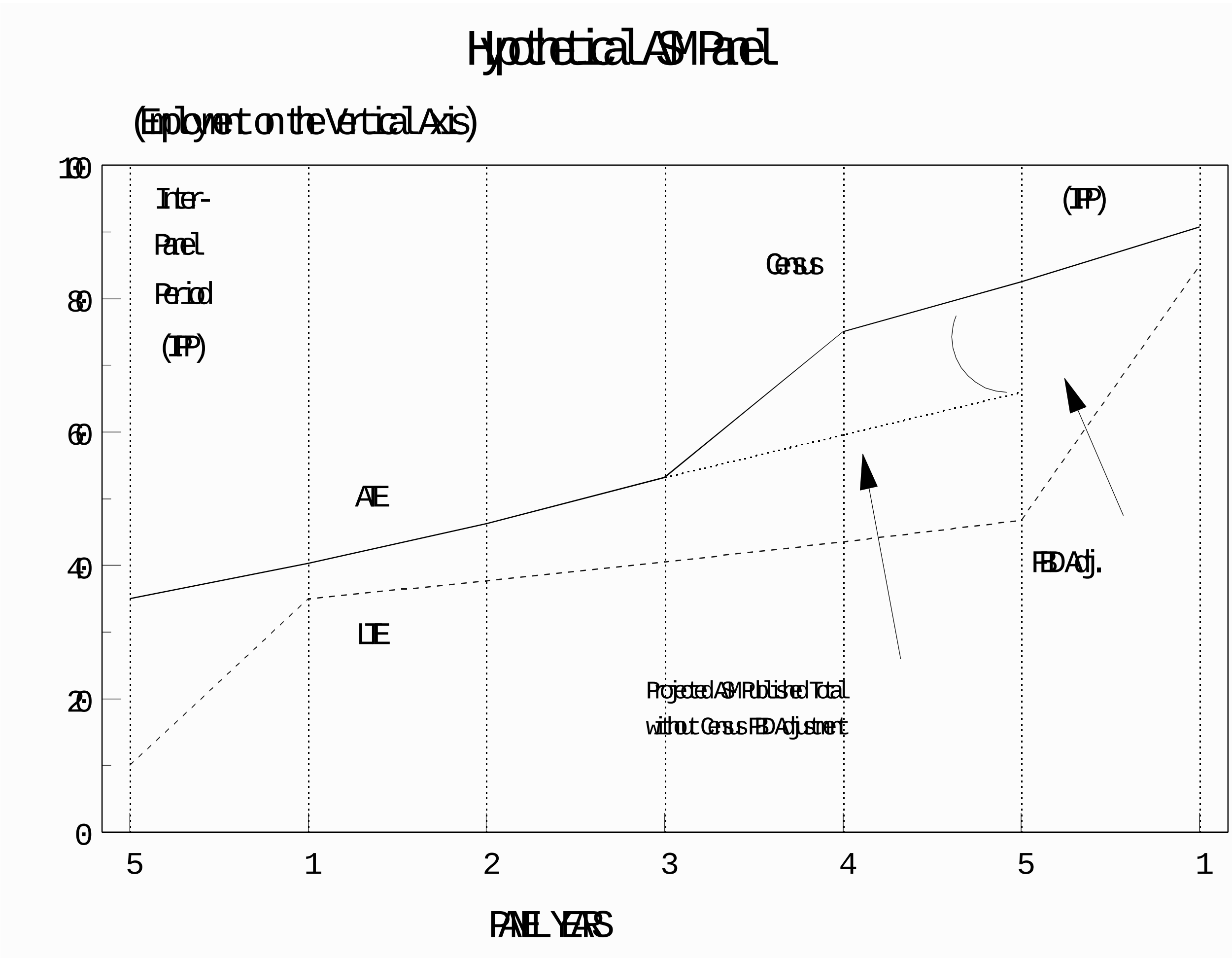
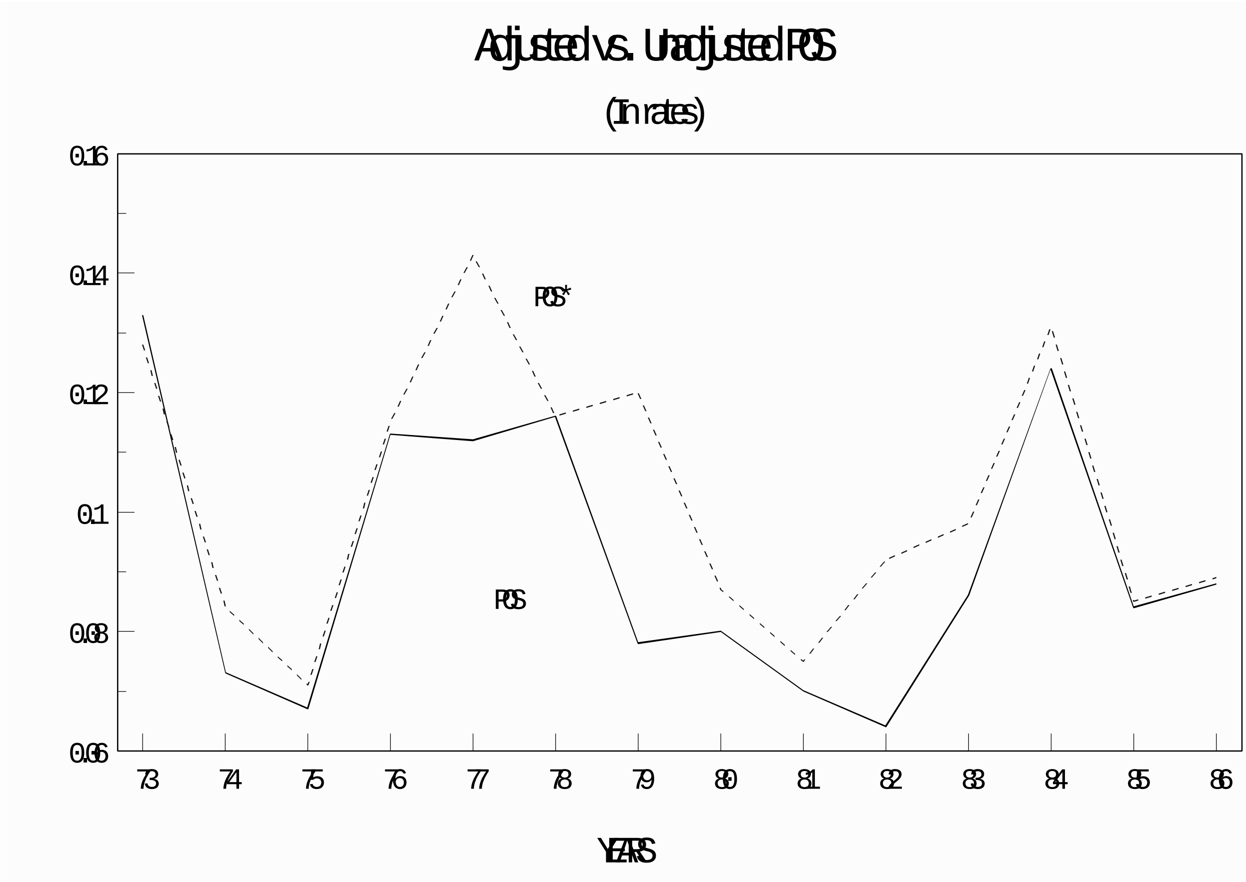

ASM-LRD Difference Decomposition
(In millions)
2.0
1.5
1.0
0.5
0
DE*
DE
IE
FE
79
80
81
82
83
84
85
86
YEARS

Figure 8



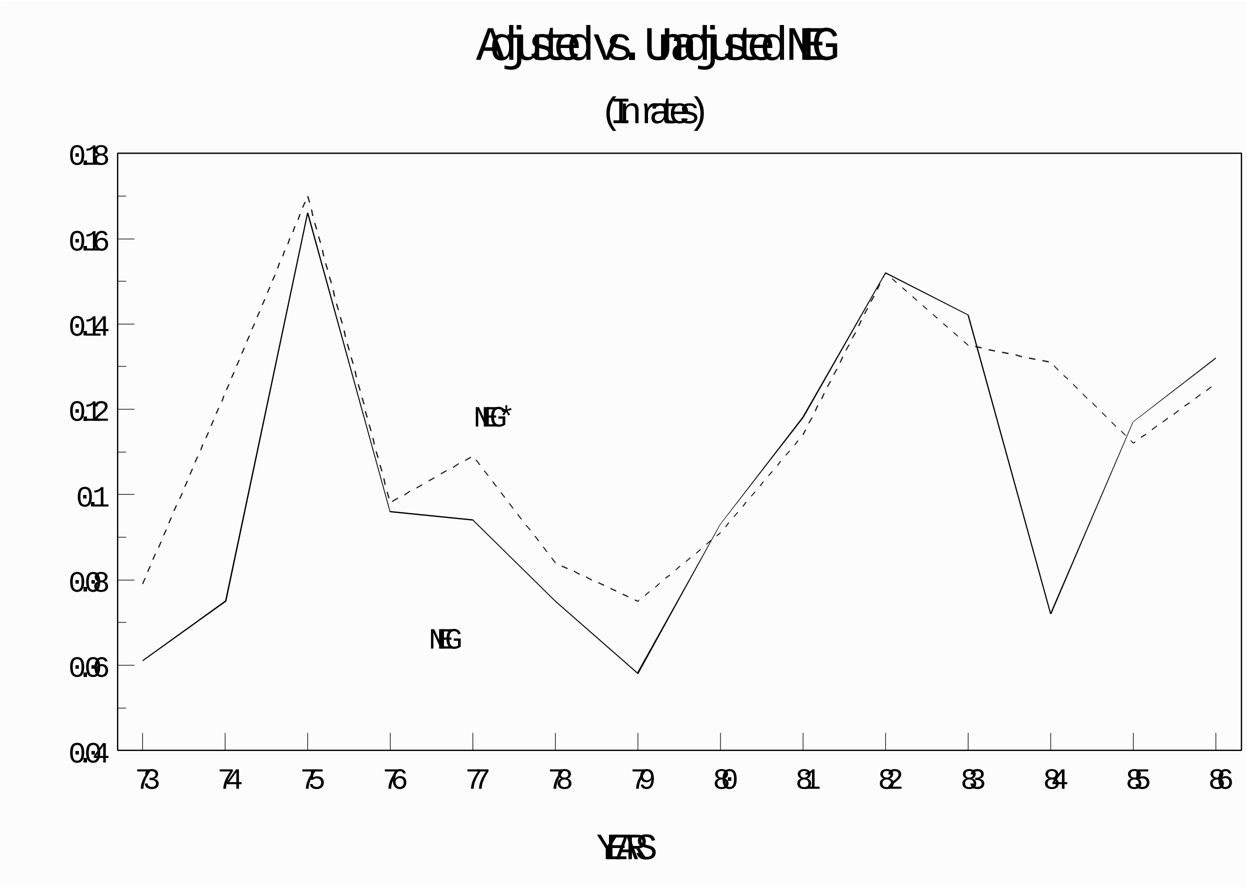
Hypothetical ASM Panel
(Employment on the Vertical Axis)
100
80
60
40
20
0
Inter-
Panel
Period
(IPP)
Census
(IPP)
ATE
LTE
FBD Adj.
Projected ASM Published Total
without Census FBD Adjustment
5
1
2
3
4
5
1
PANEL YEARS

Figure 9



Adjusted vs. Unadjusted POS
(In rates)
0.16
0.14
0.12
0.1
0.08
0.06
POS*
POS
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS

Figure 10



Adjusted vs. Unadjusted NEG
(In rates)
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
NEG*
NEG
73
74
75
76
77
78
79
80
81
82
83
84
85
86
YEARS

Table 1

Average March-to-March Total Employment Growth Rates and Size, 1972-86
(In percent)

SIC	ASM		LRD		BLS		CBP		SIZE MEANS	
CODE	MEAN	STD	MEAN	STD	MEAN	STD	MEAN	STD	ESTAB	COWKR
1	-0.13	4.70	-0.11	5.97	0.20	4.96	0.29	5.32	80	1631
20	-0.65	1.85	-0.70	2.89	-0.56	2.02	-0.61	2.10	82	479
21	-2.09	3.65	-1.93	3.65	-1.39	3.28	-1.88	5.35	455	4552
22	-2.53	6.04	-2.27	7.07	-2.13	7.03	-2.20	6.08	156	852
23	-1.88	5.74	-2.25	7.04	-1.29	6.70	-1.38	6.13	73	321
24	-0.21	8.97	0.13	11.37	0.37	9.66	1.51	11.35	32	182
25	0.49	7.37	0.90	9.76	0.70	8.36	0.69	8.15	68	454
26	-0.23	4.15	-0.15	4.87	0.01	4.07	-0.06	3.81	117	526
27	1.95	2.47	1.77	5.05	2.07	2.31	2.33	2.86	41	593
28	-0.20	2.58	-0.38	3.06	0.20	2.53	-0.11	2.70	99	1243
29	-0.57	4.97	-0.44	5.46	-0.10	13.48	-0.65	3.20	81	858
30	1.80	7.45	1.79	8.49	2.16	7.80	2.77	9.57	83	662
31	-4.78	5.98	-4.16	6.70	-4.32	7.12	-4.59	6.72	101	353
32	-1.04	5.04	-0.88	7.06	-0.75	6.18	-0.33	6.61	48	409
33	-2.88	8.20	-2.80	8.96	-2.52	7.48	-2.77	8.10	176	2934
34	-0.01	5.81	0.06	7.47	-0.14	6.48	1.14	8.15	61	605
35	0.60	7.25	0.65	8.82	1.23	7.68	1.11	8.07	65	1358
36	1.53	7.05	1.48	7.28	1.52	6.72	1.42	6.37	182	2032
37	0.52	6.20	0.57	6.67	1.15	6.49	0.68	6.81	283	6594
38	2.14	4.72	2.22	5.64	2.65	4.64	3.70	8.11	119	3123
39	-1.81	4.97	-1.54	8.08	-0.91	5.67	-0.44	6.97	41	337

Table 2

Total Employment Growth Rate Correlations, 1972-86

SIC CODE	(ATE, LTE)	(ATE, BTE)	(ATE, CTE)	(LTE, BTE)	(LTE, CTE)	(BTE, CTE)
1	0.93	0.96	0.96	0.91	0.91	0.99
20	0.67	0.63	0.75	0.47	0.53	0.95
21	0.87	0.64	0.83	0.36	0.77	0.56
22	0.96	0.96	0.96	0.91	0.93	0.98
23	0.86	0.85	0.84	0.82	0.81	0.99
24	0.85	0.95	0.87	0.86	0.80	0.91
25	0.93	0.94	0.92	0.91	0.87	0.99
26	0.94	0.96	0.95	0.89	0.91	0.97
27	0.27	0.73	0.68	0.38	0.32	0.88
28	0.92	0.84	0.82	0.78	0.75	0.98
29	0.82	0.70	0.45	0.65	0.34	0.12
30	0.97	0.94	0.88	0.96	0.92	0.95
31	0.92	0.89	0.94	0.82	0.86	0.96
32	0.92	0.97	0.95	0.88	0.88	0.98
33	0.99	0.98	0.97	0.96	0.96	0.99
34	0.93	0.96	0.89	0.90	0.82	0.93
35	0.95	0.97	0.98	0.94	0.94	0.99
36	0.97	0.97	0.98	0.98	0.96	0.98
37	0.98	0.96	0.99	0.98	0.99	0.97
38	0.91	0.88	0.63	0.84	0.67	0.69
39	0.63	0.80	0.68	0.81	0.69	0.94

Table 3

Average March-to-March Total Employment Growth Rates, 1974-1978
(In percent)

SIC CODE	ASM MEAN	ASM STD	LRD MEAN	LRD STD	BLS MEAN	BLS STD	CBP MEAN	CBP STD
1	0.55	6.39	0.33	6.35	0.31	6.98	0.46	7.06
20	-0.23	2.33	0.11	2.61	0.16	3.55	0.14	3.62
21	-3.03	0.56	-2.84	0.33	-2.09	2.36	-3.99	2.95
22	-2.06	10.01	-2.69	9.69	-1.72	12.76	-1.99	10.56
23	0.20	7.92	-0.66	7.51	-0.55	11.53	-0.42	10.56
24	1.41	12.94	0.83	12.03	0.94	15.24	1.86	14.60
25	1.16	11.82	0.60	11.45	0.48	14.18	0.64	14.43
26	-0.39	7.17	-0.31	7.18	-0.29	7.42	0.34	6.62
27	1.37	2.21	1.69	3.03	1.58	3.16	1.76	4.07
28	0.86	2.74	1.00	2.37	0.80	3.40	0.79	4.16
29	0.40	2.49	0.65	2.56	1.55	4.14	0.71	3.41
30	3.12	12.34	2.73	12.25	2.30	12.30	2.46	11.85
31	-1.44	7.81	-1.69	8.00	-1.44	12.33	-1.54	11.26
32	-0.38	6.34	-0.11	6.70	-0.90	8.59	-0.89	8.87
33	-2.39	5.57	-2.21	5.42	-1.72	5.48	-2.03	6.30
34	0.59	7.70	1.05	8.16	0.31	8.25	0.81	8.59
35	1.21	6.24	1.00	6.34	1.01	5.42	0.87	6.51
36	1.15	11.30	0.34	10.88	0.10	10.16	0.41	10.17
37	2.31	6.10	2.00	5.86	2.10	5.81	2.29	6.48
38	3.18	5.68	2.17	5.39	2.18	6.14	3.31	4.68
39	0.62	8.07	-1.24	7.88	-0.06	8.81	0.21	9.12

Average March-to-March Total Employment Growth Rates, 1979-1983

SIC CODE	ASM MEAN	ASM STD	LRD MEAN	LRD STD	BLS MEAN	BLS STD	CBP MEAN	CBP STD
1	-3.41	2.22	-4.92	2.89	-3.79	2.25	-4.17	2.11
20	-1.74	1.39	-2.88	1.85	-1.90	0.46	-2.09	0.87
21	-1.65	5.57	-2.05	6.16	-0.10	3.40	-1.53	5.39
22	-4.20	2.64	-5.32	3.90	-4.98	2.49	-5.15	2.28
23	-2.92	2.25	-5.15	4.90	-3.78	0.86	-4.14	0.90
24	-4.53	8.02	-7.27	9.73	-5.26	6.60	-5.91	6.79
25	-2.85	2.66	-5.06	4.11	-3.94	1.73	-3.82	2.02
26	-2.07	1.72	-2.72	2.46	-1.87	1.28	-2.36	2.04
27	1.40	2.00	-0.52	2.43	1.13	1.18	0.70	1.59
28	-1.26	2.97	-2.54	3.33	-1.31	2.33	-1.68	1.67
29	-1.49	6.24	-3.30	6.62	1.21	27.21	-1.41	2.49
30	-3.13	2.62	-4.96	1.39	-3.36	0.83	-4.79	1.45
31	-5.64	3.14	-6.40	3.61	-4.85	2.57	-6.03	3.08
32	-5.56	2.35	-7.15	4.08	-6.21	2.31	-6.00	2.40
33	-10.6	6.71	-11.4	7.03	-9.97	6.64	-11.1	7.50
34	-4.40	2.69	-6.18	3.09	-6.07	3.44	-5.58	2.77
35	-4.57	7.33	-6.64	7.21	-5.00	8.65	-5.36	7.92
36	-1.05	3.63	-1.74	3.43	-1.71	2.81	-1.27	3.86

37	-5.36	2.06	-6.16	2.68	-5.36	1.36	-6.21	1.83
38	0.36	3.75	-1.04	3.10	0.26	3.97	-0.96	2.77
39	-4.30	2.62	-8.02	4.49	-4.83	2.43	-5.42	3.05

Table 4

Total Employment Growth Rate Correlations, 1979-86[1]

SIC CODE	(ATE, LTE)	(ATE, LTE*)	(ATE, ATE*)	(LTE, LTE*)	(LTE, ATE*)	(ATE*, LTE*)
1	0.998	0.972	0.641	0.982	0.667	0.682
20	0.205	-0.091	-0.273	0.942	0.168	0.216
21	0.861	0.999	0.998	0.863	0.863	0.997
22	0.920	0.980	0.984	0.956	0.867	0.945
23	0.823	0.781	0.892	0.990	0.628	0.629
24	0.926	0.968	0.687	0.986	0.566	0.627
25	0.988	0.994	0.791	0.981	0.757	0.766
26	0.956	0.998	0.796	0.970	0.827	0.789
27	0.284	0.322	-0.075	0.989	-0.249	-0.334
28	0.772	0.613	0.634	0.864	0.577	0.758
29	0.258	0.569	0.794	0.552	0.315	0.905
30	0.947	0.929	0.788	0.973	0.719	0.732
31	0.790	0.958	0.905	0.910	0.752	0.913
32	0.964	0.982	0.735	0.978	0.728	0.760
33	0.997	0.997	0.994	0.997	0.994	0.995
34	0.991	0.984	0.714	0.996	0.763	0.752
35	0.943	0.914	0.800	0.988	0.801	0.779
36	0.937	0.947	0.941	0.999	0.908	0.918
37	0.987	0.994	0.987	0.984	0.973	0.992
38	0.643	0.576	0.672	0.943	0.426	0.479
39	0.395	0.644	0.663	0.854	0.153	0.387

[1] LTE=LTE; LTE*=LTE+FTE; ATE*=LTE+FTE+ITE; ATE=LTE+FTE+ITE^d.

Table 5

Correlations of Unadjusted and Adjusted Gross Flows, 1972-86
(Excluding Census and First Panel Years)

	Own				Cross			
					(POS,NEG)		(SUM,NET)	
SIC CODE	POS	NEG	SUM	NET	U	A	U	A
1	0.981	0.978	0.956	0.985	-0.81	-0.72	-0.57	-0.49
20	0.928	0.695	0.847	0.838	-0.31	0.10	0.05	0.20
21	0.982	0.998	0.997	0.996	-0.79	-0.67	-0.50	-0.51
22	0.985	0.980	0.978	0.983	-0.71	-0.65	-0.51	-0.45
23	0.981	0.937	0.852	0.971	-0.73	-0.65	-0.17	0.19
24	0.971	0.963	0.952	0.974	-0.75	-0.61	-0.22	-0.27
25	0.988	0.944	0.948	0.964	-0.70	-0.61	-0.40	-0.37
26	0.994	0.987	0.970	0.991	-0.85	-0.85	-0.72	-0.71
27	0.936	0.770	0.862	0.920	-0.36	0.23	0.02	0.01
28	0.661	0.974	0.841	0.916	-0.70	-0.44	-0.59	-0.50
29	0.898	0.978	0.950	0.924	-0.33	-0.27	-0.24	0.04
30	0.988	0.990	0.976	0.991	-0.88	-0.87	-0.58	-0.63
31	0.975	0.991	0.997	0.989	-0.60	-0.41	-0.63	-0.67
32	0.973	0.980	0.975	0.979	-0.55	-0.48	-0.45	-0.41
33	0.997	0.998	0.997	0.999	-0.62	-0.57	-0.79	-0.79
34	0.991	0.983	0.943	0.991	-0.84	-0.80	-0.55	-0.50
35	0.982	0.995	0.984	0.994	-0.77	-0.68	-0.68	-0.58
36	0.997	0.997	0.989	0.998	-0.86	-0.83	-0.75	-0.74
37	0.968	0.996	0.991	0.992	-0.68	-0.54	-0.70	-0.62
38	0.944	0.989	0.973	0.985	-0.56	-0.36	-0.52	-0.58
39	0.831	0.922	0.877	0.908	-0.78	-0.51	-0.35	-0.39