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DEVELOPMENT OF AN HISTORICAL SERIES BY NAICS CATEGORY CODE FOR THE MANUFACTURERS' SHIPMENTS, INVENTORIES, AND ORDERS (M3) SURVEY

by

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1. INTRODUCTION

Beginning with the 1997 Census of Manufactures, the manufacturing surveys of the Manufacturing and Construction Division (MCD) of the U.S Census Bureau began collecting data under the North American Industry Classification System (NAICS). The time frame for individual surveys within the division to convert from the Standard Industrial Classification (SIC) system to NAICS varied. For the Manufacturers' Shipments, Inventories, and Orders (M3) survey, the conversion took effect for the April 2001 reporting period. The M3 is a non-probability monthly survey of companies, and its estimates display seasonal patterns. Therefore, prior to seasonally adjusting the new series, it was necessary to develop as input several years of historical (backcasted) NAICS coded data in order to satisfy data requirements of the X-12-ARIMA seasonal adjustment program. It was also necessary to develop annual NAICS benchmarks those same years for the major M3 variables so that the input series to the X-12-ARIMA program was first adjusted to proper levels. Earlier decisions at the Economic Directorate level stipulated Census year 1992 as the earliest starting point for any historical NAICS series, and that was chosen as the starting point for the M3 as well. It is the purpose of this document to describe in some detail the work done to develop the NAICS historical series for the M3 survey. Two MCD branches were responsible for this work: the Manufacturing Programs Methodology Branch (MPMB) and the M3 branch. In this report, we presume the reader has some familiarity with aspects of the M3 survey including coding structure, data items, link-relative estimation, and benchmarking. Refer to the M3 survey internet web site at www.census.gov/indicator/www/m3 for more comprehensive survey documentation. Before proceeding with a description of the work, we provide a brief discussion of NAICS and the coding structure of the M3.

2. NAICS CODING IN THE M3

NAICS is a system for classifying establishments jointly developed by the United States, Mexico, and Canada, and is a replacement for the 1987 Standard Industrial Classification (SIC) system. Whereas the SIC system classified establishments by the type of activity, NAICS is founded on a production-oriented, or supply-based, conceptual framework, meaning that producing units that use identical or similar production processes are grouped together.

NAICS employs a 6-digit coding structure, the first five of which mean the same thing for all three countries. The 2-digit NAICS code designates the sector. The 3-digit NAICS code designates the subsector, which corresponds to the major group (2-digit) coding under the SIC system. The 4-digit code designates the industry group, which under the SIC system was a 3-digit code. The 5-digit code identifies the industry and is comparable to the 4-digit SIC code. The sixth digit, if other than zero, represents individual country-level national industries.

Under the SIC system, the M3 collected data for 80 industry groupings referred to as category codes. Generally speaking, these category codes corresponded to SIC-3

aggregations, i.e., industry group aggregations. For various reasons, including insufficient reporting, further consolidation was performed for publication purposes. As a result, 45 aggregate levels were published for shipments and inventories, and even fewer levels were published for new and unfilled orders.

The M3 staff, after considerable review, produced a proposed set of NAICS category codes. This list was submitted for comment to the Bureau of Economic Analysis (BEA), and a subsequent revised list was received from them. A series of revisions followed resulting in final agreement on a set of 89 category codes. The final structure associated one or more category codes with each 3-digit NAICS code. Each category code within a given NAICS-3 code was composed of one or more of the NAICS 6-digit codes contained within the NAICS-3. As such, this was a completely hierarchical structure.

3. OVERVIEW OF PROJECT

As indicated in the introduction, this project involved two major operations. The first was to develop independent annual benchmarks for three of the four major M3 variables (shipments, inventories, unfilled orders) by NAICS category code. Category codes are groupings of related industries and are the tabulation levels defined for the M3. The fourth variable, new orders, is derived from shipments and unfilled orders, and, therefore, is consistent with those benchmarks. Historically, annual benchmarks from either the Census of Manufactures or the Annual Survey of Manufactures (ASM)--depending on the year (Censuses are conducted for years ending in “2” and “7”)--have been used to adjust the M3 monthly estimates. Without this adjustment and over time, the annualized monthly estimates for shipments and the end-of-year estimates for inventories would begin to increasingly deviate from comparable figures produced for the larger and more reliable Census and annual surveys. The non-probability nature of the M3 panel would likely contribute to these deviations. Month-to-month trends of the original monthly series are preserved to the degree possible by the benchmarking methodology. Since 1992 was designated as the starting point for the historical series, derived NAICS benchmark values were required for years 1992-1996. Thereafter, Census and ASM data collections were on a NAICS basis, so actual benchmarks became available. The second of the two major operations was to develop a monthly NAICS series over the same time span and to benchmark these series to the appropriate benchmark values. In section 4, we discuss the development of annual benchmarks. In section 5, we discuss the development of the monthly series.

4. DEVELOPMENT OF ANNUAL BENCHMARKS

4.1 Selection of Method

In our preliminary planning, we considered two basic approaches for developing the annual category code benchmarks—a macro (or tab level) approach and a micro (or establishment level) approach. The macro method would decompose and then re-aggregate the ASM/Census published data each year. Using both the SIC and NAICS M3 category definitions, we would determine which SIC categories contributed some (or all) of their data to a NAICS category code, and then, using ASM/Census published data, we would estimate annual percentage contributions of the old categories to the new. After applying the percentages, the sum of the allocated pieces would be the NAICS category total and, therefore, the desired benchmark. Allocation factors would be calculated for each year to be considered.

The micro approach would use establishment level data from the Census and ASM and aggregate to category code totals. This would be accomplished by using Census product data to first code all manufacturing establishments to NAICS industry codes. These codes would be carried forward into ASM years for those plants in the annual survey. Otherwise, ASM product class data would be used to determine plant codes. By summing appropriate establishment records (i.e., those whose NAICS industry codes belong to a given M3 NAICS category code), we would be able to determine annual totals at the category level for each of the years. Since these sums would be based on Census and ASM data, they, by definition, would be the appropriate annual benchmarks.

Each of these methods had inherent weaknesses. The most obvious weakness for both related to data collection in the ASM/Census. The annual allocation factors described above for the macro method were dependent (as will be seen) on the availability of product or product class data in the Census or ASM, respectively. However, only shipments data are collected at this level. Inventory data are collected in both the Census and ASM, but not by product or product class, and unfilled orders data are not collected at all. So, for inventories, it would be necessary to assume their allocation factors were related to or the same as the factors for shipments. For unfilled orders, M3-based relationships would have to be used to derive unfilled orders benchmarks from either shipments or inventories.

Similarly, using the micro approach, we could not directly obtain unfilled orders benchmarks since this variable was not available. At best, we could consider only the companies in the M3 survey (for whom total unfilled orders was known) and apply company percentages derived for either shipments or inventories to allocate the company's monthly unfilled orders across the appropriate NAICS category codes. The M3 estimation methodology would then have to be applied to these company values and a final adjustment made to simulate a December benchmark level. Even more limiting for the micro approach is the fact that the method just described for unfilled orders could realistically be applied only for a Census year. This is because the ASM generally does not include all establishments of a given company, nor does it include all companies (partially or otherwise) belonging to the M3. There were other limitations. For example,

the assignment of plant level NAICS industry codes is problematic at times because the SIC product (product class) codes are often split among multiple NAICS codes, so arbitrary assumptions about their allocations would have to be made. This same problem would affect the allocation factors of the macro method. As a final point, the micro method would not reflect known patterns of reporting in the M3 survey. For example, we know many M3 companies report incomplete data and/or they often combine category code data under one code. We would not attempt to account for this in developing benchmark levels from the ASM and Census. Of course, this incompatibility of reporting in the M3 and Census/ASM has always existed

Because of the need to convert the M3 to NAICS on an expedited basis, we were not afforded the opportunity to formally compare and evaluate the two methods. After some consideration, we came to the conclusion that the macro approach was the preferred method for generating annual benchmarks for the NAICS categories. This decision reflected not only the belief that the limiting factors described above were less prohibitive, but also the fact that this was a less complex methodology and could be completed in a more timely fashion. The timing issue was of crucial importance because of the conversion deadline. There was also a general sense that the two methods would not yield widely differing results. In application, however, we modified slightly the procedure described above in that we focused our work at NAICS-6 industry levels rather than at NAICS category levels.

4.2 Development of Annual Benchmarks

As we have previously mentioned, M3 shipments and inventories data are benchmarked to either ASM or Census data, depending on the year. The benchmarking methodology revises the input series subject to certain constraints. These constraints are that (1) the sum of the monthly revised shipments data must equal ASM/Census annual shipments and (2) the revised December inventories values must equal total ending inventories as estimated by the ASM/Census. Unfilled orders benchmarks are developed independently since this data item is not collected in the ASM/Census program. It should be noted that for some M3 categories, unfilled orders are not requested on the M3 survey instrument and are assumed zero. For the categories where they are collected, benchmarks for December unfilled orders are obtained each year by taking the original December estimate and applying to it the ratio of ASM/Census shipments to M3 annual shipments. In other words, the percentage deviation of annualized M3 shipments from the shipments benchmark is the same percentage deviation assumed for unfilled orders. This tie to shipments inevitably causes the benchmark levels for unfilled orders to deteriorate over time. So, periodically, an independent Unfilled Orders Survey is conducted to provide an updated benchmark for the current year and a basis for revising prior benchmarks. Most recently, this was done on a NAICS basis for survey year 1999. However obtained, the benchmark constraint for unfilled orders is similar to that for inventories, namely, the revised December value must equal the benchmark value. Finally, we reiterate that new orders, the fourth major M3 variable, requires no independent benchmark since it is

derived from shipments and unfilled orders, and thus, is consistent with those benchmarks.

Our initial goal was to develop benchmark values for the new NAICS categories using ASM/Census data for the years 1992-1996. As we have previously noted, not only were these values needed as benchmarks, but obtaining them also provided the means for developing a higher level set of category code allocation factors that were eventually applied to the monthly M3 SIC data to obtain the NAICS macro-based monthly series. The approach we took was to first develop benchmark values for each individual NAICS-6 code and then aggregate to the NAICS category code levels. We chose to work at the NAICS-6 level rather than at the category level because when this work began, the number of categories and their definitions were in a state of flux. But we knew, ultimately, that the category codes would be defined by one or more NAICS-6 codes, so we could easily re-derive category code totals should they be redefined if our building blocks were NAICS-6 industries.

The April 1, 1997 **Federal Register** notice provided our first access to the structural relationships between the SIC coding system and NAICS. Later on, the 1997 NAICS manual was released and became our prime source of comparison. The manual reflected minor changes made subsequent to the release of the **Federal Register**. Appendix A of the manual showed the relationship of each NAICS-6 code to its SIC-4 counterpart(s) and provided brief descriptions of both sets of codes. In many cases, the relationships were one to one, but for a significant number of NAICS-6 codes, two or more SIC-4 codes were related. Conversely, as shown in Appendix B of the manual, a given SIC-4 code was often related to more than one NAICS-6. In these multiple code situations, we relied almost exclusively on the verbal descriptions to determine which parts (i.e., which products) of each related SIC-4 were included.

4.2.1 Shipments

We began with shipments (TVS) for Census year 1992 because shipments is the only M3 variable of interest that is collected at detailed levels and because Census 7-digit product data are more detailed than the 5-digit product class data of the ASM. We wanted the most detailed descriptions available to compare to the descriptions provided in the NAICS manual. The steps we followed can be summarized as follows. We first identified the SIC-4 industries that contributed to a given NAICS-6 code. Appendix A of the NAICS manual provided this list. We then estimated a percentage of shipments that each SIC-4 contributed to the NAICS-6. The product descriptions, which allowed us to identify which products primary to an SIC-4 would be coded to the NAICS-6, and the product tables of the 1992 Census Industry Series releases allowed us to approximate this percentage. And finally, we applied this percentage to the SIC-4 shipments total and summed over all contributing SIC-4 industries to get the NAICS-6 benchmark. Appendix A to this document provides an example of the use of the Census product tables to derive SIC-4 allocation factors for a given NAICS-6 industry.

As noted, Appendix A of the NAICS manual provided the list of SIC-4 industries linked to a given NAICS-6 industry code. With this information, we wanted to determine to the extent possible which products of these SIC-4 industries would be eventually coded to the NAICS-6 code. We made this determination by comparing the product descriptions to the NAICS manual descriptions. The results we achieved in comparing descriptions were mixed. For many NAICS-6 industries, the descriptions clearly coincided with one or more product descriptions. Often, entire product classes defined the SIC-4 contributing part. However, for a number of situations, we could not relate complete products to NAICS-6 codes. For purposes of allocation, we then were forced often to make arbitrary decisions. For example, if we concluded that a product contributed to three different NAICS-6 codes, we might have assumed a one-third allocation to each. This assumption was of no consequence, of course, as long as all three NAICS-6 codes belonged to the same category code. In a few instances, we conferred with Census/ASM analysts to see if they could provide expertise on how best to allocate. At the end of this work, we had determined which of the SIC-4 products, either wholly or in part, belonged to each NAICS-6 industry code.

To associate values and SIC-4 percentage contributions with these product codes, we used the Census product tables (see Appendix A). These tables summarize quantity and value of shipments for all products primary to each SIC-4 industry. The tabs include data from all establishments producing these products *regardless* of whether they are primary producers (classified in the industry) or secondary producers (classified elsewhere). An NSK (not specified by kind) product total also appears showing the contribution of plants coded to the industry but not specifying what particular products were produced. We formed the allocation ratio as the summed values (or partial values) of the contributing products to the sum of all the product codes less the NSK. Note that equivalent ratios would have resulted had we first allocated the NSK data to the individual products in the same proportions as they were originally tabbed, and used the sum of the revised values as the base. There was an inherent limitation in using these ratios to allocate SIC-4 industry totals. This was due to the fact that the total of the product values (which is the basis for the ratios) for a given SIC-4 does not, in general, equal the SIC-4 industry total for shipments (which is the value to be allocated) because the first sum includes secondary producers, and the second does not. Either value may be the larger. We assumed as a general rule the notion that the greater the difference between these two values, the less reliable was the ratio for the purpose of allocating SIC-4 industry totals.

We now had the following situations. If the entire set of product codes for an SIC-4 industry went to only one NAICS-6 industry, the allocation factor was 1.00. If the set went to more than one NAICS industry, the allocation factors summed to 1.00 although if one (or more) of the NAICS industries was nonmanufacturing, those data were out of scope of the M3 and did not contribute to the NAICS category benchmark. To obtain each 1992 NAICS-6 benchmark, we summed the allocated pieces over all contributing SIC-4s. Lastly, we obtained NAICS category code benchmark totals by adding the appropriate NAICS-6 benchmark totals.

For ASM years 1993-1996, a similar procedure was followed to derive SIC-4 allocation factors except product class tables replaced the Census product tables. Whenever SIC-4 contributions were defined precisely by ASM product class codes, we determined value and percentage contributions using ASM product class data for each of those years. If the contributing pieces were not identified by product class codes, then we split the product class codes based on the Census year analysis. For example, suppose a product class consisted of two products, but each product was coded to a different NAICS-6 code, and the codes were not in the same NAICS category. Suppose further that in 1992, the two products were, respectively, 30% and 70% of the product class total. Then, for the ASM years, we would assume the same 30-70 split of the product class total to the respective NAICS-6 industries. Once the allocation factors were derived and applied, summing the contributing SIC-4 values to NAICS-6 totals and the NAICS-6 totals to the category code levels provided annual TVS benchmarks for all category codes and all years.

4.2.2 Inventories and Unfilled Orders

As has been noted, inventories data are not collected at detailed levels in the ASM/Census program, and unfilled orders data are not collected at all, therefore, we could not derive allocation ratios independently for these items. We decided to allocate the SIC-4 inventories totals each year using the same allocation ratios as derived for shipments. We applied these ratios to the appropriate SIC-4 inventories totals and summed to obtain NAICS-6 totals. When the NAICS-6 values then were summed to the category code level, these values represented end-of-year (December) inventories constraints that had to be satisfied by the final M3 NAICS benchmarked historical series. Since there were no SIC-4 totals for unfilled orders to apply ratios to, no action was taken at this point for unfilled orders. Their final treatment is described in section 5.2.

One other point regarding inventories should be noted. The 1993 ASM was the last year in the five-year cycle of that panel. A new ASM panel was selected in 1994 based on the 1992 Census results. Each year the ASM collects both ending year inventories and beginning year inventories. Conceptually, the ending year inventories for a given year are equivalent to the beginning year inventories of the next year, but with independent samples for 1993 and 1994, these estimates were not the same. The 1994 beginning inventories were assumed to be superior estimates over 1993 ending inventories because of known deterioration of the older panel. Consequently, we used 1994 beginning inventories as the basis for establishing 1993 benchmark values.

4.3 Comparison with Independent 1992 Benchmark Values

At the request of the M3 staff, Tim Dunne of the Center for Economic Studies (CES), U.S. Census Bureau, performed special NAICS-based coding of the 1992 Census data file. Tim was provided with a concordance file that mapped product codes into NAICS industries. Most mappings were one-to-one, but, as with our experience, several products matched to multiple NAICS codes. Tim merged these mappings into the Census

database, so that each product record of every Census establishment had associated with it the NAICS code(s) from the concordance file. For every product code associated with more than one NAICS code, he independently and randomly selected one NAICS code assuming equally likelihood probabilities. At this point, every product record of a given establishment was associated with a unique NAICS code. Tim then aggregated product data for every establishment record by NAICS industry code, and the code with the largest value was assigned as the establishment industry code. Subsequently, Tim performed a second coding operation assigning NAICS category codes. The use of random assignments occurred fewer times in this second operation since potential NAICS industry codes for an establishment were often in the same NAICS category.

We obtained both of these files and tabulated shipments and inventories to NAICS category levels to compare to our 1992 benchmarks. Based on his second, more accurately coded version, we found that many code totals were in close agreement with the benchmarks. Some were not particularly close, and they seemed to coincide with codes that had rather high levels of random assignments by Tim and arbitrary allocations by us. With no basis for concluding which results were closer to the truth, these results highlighted the speculative nature of estimating NAICS code values when we could not directly relate NAICS and the SIC coding systems.

5. DEVELOPMENT OF NAICS MONTHLY SERIES

5.1 Selection of Method

The second of the two major operations in this work was to develop a NAICS monthly series for the years 1992-1996. Again, macro and micro approaches were considered. Ultimately, both methods were done for comparative purposes. The macro method was merely an extension of the macro benchmarking results. These results allowed us to derive annual allocation factors for shipments, inventories, and unfilled orders that decomposed SIC category level data into NAICS category components. We then simply applied these annual factors to the 12 monthly category code estimates for the year, and combined the appropriate pieces to form the monthly NAICS category estimates. Since the deconstructed SIC series were already benchmarked, the reconstructed NAICS series were benchmarked as well and were consistent with the derived annual benchmarks.

The micro approach used results from the 1997 Census to allocate M3 SIC company data to NAICS categories. Once done, the usual link-relative estimation procedure was performed on the company data to produce monthly NAICS estimates. The macro-based estimates for January 1992 served as the original link points for the micro-based estimates. Finally, the link-relative estimates for each of the three variables for each year were benchmarked to the annual benchmark values previously derived.

It was decided at the outset that the micro approach was the preferred approach since it involved actual M3 company data and would more accurately reflect seasonal patterns. The macro method, as noted, was also performed to provide a basis for comparison and

also to serve as a backup option should the micro results, for whatever reason, appear dubious. As also noted, the January 1992 macro estimates served as the original link points for link relative estimation.

Below, we discuss in more detail the step-by-step process we followed in developing the historical series.

5.2 Development of SIC M3 Category Contribution Ratios

To produce the macro historical monthly series, a higher level set of allocation ratios was required to decompose the SIC M3 category published totals into their NAICS category components for each of the years 1992-1996. These ratios were readily derived each year for shipments and inventories from the information we had available as a result of the benchmark derivations for each NAICS-6 code, namely its SIC-4 contributors and corresponding values. Appendix B provides an example of the derivation of allocation factors for the SIC categories contributing to a given NAICS category code.

Consider a given M3 SIC category code. It consisted of one or more SIC-4 codes. These SIC-4 codes each went to one or more NAICS-6 codes that in turn partially defined one or more NAICS category codes. We summed up the SIC-4 values that went to each NAICS category code. These sums represented the SIC category contributions to these NAICS categories. We then divided each of these summed contributions by the total SIC category value to estimate the percentage allocations of the SIC category code to the recipient NAICS categories. These are the allocation ratios we desired. This operation was performed for both shipments and inventories, giving us allocation ratios for these two items for the years 1992-1996. In general, the allocation ratios for a given SIC category summed to one unless some part of a component SIC-4 code was no longer classified in manufacturing under NAICS. Since, as we have noted, there were no unfilled orders data available by SIC-4, we could not perform this operation for unfilled orders. Therefore, we set the allocation ratios for unfilled orders equal to the shipments allocation ratios.

5.3 Development of Initial Macro Monthly Historical Series for NAICS Categories

The SIC category code allocation ratios derived for shipments, inventories, and unfilled orders were based on Census/ASM data and, therefore, were annual ratios. To decompose monthly data, we needed monthly ratios, so we assumed the monthly allocation ratios to be the same as the annual ratios. Since there was some variation in the yearly values of these ratios (see Appendix B) for a given item, however, we decided to perform one minor adjustment on the ratio values before applying them. This adjustment was to smooth the annual differences over twelve month spans. This prevented the annual change from being concentrated in one month of the year. For shipments, which are an accumulation of monthly values for the year, the smoothing was performed so that the June ratios were the ratios coinciding with the annual ratios. We reasoned that the annual ratios were in some sense an average of the monthly values, and,

therefore, that it was somewhat reasonable to associate this average with the middle of the year. For inventories and unfilled orders, which are point-in-time measures, the annual ratios themselves corresponded to end-of-year or December values, so the smoothing was performed so that the December ratios assumed the values of the annual ratios.

We received a monthly data series (1992-1996) from the M3 staff for each M3 category code that reflected, at that time, the most recent benchmarking to the 1996 ASM. To obtain the NAICS historical monthly series, we applied the appropriate allocation factors for shipments, inventories, and unfilled orders to these data, and then summed the allocated data to NAICS category levels. Since the M3 series were benchmarked series, the NAICS-based series for shipments and inventories, which were reallocations of these series, should closely approximate the benchmark values we derived earlier for the NAICS categories for these items. We found this to be the case. Small discrepancies were attributed to the smoothing operation and to rounding. Although we had no derived category benchmarks for unfilled orders, the December values obtained through the allocation process, by the same reasoning, were considered benchmarks.

Finally, a NAICS-based new orders series was derived from the shipments (TVS) and unfilled orders (UFO) series. For each month j, the new orders value was set equal to $TVS_j + (UFO_j - UFO_{j-1})$.

5.4 Development of Final Macro Monthly Historical Series for NAICS Categories

Although the 1997 Census was published on a NAICS basis, SIC codes were available in the Census database. This allowed us to obtain tabulations of Census data by SIC code, repeat our methodology to estimate NAICS category code totals (benchmarks), and compare the method estimates to actual benchmarks obtained from summing published NAICS-6 industries to category levels. For shipments, this comparison revealed that 51 of the 89 category method benchmarks were within one percent of the actual benchmarks, 65 were within two percent, 73 within five percent, and 84 within ten percent. Accordingly, we ratio adjusted the originally derived shipments benchmarks for each of the years 1992-1996 to account for these deviations. The same deviations were assumed for each year since we had no reason to believe that the method applied to earlier years would have been any better or worse than for later years. We repeated this comparison for inventories to produce adjusted inventories benchmarks as well.

For unfilled orders, we were able to do an independent adjustment of those benchmarks because the results of the 1999 Unfilled Orders Survey became available. Recall that in most years, unfilled orders benchmarks, not being available from the ASM/Census program, were derived from the December unfilled orders monthly estimates by assuming the same relative differences as occurred between annualized M3 shipments and the shipments benchmarks. Because over time this link is tenuous, an independent Unfilled Orders Survey is done periodically. The results from this survey not only provide current year benchmarks, but they also are used to revise the derived benchmarks

from earlier years for unfilled orders. Prior to 1999, the last Unfilled Orders Survey was conducted in 1986—a 13 year span. The unfilled orders benchmark adjustments (revisions) were made assuming a straight-line allocation of the difference between the 1999 Unfilled Orders Survey benchmark values and the 1999 derived benchmarks. The allocation conceptually covered 14 years including the previous benchmark year 1986 where no difference was assumed between the 1986 original and revised values. Counting from zero, this meant 0/13 of the difference was allocated to December 1986, 1/13 of the difference to December 1987, and so on. Since, in actuality, we were only concerned with revising the years 1992-1998, we applied the algorithm consecutively from 6/13 to 12/13 to cover those years.

To obtain a revised monthly series consistent with the newly revised benchmarks, we ran the benchmarking program on the initial macro series for each of the three items. The same constraints previously mentioned for shipments, inventories, and unfilled orders were stipulated. Monthly new orders were then re-derived from the resulting shipments and unfilled orders values. These series represented the final macro series and no further adjustments were made.

5.5 Development of Micro NAICS Historical Series

Concurrently with the work of MPMB to produce the macro series, the M3 staff worked to produce an original NAICS series from company-level data—the micro approach. The basis of this approach was to access the 1997 Census shipments and inventories data for the M3 companies and determine how these data were distributed across the NAICS category codes. Each company's unfilled orders were assumed to be distributed the same as its shipments. Then, beginning with year 1992, actual M3 company data for each month were distributed across NAICS categories based on these Census year distribution patterns. The same patterns were assumed for all months and all years.

Once the company data were allocated for each month, the link-relative estimation procedure was invoked to produce "original" NAICS category code monthly estimates. Link-relative estimation requires a starting or original link point. January 1992 values, obtained from the macro series and which, therefore, simulated benchmarked values, served as the original link points in the estimation procedure. These resultant series then were benchmarked to the final adjusted benchmark values obtained from the macro analysis. As usual, new orders were derived from shipments and unfilled orders for each month.

As stated before, the micro monthly series was intended for use as the actual historical series to be used for seasonal adjustment purposes unless, in comparison with the macro series, serious anomalies were suspected. The comparison provided us no basis for modifying its intended use.

One final step was to partition the monthly inventories values into their component details: materials and supplies, work-in-process, and finished goods. The M3 staff

developed factors by category code for each year, and these in turn were applied to the total inventories series to produce the detailed series.

6. TREATMENT OF ENTERING MANUFACTURING AND EXITING MANUFACTURING ACTIVITY

Throughout this documentation, we have described activities as if there were no actual change in the manufacturing universe, but rather only a reallocation of manufacturing activity. In fact, the manufacturing universe had changed. Under NAICS, some activity was manufacturing for the first time, while some previous manufacturing activity became nonmanufacturing. The activities subject to movement were, of course, clearly identified in the **Federal Register** notice and the NAICS manual.

As we allocated SIC-4 data across NAICS-6 codes, we allocated only that data that remained in manufacturing under NAICS, since only manufacturing NAICS codes were of interest. The result was that some allocation percentages for a given SIC-4 code, if summed across all appropriate NAICS-6 codes, summed to less than 100 percent. The portion that was missing measured activity no longer in manufacturing.

We made no attempt in the beginning to directly include incoming manufacturing activity, as we had no access to that data at the outset of this project. More importantly, we had concluded that its impact was of minimal significance, both in its effect on the level of the survey estimates and on seasonal adjustment patterns. Indirectly, however, the adjustments resulting when comparing 1997 method benchmarks to actual benchmarks (see section 5.4) did account for incoming activity since this activity was included in the 1997 actual benchmarks.

7. GOVERNMENT/NON-GOVERNMENT BREAKOUT

Several pairs of NAICS categories are government and non-government splits of the same defining NAICS industries. These category definitions coincided closely, but not exactly, with the SIC M3 categories that split data by defense and non-defense. The M3 does not publish by these breakouts, but they do provide BEA with special tabs showing these data. Our initial macro work provided both estimates and benchmarks with government and non-government categories combined, as we had no basis for splitting the data. The M3 staff later provided factors that allowed us to split the combined values.

8. LIMITATIONS AND ASSUMPTIONS

Throughout this report, we have pointed out specific weaknesses and limitations of the methods used to generate the estimates and benchmarks for the historical series, and we have mentioned basic assumptions that were made. We reiterate, in no particular order, some of the more important limitations and assumptions. We are unable to quantify to what degree the resultant series (both micro and macro) are affected by these limitations.

- To develop annual NAICS-6 shipments benchmarks for 1992, we attempted to identify the SIC products that belonged to each NAICS-6 industry. This was done on the basis of product descriptions and the NAICS manual code descriptions. For most product codes this was straightforward, but for many, it is likely that we included them with the incorrect NAICS-6 code. If so, this clearly affected the levels of the NAICS-6 shipments benchmarks, and the corresponding levels of the NAICS category code benchmarks. Also, in some instances, products were split among multiple NAICS-6 codes. We made arbitrary decisions (usually equal allocations) in splitting data among the multiple codes. If these multiple codes were not contained within the same NAICS category code, the levels of the category code benchmarks were affected. These problems were compounded in ASM years where less detailed product class data were used to arrive at benchmark levels. As an example, when NAICS-6 codes were not completely defined by one or more product classes, we used Census year results to determine the split of product classes across NAICS-6 codes.

- The ratios used to allocate SIC-4 industry shipments to NAICS-6 industries were based upon all producers of the products primary to the SIC-4 regardless of their classification. Where the contributions of secondary producers of these products were significant, these allocation factors were probably less reliable.

- When we allocated SIC-4 data, we did so to all NAICS-6 categories indicated by the NAICS manual. Thus, we made no attempt to anticipate to what extent M3 companies would combine or otherwise alter category data. In this sense, our benchmark totals and the macro monthly series resemble a “pure” rather than “actual” reporting pattern.

- To develop annual NAICS-6 inventories benchmarks, we used the same SIC-4 allocation factors as were derived for shipments. This was because the Census and ASM programs do not collect inventories by product or product class. Since unfilled orders data are not collected at all in the Census and ASM, no SIC-4 allocation factors were derived at all for unfilled orders.

- The higher level allocation factors for shipments and inventories used to decompose the M3 SIC category codes were readily derivable from the information used to develop the NAICS-6 benchmarks for these variables, namely the SIC-4 contributors and their respective shipments and inventories values. However, since we had no such information for unfilled orders, we decomposed unfilled orders using the factors derived for shipments.

- In decomposing the monthly SIC series to derive the macro series, we assumed that the annual SIC category code allocation percentages held for the months of the year as well. In the smoothing of annual percentage changes over 12-month spans, we assumed uniform monthly increases (decreases) that summed to the annual changes.

- In adjusting the 1992-1996 initial benchmarks for shipments and inventories based on the 1997 comparison of actual benchmarks to method benchmarks, we assumed the same adjustment for all years. In adjusting the 1992-1998 initial unfilled orders benchmarks based on the 1999 Unfilled Orders Survey results, we assumed a straight-line allocation of the differences between the two covering the 13-year span between the two most recent Unfilled Orders Surveys.

- The allocation of company level data needed for deriving the micro series was based strictly on 1997 Census data, but the same allocations were applied for all years.

- The micro data were benchmarked to the macro-obtained annual totals, and thus, for the years 1992-1996, were subject to the limitations of the macro benchmarks. Actual benchmarks were available for 1997 forward. Also, since a benchmark-level value was needed as the initial link (January 1992) for generating the original NAICS micro series, the macro based January 1992 value, which simulated a benchmarked value, was used.

- Incoming activity new to manufacturing under NAICS was not directly accounted for in the development of the original NAICS benchmarks. The revised benchmarks arising from the comparison of 1997 method benchmarks to actual benchmarks did adjust for incoming activity since this activity was included in the actual benchmarks.

Appendix A.
Example of the Use of Census Product Tables to Develop SIC-4 Allocation Factors for Shipments

The first steps in the development of NAICS-6 industry benchmarks were to determine which SIC-4 codes contributed to a given NAICS-6 industry and to estimate for each SIC-4 code what proportion of its shipments should be allocated to the NAICS-6 code. In this example, we illustrate how for Census year 1992, we used the Census product tables to estimate these allocation factors. A similar procedure using ASM product class tables was used for the years 1993-1996. The codes, data, and relationships we define below are not necessarily real or accurate, but will illustrate the steps followed.

Suppose we have NAICS-6 industry 313131 and we have determined that SIC-4 industries 2131, 2132, and 2134 are the contributing industries. Consider the product table for industry 2131. This table includes quantity and value of all the products of industry 2131 regardless of whether they are produced by primary establishments (classified in the industry) or secondary establishments (classified elsewhere). An NSK (not specified by kind) code also appears, showing the contribution of plants coded to the industry that did not or were not required to report product data. Suppose for industry 2131 we have seven products plus one NSK product (2131000) defined with the following shipments values in dollar units.

PRODUCT CODE	1992 SHIPMENTS
2131111	$200,000
2131112	$33,000
2131231	$116,000
2131232	$120,000
2131341	$5,000
2131342	$20,000
2131343	$62,000
2131000 (NSK)	$44,000
Total	$600,000

Next, suppose that we had determined from the product descriptions that all of 2131232 and ¼ of 2131342 contributed to 313131. All remaining data went to other NAICS-6 codes. Using this knowledge, we determined the allocation factor for 2131; but, first we accounted for the NSK value, either by distributing it across the seven defined products in the same proportions as currently reported (in which case 600,000 dollars remains the base), or by subtracting it from the total and using the sum of the product numbers as

reported (556,000 dollars) as the base. In either case, the allocation factor will be the same.

If we do the latter, then we estimate the proportion of 2131 going to 313131 as:

{1.00(120,000) + 0.25(20,000)} / 556,000 = 22.5%

We repeated this process for SIC industries 2132 and 2134. Suppose these allocations were 100.0% and 55.0% respectively, and that the shipments totals for industries 2131, 2132, and 2134 were 1,000,000 dollars, 2,000,000 dollars, and 25,000,000 dollars, respectively. Note that the industry total for 2131, as is usually the case, does not equal the total sum of products for 2131; either value can be larger. Finally, we estimated the 1992 benchmark value for shipments for 313131 by applying the allocation factors to the industry totals and summing. In this example, the final benchmark shipments value is:

.225(1,000,000) + 1.00(2,000,000) + .55(25,000,000) = 15,975,000 dollars.

Appendix B.
Example of the Derivation of SIC Category Shipments Allocation Factors for a NAICS Category

The procedure to derive the macro series was to decompose the monthly SIC category estimates into NAICS category components and then combine appropriate components to obtain monthly NAICS category estimates. Doing this required the derivation of allocation factors to apply to the monthly estimates. These allocation factors were derived using the information resulting from the NAICS-6 benchmark derivations. Different allocation factors were derived for each year, but the same factors, save for smoothing changes (see below), were applied to all the months of a 12-month span. Below, we illustrate this procedure for NAICS category code 311A for shipments. The table below provides the basic data required by year.

311A

NAICS-6	SIC-4	Old M3 Cat	Total Value of Shipments (Billions)				
			1996	1995	1994	1993	1992
311211	2034	20E	0.6	0.6	0.6	0.5	0.6
	2041	20E	7.4	7.3	7.1	6.8	6.3
311212	2044	20E	2.5	1.9	2.0	1.9	1.7
311213	2083	20D	0.9	0.7	0.6	0.6	0.6
311221	2046	20E	9.0	8.5	7.6	6.9	7.0
311222	2075	20C	12.8	11.9	11.3	10.6	9.6
	2079	20C	1.1	1.0	1.1	1.1	1.1
311223	2074	20C	0.8	0.7	0.7	0.6	0.6
	2076	20C	0.6	0.6	0.5	0.6	0.6
	2079	20C	0.1	0.1	0	0	0
311225	2074	20C	0.1	0.1	0.1	0.1	0.1
	2075	20C	1.4	1.3	1.2	1.1	1.1
	2076	20C	0.1	0.1	0.1	0.1	0.1
	2079	20C	4.0	3.6	3.9	3.9	3.7
311230	2043	20E	9.1	11.5	11.5	10.6	9.7
TOTALS			50.5	49.9	48.3	45.4	42.8

Column 1 shows the NAICS-6 industries that comprise category code 311A. Column 2 shows for each NAICS industry code the SIC-4 industries that contributed some or all of their data to it. Note that the same SIC-4 code often contributed to more than one NAICS industry. It is possible that these codes also contributed to NAICS-6 codes belonging to other NAICS category codes. Column 3 indicates the old M3 (SIC) category code where the SIC-4 code was tabbed when the survey was SIC-based. The yearly values are the respective contributions of the SIC-4 industries to the NAICS-6 industries. These are the annual values previously calculated when deriving NAICS-6 benchmark values (see Appendix A). The sums of the contributing values are the total values at the bottom of the table and are the annual benchmark totals estimated for 311A for each year.

The table shows precisely which old M3 categories contributed to the NAICS category, and it shows the value of those contributions by year. If we sum these values by old M3 category, we have the total annual contributions (Cont) of the old M3 categories. If we next divide these contributions by the total annual estimates (Tot) for the M3 categories, we have the allocation factors (Pct) we desire. The table below summarizes the results for the three old M3 categories that contributed to NAICS category 311A.

Percentage Contribution of Old M3 Categories to 311A

Old M3 Cat	1996	1995	1994	1993	1992
20C- Tot	23.4	21.3	20.8	20.0	18.8
Cont	21.0	19.4	18.9	18.1	16.9
Pct	89.7%	91.1%	90.9%	90.5%	89.9%
20D- Tot	68.4	64.4	61.3	58.6	57.9
Cont	0.9	0.7	0.6	0.6	0.6
Pct	1.3%	1.1%	1.0%	1.0%	1.0%
20E- Tot	209.2	204.4	196.9	190.5	183.6
Cont	28.6	29.8	28.8	26.7	25.3
Pct	13.7%	14.6%	14.6%	14.0%	13.8%

Note that the percentage contribution of each old M3 category varies somewhat over the years. It is these values we smoothed over twelve month periods to avoid having the change being concentrated in one month. The smoothing constraint for shipments was that the allocation factor for June of each year corresponded to the factor shown in the table. Thus, for example, the transition for 20C from the 90.9 percent factor in 1994 to the 91.1 percent factor in 1995 occurred from June 1994 to June 1995. Since we had no transition into 1992 nor from 1996, we used the 1992 factor (89.9%) for the first six months of 1992, and the 1996 factor (89.7%) for the last seven months of 1996.