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# Measuring State Exports: Is There a Better Way?

THE RISING LEVEL OF U.S. EXPORTS in recent years has caused jobs and incomes in many states to become more closely tied to exports. To assess the economic effects of state exports, it is essential to have reliable information on the level of export activity by firms within the individual states. Such information is essential for numerous other purposes as well. For example, policymakers and others interested in state economic development require export data to assess the effectiveness of programs designed to stimulate export activity; they also require such data to assess the effects of trade policy changes, such as the proposed free trade agreement with Mexico.[1] Unfortunately, no ideal measure of state export activity currently exists.

This article describes the two available state export series and compares their estimates of manufactured exports. Such a comparison was not possible until recently because the two series were not available for the same year. Our comparison for 1987 reveals that the two series provide conflicting information about export activity in many states.

The most prominent deficiency of both measures is that they are based on the value of export shipments by firms within a state rather than on the value of goods produced within a state that are exported. While this distinction may sound arcane, the discussion below indicates that it is not. Moreover, income and employment in a state are dependent on the latter measure, not on the value of export shipments. To address this deficiency, a third estimate of state manufactured exports is developed in this article. Comparisons show the differences between this new measure and one of the existing measures of export activity. Such a comparison further illuminates the shortcomings of the two

[1]As reported in *Business America* (1991), state governments engage in a wide variety of activities to promote exports. These activities include overseas trade missions, technical assistance (such as seminars on the legal and financial aspects of trade), and the dissemination of trade leads. Seven states have export finance programs; 41 states maintain offices in 24 countries to promote trade. These promotional activities raise the issue of whether international exports by firms within a state generate different economic results than domestic exports (or exports to other states by firms within a state). Empirical evidence to assess whether such a distinction is meaningful in an economic sense is scarce. See Webster et al. (1990) for evidence that the employment effects of international exports exceed those of domestic exports for many industries.

available series and the advantages of a series like that developed here.

## EXISTING MEASURES OF STATE EXPORTS

Historically, the focus of U.S. trade data has been on country-to-country trade flows (that is, U.S. exports to and imports from individual countries). Recently, increasing attention has been focused on trade flows involving individual states. Exports of Boeing aircraft from Washington and imports of foreign cars by Missouri residents are just two examples of traded goods that have attracted attention to the fact that state jobs and incomes are related to the international economy. Our focus is restricted to export activity at the state level. To date, those interested in the magnitude of these flows have relied on two data sources published by the U.S. Census Bureau: *Exports From Manufacturing Establishments (EME)* and the *Origin of Movement of Commodities (OMC)*.

### *Exports From Manufacturing Establishments*

Approximately 56,000 of 220,000 manufacturing establishments are asked in the Annual Survey of Manufactures to report the total value of products shipped for export.[2] Since many establishments do not know the final destination of their products, the reported exports understate the value of all manufacturing export shipments. To compensate, the total amounts reported are adjusted to include estimates of exports by other distributors, such as wholesalers.

Differences between the directly reported values and the national total derived from Shipper's Export Declarations are allocated to states.[3] A Shipper's Export Declaration is a document that exporters must file which includes the value of each export shipment.[4] The allocation procedure is complicated slightly because the industry classification scheme used in Shipper's Export Declarations differs from that used in the Annual Survey of Manufactures. An additional complication is that the value of export shipments in Shipper's Export Declarations includes freight and wholesale margins. Since the value of export shipments in the *EME* is reported as shipments leave the plant, the costs associated with transportation and wholesaler activity must be removed from the values reported in Shipper's Export Declarations.

*EME* was first produced in 1960 as the *Origin of Exports of Manufactured Products*. It was produced at varying intervals until it became an annual report in 1983. This series possesses some significant shortcomings. First, the series is restricted to manufactured exports. It provides no information for establishments engaged in exporting services or unprocessed commodities produced by the agricultural, mining, forestry and fishing sectors.[5]

Second, this series is available with a two-year or more delay. For example, data for 1985 and 1986 became available in early 1989 and data for 1987 became available in 1991. Many analysts view these data as having only historical value because information on recent activity is not available for use in current decisions, such as those involving targeting export promotion expenditures.[6]

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[2] At five-year intervals, a more comprehensive coverage of manufacturing establishments occurs with the Census of Manufactures. See appendix A of U.S. Census Bureau (1991) for details on the 1987 *Census of Manufactures* and the 1986 *Annual Survey of Manufactures*.

[3] For details, see appendix C of the U.S. Census Bureau (1991).

[4] A Shipper's Export Declaration must be filed for all export shipments except for those going to Canada. Effective November 30, 1990, this document was no longer required for Canadian shipments because of a decision to substitute Canadian import statistics for U.S. export statistics. See Ott (1988) for an explanation why Canadian import data are considered more accurate than U.S. export data.

[5] Processed food, forestry, petroleum and coal products that originate in these primary sectors are included as manufactured exports.

[6] Such decisions are also complicated by the fact that, until 1987, export data were generally unavailable at the three-digit Standard Industrial Classification (SIC) level. The SIC is the standard by which establishment-based U.S. government economic statistics are classified by industry. For details, see U.S. Office of Management and Budget (1987). For manufacturing, 20 industries are identified at the two-digit SIC level. The industry becomes more narrowly defined as the number of digits for an SIC level increases. Prior to 1987, the export data were presented at the two-digit SIC level, or only for broad industries. An example of the disaggregation offered by the use of three-digit SIC codes is chemicals and allied products (SIC 28) which has eight industry groups: industrial inorganic chemicals (SIC 281); plastics materials and synthetics (SIC 282); drugs (SIC 283); soaps, cleaners and toilet goods (SIC 284); paints and allied products (SIC 285); industrial organic chemicals (SIC 286); agricultural chemicals (SIC 287) and miscellaneous chemical products (SIC 289).

The final and most important shortcoming is that this series reports the value of shipments instead of what is termed "value added." Value added is the value of a firm's sales minus the value of the goods and services it purchases from other firms to make its products. As the term implies, value added measures the dollar value a firm adds to the value of purchased inputs in its production process.

One way to calculate the market value of final goods and services produced during a year is to sum the value added at each stage of production by the firms in an economy.[7] To illustrate, assume an automobile producer had total sales of $18 billion, of which $10 billion reflect the value of steel, tires, plastics, electricity and other inputs used by the producer to make automobiles. The cost of these intermediate inputs is subtracted from the producer's revenue to calculate value added, so the automobile producer's value added was $8 billion. This procedure is repeated for each firm in the economy; the sum of all firms' value added equals the total value of production within an economy.

Using the value of export shipments rather than the value added related to exports might be a misleading indicator of export activity in a state. Some manufactured products are not exported directly, but are combined as inputs with other resources to produce an export. If these inputs were produced in one state and transported to another for final processing, the value of export shipments from the latter manufacturing establishment in the exporting state would overstate the value added that actually occurred in that state.[8] The value of export shipments includes value added in both states.

A state's value of export shipments will exceed its export value added if its exporting firms rely heavily on inputs produced elsewhere or if its firms produce relatively few inputs used by exporting firms in other states. On the other hand, the value of export shipments from a state will fall short of its export value added if its exporting firms produce more inputs that are used by exporting firms in other states than its firms purchase from elsewhere. Export value added and the value of export shipments will only be the same if the value of shipments used to produce exports in other states exactly offsets the value of inputs from other states that are used to produce exports. Overall, a state's value of export shipments may overstate, understate or equal the value added that actually occurred in the state. The empirical importance of this difference is examined below.

## *Origin of Movement of Commodities*

Prompted by a request from the transportation industry, a second export series, the *OMC*, began in 1987. The goal of this series is to identify where merchandise begins its export journey so that it can be tracked to its port. In the case of a manufactured good, the so-called "point of origin" does not require that the location of production of all component parts be identified, but rather where a completed manufactured good began its export journey. According to the instructions that accompany the Shipper's Export Declaration, the point of origin could be any of the following: 1) the state in which the merchandise actually began its journey to the port of export (indicated by the two-digit U.S. Postal Service abbreviation); 2) the state of origin of the commodity with the greatest share of value in a bundle of exports; or 3) the state of consolidation (the state where goods are consolidated by an intermediary for overseas shipment). In practice, the ports from which goods are shipped overseas are frequently used to identify the point of origin. This discretion in identi-

[7]The value added approach is one of three standard methods for calculating the market value of production. The other methods focus on income and expenditures. The income approach sums the incomes derived from economic activity, which are primarily wage, profit and interest incomes from employment of labor and capital resources. The value added in an establishment is the income generated by the establishment's activity. The expenditure approach sums four general categories of spending on goods and services: consumption, investment, government and net exports (that is, exports minus imports). The income and expenditure approaches are used more extensively in the United States than the value added approach. In the European Community, however, the value added approach is used extensively in the administration of taxes.

[8]Although such intermediate products are identified by the state of production as "supporting exports" in the *EME*, the state from which they are ultimately exported is not indicated. In addition, adding a state's supporting exports to its final shipments would result in some "double counting" of exports and overstate the value added associated with manufactured exports. Note that the national value of export shipments is a theoretically appropriate measure of value added because the sum of export shipments across all establishments does measure the market value of these manufactured exports. At the national level, there is no double counting. The shipments of intermediate inputs used for the exports are already included in the value of export shipments and are not added again in the calculation of manufactured exports.

fying the point of origin reflects the fact that determining the location of production is not a primary objective of this data series.[9]

Origin of movement totals are determined by sorting Shipper's Export Declarations by the state where a commodity became an export. A problem, however, is that Declarations for many shipments contain no point of origin. For example, in 1987 about 25 percent of the 9.7 million Declarations for shipments contained no state code. To make the data more useful, the Census Bureau contracted with the Massachusetts Institute for Social and Economic Research to develop estimates for the origin of shipments lacking state codes.[10] This expanded series is used in the following discussion and is referred to as the *OMC* series.

This newer series has some desirable characteristics relative to the export data provided directly by manufacturing establishments in the *EME*, although the older series is generally viewed as the more reliable of the two series.[11] One attractive feature of the *OMC* is that the data are available with a lag of months rather than years. In addition to manufactured exports, shipments data on nonmanufactured merchandise exports are provided. The initial foreign destination of these goods is provided as well. Consequently, information about state-to-country export flows is available for the first time. Like the *EME*, however, this series does not approximate the extent of value added in a state resulting from manufactured exports.

## A COMPARISON OF THE TWO SERIES

While there are several reasons why the two export series might differ, it is possible that the actual differences are small enough to allow the data to be used interchangeably. No comparison of the two series has been possible previously because 1987 was the first year for which the data in the *OMC* were available and the 1987 *EME* was just released in April 1991. First, we compare each state's level of exports as indicated in the *EME* and the *OMC*. Next, we investigate whether a state's rank differs between the two measures. To complete the analysis, a particular facet of the linear relationship between the two export series is examined. See appendix A for details on the three methods used to compare the two 1987 series, as well as the two 1986 export series discussed later. If the two series are closely related, then the *OMC* data, which are available after a considerably shorter lag, could be used in place of the *EME* data.

### *Comparing Levels: 1987 Export Series*

Table 1 shows the value of 1987 manufactured exports according to the two series for the 51 "states" (50 states and the District of Columbia) and the total of the states. One reason the two series differ is that the data in the *OMC* include transportation costs and wholesale margins, while the data in the *EME* are the value of exports at the producing plant. This accounts for the bulk of the $22.3 billion excess of the *OMC* state total over the *EME* state total in table 1.[12]

If these items were the only source of difference, the export value in the *OMC* for each state would be higher than the value in the *EME*. Also, the difference would be greater for those states farthest from major ports or a foreign border, reflecting the higher transportation costs. Table 1 shows that exports according to the *OMC* are higher than the level according to the *EME* in just 20 of the 51 states. This is in sharp contrast to the expectation that the *OMC* measure should be higher based on differences in its coverage and on the difference in the state totals. This discrepancy occurs primarily because of the *OMC*'s focus on where merchandise began its export journey. Since this location is often

[9]Smith (1989, 1990) notes that identifying the production locations of exported goods is especially difficult for agricultural and mined commodities. Small shipments of these commodities are often combined at storage facilities prior to reaching their port of embarkation. Shippers tend to report either the state of consolidation or the port as the state of origin.

[10]Details on the methods to generate these estimates can be found in Lerch (1990).

[11]See Farrell and Radspieler (1990) and Little (1990).

[12]Appendix B of the *Exports from Manufacturing Establishments: 1987* shows the difference between the value of exports at the port of export and the estimated plant value to be $28 billion.

Table 1

## Manufactured Exports by State for 1987

| State | 1987 Exports[1] EME | 1987 Exports[1] OMC | Differences Levels[2] | Differences Percentage[3] | Rank EME | Rank OMC |
|---|---|---|---|---|---|---|
| Alabama | $2,138.6 | $1,896.8 | $ -241.8 | -11.3% | 25 | 26 |
| Alaska | 889.6 | 1,516.0 | 626.4 | 70.4 | 36 | 30 |
| Arizona | 2,086.0 | 2,772.7 | 686.7 | 32.9 | 27 | 21 |
| Arkansas | 1,353.0 | 636.1 | -717.0 | -53.0 | 33 | 41 |
| California | 22,996.1 | 30,448.7 | 7,452.6 | 32.4 | 1 | 1 |
| Colorado | 1,818.4 | 1,623.4 | -195.0 | -10.7 | 30 | 29 |
| Connecticut | 4,741.1 | 3,096.9 | -1,644.2 | -34.7 | 14 | 19 |
| Delaware | 519.7 | 842.0 | 322.3 | 62.0 | 43 | 35 |
| District of Columbia | 100.7 | 265.1 | 164.4 | 163.3 | 50 | 45 |
| Florida | 4,803.0 | 9,602.8 | 4,799.8 | 99.9 | 13 | 6 |
| Georgia | 3,561.1 | 3,380.1 | -181.0 | -5.1 | 20 | 18 |
| Hawaii | 175.3 | 153.5 | -21.8 | -12.4 | 47 | 49 |
| Idaho | 765.8 | 462.0 | -303.8 | -39.7 | 39 | 42 |
| Illinois | 8,687.8 | 8,471.5 | -216.3 | -2.5 | 7 | 8 |
| Indiana | 5,001.1 | 4,102.9 | -898.2 | -18.0 | 12 | 15 |
| Iowa | 2,552.6 | 1,756.3 | -796.3 | -31.2 | 24 | 28 |
| Kansas | 1,858.2 | 1,448.2 | -410.1 | -22.1 | 29 | 31 |
| Kentucky | 2,906.4 | 1,930.9 | -975.5 | -33.6 | 23 | 25 |
| Louisiana | 3,408.7 | 5,865.2 | 2,456.5 | 72.1 | 21 | 11 |
| Maine | 779.7 | 636.1 | -143.6 | -18.4 | 37 | 40 |
| Maryland | 1,927.9 | 1,881.1 | -46.8 | -2.4 | 28 | 27 |
| Massachusetts | 6,347.9 | 8,093.9 | 1,746.0 | 27.5 | 9 | 9 |
| Michigan | 12,412.0 | 17,618.2 | 5,206.2 | 41.9 | 4 | 3 |
| Minnesota | 4,733.3 | 3,850.1 | -883.2 | -18.7 | 15 | 16 |
| Mississippi | 1,712.1 | 1,122.3 | -589.8 | -34.4 | 31 | 32 |
| Missouri | 5,148.6 | 2,851.0 | -2,297.6 | -44.6 | 11 | 20 |
| Montana | 135.7 | 167.0 | 31.3 | 23.0 | 49 | 48 |
| Nebraska | 768.7 | 693.5 | -75.2 | -9.8 | 38 | 39 |
| Nevada | 170.3 | 356.8 | 186.5 | 109.5 | 48 | 44 |
| New Hampshire | 1,160.4 | 835.0 | -325.4 | -28.0 | 34 | 36 |
| New Jersey | 3,982.5 | 6,347.6 | 2,365.1 | 59.4 | 17 | 10 |
| New Mexico | 206.0 | 148.9 | -57.1 | -27.7 | 46 | 50 |
| New York | 11,824.0 | 17,614.8 | 5,790.8 | 49.0 | 5 | 4 |
| North Carolina | 5,670.6 | 4,898.0 | -772.6 | -13.6 | 10 | 13 |
| North Dakota | 222.6 | 217.4 | -5.2 | -2.3 | 45 | 47 |
| Ohio | 13,041.1 | 8,991.1 | -4,050.0 | -31.1 | 3 | 7 |
| Oklahoma | 1,355.4 | 991.3 | -364.1 | -26.9 | 32 | 33 |
| Oregon | 2,121.1 | 2,294.6 | 173.5 | 8.2 | 26 | 23 |
| Pennsylvania | 6,717.3 | 5,734.5 | -982.8 | -14.6 | 8 | 12 |
| Rhode Island | 691.9 | 408.5 | -283.4 | -41.0 | 40 | 43 |
| South Carolina | 3,234.7 | 2,159.6 | -1,075.1 | -33.2 | 22 | 24 |
| South Dakota | 270.3 | 56.0 | -214.3 | -79.3 | 44 | 51 |
| Tennessee | 3,567.2 | 2,309.3 | -1,257.9 | -35.3 | 19 | 22 |
| Texas | 14,046.3 | 22,662.3 | 8,616.0 | 61.3 | 2 | 2 |
| Utah | 589.1 | 757.0 | 167.9 | 28.5 | 42 | 37 |
| Vermont | 598.6 | 704.3 | 105.7 | 17.7 | 41 | 38 |
| Virginia | 3,656.6 | 4,750.8 | 1,094.2 | 29.9 | 18 | 14 |
| Washington | 10,841.7 | 11,793.9 | 952.2 | 8.8 | 6 | 5 |
| West Virginia | 1,126.2 | 920.0 | -206.2 | -18.3 | 35 | 34 |
| Wisconsin | 4,108.5 | 3,500.4 | -608.1 | -14.8 | 16 | 17 |
| Wyoming | 39.5 | 227.2 | 187.7 | 475.2 | 51 | 46 |
| Total | $193,571.0 | $215,863.5 | $22,292.5 | 11.5 | — | — |

Sources: *EME*: U.S. Department of Commerce, Bureau of the Census, *Exports from Manufacturing Establishments: 1987* (GPO, 1991). *OMC*: Massachusetts Institute for Social and Economic Research, University of Massachusetts, "U.S. Exports by State of Origin of Movement," data tape (1990).

[1] Millions of dollars.

[2] *OMC* value minus *EME* value.

[3] ((*OMC* - *EME*)/*EME*)100.

identified as a port, the *OMC* estimates of exports are more concentrated in states that contain, or are near, major ports. Also, in some states where transportation costs might be expected to be relatively high, such as Nebraska and Kansas, the export value in the *OMC* is lower than the value in the *EME*, again contrary to the expectations based on transportation costs alone.

The importance of ports in the *OMC* data is further illustrated in figure 1, which plots the level of exports in each series. If each state's exports were identical in both series, all points would fall on the line labeled "line of equality." The points below the line of equality indicate that states' exports in the *OMC* often are lower than reported in the *EME*. In seven of the states labeled in figure 1— California (CA), Florida (FL), Louisiana (LA), Michigan (MI), New Jersey (NJ), New York (NY) and Texas (TX)—the value using the *OMC* is much higher than the value using the *EME*. In these states, total exports using the former measure exceed exports using the latter measure by almost $37 billion. This pattern is consistent with the fact that data in the *EME* indicate the value of exports shipped from a state's manufacturers, while the data in the *OMC* are more likely to indicate the value of exports shipped from the state of consolidation or the port. Therefore, using the value in the *OMC* as a measure of a state's export activity can be misleading.

As table 1 shows, the percentage differences are also considerable for many states. For example, the value of exports from Wyoming measured in the *OMC* is nearly six times higher than that reported in the *EME*, while the *OMC* estimate for South Dakota is 79.3 percent lower. On average, the absolute value of the difference for a state is 44 percent; excluding Wyoming reduces the average difference to 35.3 percent.

The overall correspondence between the dollar levels of the two series is highlighted by calculating the simple correlation between them. This measure ranges from negative one to positive one and equals one when the two measures are perfectly correlated. In the present case, the correlation of .95 is high. Thus, when a state's *OMC* export value is higher than the average *OMC* export value using all states, the state's *EME* export value also tends to be higher than the average *EME* export value.

Figure 1 shows this general correspondence by plotting the states' 1987 exports as indicated by the two series. Most observations cluster around the line of equality. Still, the substantial difference between the two series for several states indicates that the two measures are not identical.

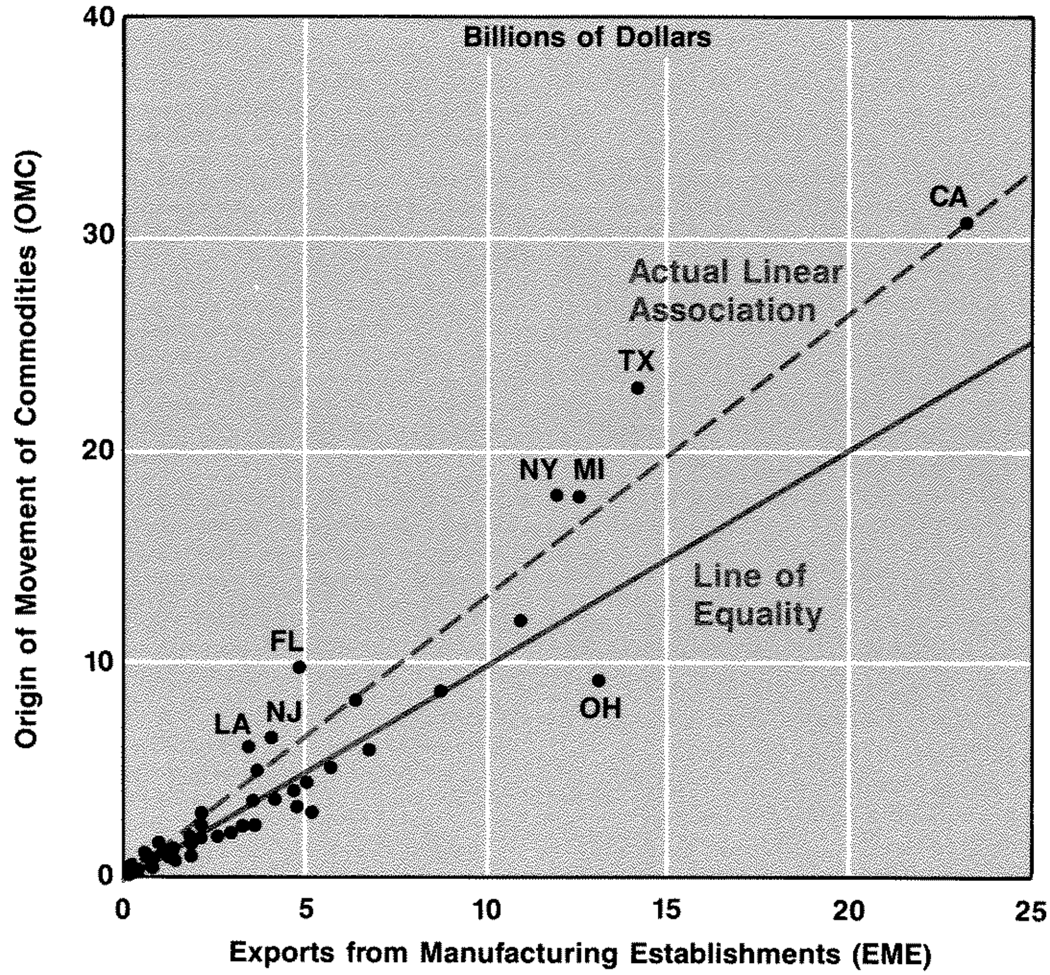
## *Comparing Ranks: 1987 Export Series*

Another useful comparison between the two series involves ranking the states to see if states with larger (smaller) export values using one measure also have larger (smaller) export values using the other measure. Ranks are often used as a summary measure of a state's relative export performance. If each state had the same or, at least, a similar rank among the 51 states using either series, then the more current data in the *OMC* could be used to rank the states in a more recent year.

In view of the high simple correlation between the two series, it is no surprise that table 1 indicates a general similarity between a state's export ranks using the two measures. California and Texas, for instance, rank first and second in both series. This general impression is corroborated by the calculation of a Spearman rank correlation that allows for pairwise comparisons of the alternative proxies. This coefficient ranges from negative one to positive one; it equals one when measures yield identical rankings and minus one when the rankings are identically inversely related. The correlation between the two series' export ranks is .96, which is very close to one.

Although this high correlation indicates a close overall correspondence between the rankings according to the two series, policymakers or researchers who rely on the more current ranking available from the *OMC* as an indicator of the relative scope of export activity in a specific state can easily be misled. The ranking of each state in the *OMC* is not identical to the more reliable ranking in the *EME*. Florida and Louisiana, for example, rank considerably higher according to the *OMC*, due to the major ports in those states from which a large volume of merchandise is shipped. Missouri, on the other hand, ranks only 20th using the more current *OMC* measure, but is 11th according to the *EME*.

# Figure 1
# A Graphical Comparison of Two State Export Series: 1987




### *A Closer Look at the Linear Association Between the 1987 Export Series*

A more rigorous criterion to assess the interchangeability of the two measures reveals a substantial difference between the two series. This criterion, termed difference preservation, requires that the two export series differ by no more than some constant across states. If this criterion is met, one export series could be reliably used as an index for the other.

If the *OMC* data preserved the difference in the *EME* data, the association between the two series could be illustrated by a line indicating equality of a state's exports, give or take some constant. In figure 1, such a line would be parallel to the line of equality. This is not the case, however. The dashed line, based on the actual linear association between the two series, is clearly not parallel to the line of equality. Consequently, one measure is not interchangeable for the other. This means that researchers and other users of state export data in statistical studies should not use one measure as a proxy for the other because the results can vary depending upon which measure is used. In practice, this finding applies to the use of the more timely *OMC*-based measure as a proxy for the *EME*-based measure.

## A NEW STATE EXPORT MEASURE BASED ON VALUE ADDED

Existing state export series indicate the value of export shipments rather than export value added. As such, they reflect both the value added in a state's factories as well as the value added embodied in intermediate goods which may have been produced in other states. For example, an airplane assembled and exported from the state of Washington may have components manufactured in California and Texas. Consequently, these series fail to identify the true amount of state economic activity used to produce manufactured exports.

To address this problem, we estimate a measure of each state's value added associated with manufactured exports. In conjunction with the *EME*, the Census Bureau provides data for each state regarding the number of manufacturing workers producing manufactured exports in each industry as well as the number of nonmanufacturing workers in jobs related to the production of manufactured exports. In fact, approximately the same number of nonmanufacturing jobs as manufacturing jobs are related to manufactured exports. This reflects the fact that manufacturing requires the productive efforts of workers (such as lawyers, accountants and transportation and communication workers) from various nonmanufacturing industries.

Unlike the value of export shipments, the level of export-related employment is directly related to the value added of exports in a state; such employees directly generate the value added. This employment information is used to estimate state export value added. The estimates are based on the assumption that the productivity (output) of each export-related employee is no different than the average worker's productivity in that industry and state. Consequently, export value added in a state is equal to the sum over all industries of the number of export-related employees in a state multiplied by their productivity.

One data series necessary for such estimates, gross state product—the market value of the goods and services produced within a state during a year—is not currently available for 1987. Since this precludes calculating export value added for 1987, our measure of exports is estimated for 1986. Appendix B provides a detailed discussion of the methodology used in estimating state export value added.

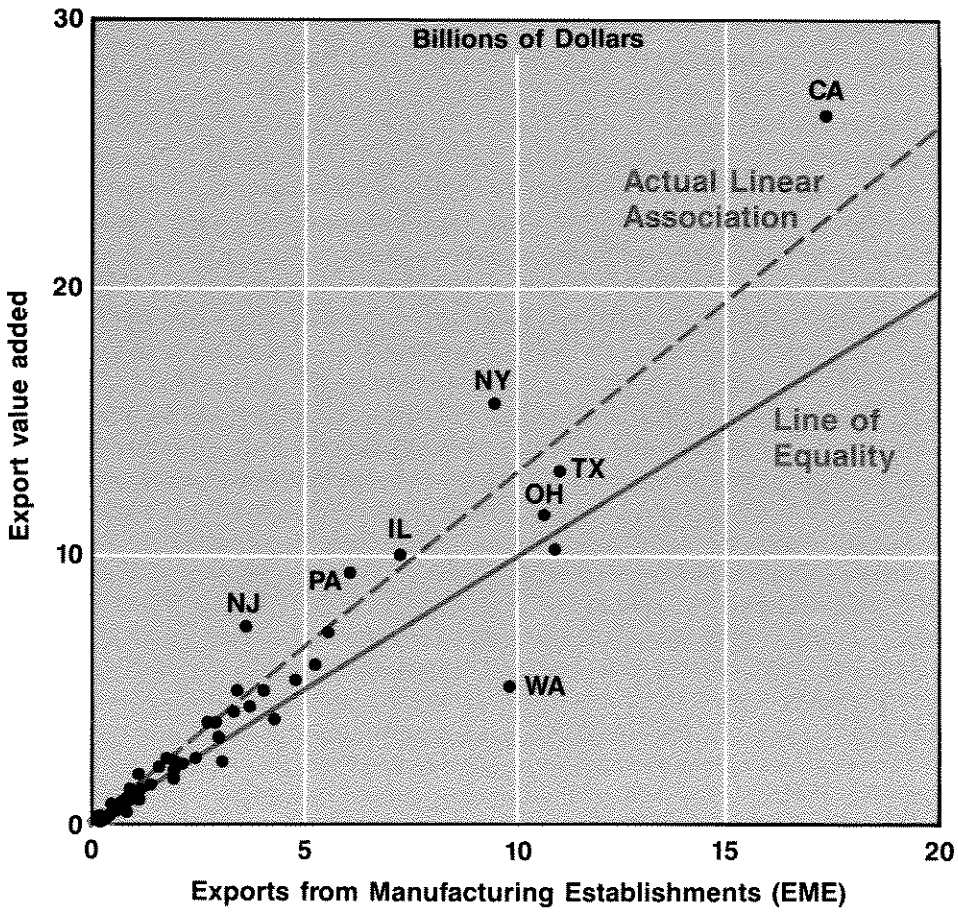
### *Comparing Export Value Added Vs. EME*

Figure 2 and table 2 compare the value of the newly constructed series of manufactured exports, export value added, with the value of state export shipments from the *EME*. Summing over all states, the export value added total ($196,656.2 million) exceeds the total in the *EME* ($159,374.5 million) by $37,281.7 million. Three-fourths of this difference is due to transportation costs and trade margins that are included in our calculations, but are not in the *EME* total.

The differences between the two measures at the level of individual states, however, reflect much more than transportation costs and trade margins. Rather, they reflect the fundamental distinction between value added and value of shipments accounts. The state of Washington is especially noteworthy as the level of export value added is approximately one-half the level of exports in the *EME*. This suggests that manufacturing export shipments from Washington contain a large percentage of intermediate inputs produced elsewhere.[13] Using the export shipments value as a measure of this state's export activity is clearly misleading.

[13]This is consistent with the Washington State input-output model for 1982 (Bourque, 1987). For example, in Washington's largest export sector, aerospace, inputs from other states equal 56.2 percent of the sector's shipments.

# Figure 2
## A Graphical Comparison of Two State Export Series: 1986




Using export shipments values also can cause inaccurate inferences in terms of understating a state's export activity. For example, the export value added in 12 states exceeds the values in the *EME* by more than 50 percent. Wyoming, with an export value added that is more than nine times its *EME*-based export value, is by far the most extreme example. The primary reason is that firms in Wyoming process large quantities of oil and coal that are shipped to other states for use in manufactured exports.

While Wyoming is a small exporter regardless of the measure used, the large percentage differences are not restricted to relatively small exporters. California, the nation's leading exporter by both measures, is estimated to export 53.5 percent more on the basis of value added than it does on the basis of shipment data. Thus, California firms are supplying large amounts of goods and services ultimately exported in the form of manufactured exports from other states.

These differences for many states between export value added and the *EME*-based measure of state exports raise the issue of the general association across all states between the measures. As was done above, the ranking of states' export value added was compared with the ranking of exports reported in the *EME* to

Table 2

**Manufactured Exports by State for 1986**

| State | 1986 Exports[1] EME | 1986 Exports[1] Value Added | Differences Levels[2] | Differences Percentage[3] | Rank EME | Rank Value Added |
|---|---|---|---|---|---|---|
| Alabama | $1,684.9 | $2,427.1 | $742.2 | 44.1% | 29 | 22 |
| Alaska | 712.9 | 545.8 | -167.1 | -23.4 | 38 | 43 |
| Arizona | 1,755.8 | 2,283.7 | 527.9 | 30.1 | 27 | 24 |
| Arkansas | 1,065.4 | 1,299.2 | 233.8 | 21.9 | 33 | 33 |
| California | 17,216.4 | 26,421.4 | 9,205.0 | 53.5 | 1 | 1 |
| Colorado | 1,477.7 | 2,087.0 | 609.3 | 41.2 | 30 | 28 |
| Connecticut | 3,996.4 | 4,968.0 | 971.6 | 24.3 | 13 | 13 |
| Delaware | 429.5 | 794.5 | 365.0 | 85.0 | 42 | 39 |
| District of Columbia | 91.0 | 194.3 | 103.3 | 113.5 | 50 | 49 |
| Florida | 3,372.6 | 4,966.2 | 1,594.0 | 47.3 | 16 | 14 |
| Georgia | 2,826.7 | 3,685.0 | 858.3 | 30.4 | 20 | 19 |
| Hawaii | 214.3 | 160.8 | -53.5 | -25.0 | 45 | 51 |
| Idaho | 502.6 | 548.1 | 45.4 | 9.0 | 40 | 42 |
| Illinois | 7,209.2 | 10,107.3 | 2,898.0 | 40.2 | 7 | 6 |
| Indiana | 4,787.4 | 5,352.8 | 565.4 | 11.8 | 11 | 11 |
| Iowa | 1,932.4 | 1,893.0 | -39.4 | -2.0 | 24 | 29 |
| Kansas | 1,835.0 | 1,690.3 | -144.7 | -7.9 | 26 | 31 |
| Kentucky | 1,939.8 | 2,191.2 | 251.4 | 13.0 | 23 | 26 |
| Louisiana | 3,020.3 | 2,374.9 | -645.4 | -21.4 | 18 | 23 |
| Maine | 800.6 | 799.6 | -1.1 | -0.1 | 36 | 38 |
| Maryland | 1,740.5 | 2,162.7 | 422.2 | 24.3 | 28 | 27 |
| Massachusetts | 5,513.8 | 7,139.8 | 1,626.0 | 29.5 | 9 | 9 |
| Michigan | 10,878.0 | 10,273.9 | -604.1 | -5.6 | 3 | 5 |
| Minnesota | 3,691.9 | 4,327.7 | 635.8 | 17.2 | 14 | 15 |
| Mississippi | 1,337.1 | 1,401.7 | 64.5 | 4.8 | 31 | 32 |
| Missouri | 4,267.9 | 3,896.3 | -371.6 | -8.7 | 12 | 17 |
| Montana | 101.2 | 232.8 | 131.6 | 130.1 | 49 | 48 |
| Nebraska | 753.3 | 808.0 | 54.7 | 7.3 | 37 | 37 |
| Nevada | 167.1 | 243.5 | 76.4 | 45.7 | 48 | 47 |
| New Hampshire | 892.6 | 1,193.0 | 300.4 | 33.7 | 35 | 34 |
| New Jersey | 3,548.1 | 7,248.5 | 3,700.0 | 104.3 | 15 | 8 |
| New Mexico | 177.7 | 335.4 | 157.7 | 88.7 | 47 | 44 |
| New York | 9,412.4 | 15,660.5 | 6,248.0 | 66.4 | 6 | 2 |
| North Carolina | 5,260.8 | 5,916.7 | 655.9 | 12.5 | 10 | 10 |
| North Dakota | 214.7 | 289.0 | 74.3 | 34.6 | 44 | 45 |
| Ohio | 10,653.0 | 11,561.7 | 908.7 | 8.5 | 4 | 4 |
| Oklahoma | 1,084.6 | 1,819.6 | 735.0 | 67.8 | 32 | 30 |
| Oregon | 1,862.7 | 2,264.5 | 401.8 | 21.6 | 25 | 25 |
| Pennsylvania | 6,026.6 | 9,373.2 | 3,347.0 | 55.5 | 8 | 7 |
| Rhode Island | 481.9 | 748.7 | 266.8 | 55.4 | 41 | 40 |
| South Carolina | 2,398.0 | 2,451.8 | 53.8 | 2.2 | 22 | 21 |
| South Dakota | 212.7 | 250.8 | 38.1 | 17.9 | 46 | 46 |
| Tennessee | 2,910.4 | 3,212.1 | 301.7 | 10.4 | 19 | 20 |
| Texas | 10,981.5 | 13,195.1 | 2,214.0 | 20.2 | 2 | 3 |
| Utah | 668.5 | 944.0 | 275.5 | 41.2 | 39 | 36 |
| Vermont | 384.0 | 651.3 | 267.3 | 69.6 | 43 | 41 |
| Virginia | 2,704.0 | 3,701.8 | 997.8 | 36.9 | 21 | 18 |
| Washington | 9,862.8 | 5,176.1 | -4,687.0 | -47.5 | 5 | 12 |
| West Virginia | 983.2 | 1,049.1 | 65.9 | 6.7 | 34 | 35 |
| Wisconsin | 3,313.5 | 4,163.6 | 850.1 | 25.7 | 17 | 16 |
| Wyoming | 19.1 | 173.2 | 154.1 | 806.9 | 51 | 50 |
| Total | $159,374.5 | $196,656.2 | $37,281.7 | 23.4 | — | — |

Sources: *EME*: U.S. Department of Commerce, Bureau of the Census, *Exports from Manufacturing Establishments: 1986* (GPO, 1989). Export Value Added: Authors' calculations.

[1]Millions of dollars.

[2]Export Value Added minus *EME* value.

[3]((Export Value Added – *EME*)/*EME*)100.

determine whether states with larger (smaller) export values using one measure in 1986 also had larger (smaller) export values using the other measure in the same year. The two measures yield a general similarity between a state's export ranks. The Spearman rank correlation is .98, which is virtually one.

The ranks of a number of states, however, differ substantially across the two measures. Nine states have ranks that differ by five places or more. The largest changes involve Washington, which drops from fifth place using export shipments to twelfth place using export value added, and New Jersey and Alabama, both of which moved up seven places (New Jersey from 15 to 8 and Alabama from 29 to 22) when using value added.

The overall correspondence between these two measures is also indicated by the simple correlation between the two measures. The simple correlation is .95. This close correspondence is evident when the two series for each state are plotted as in figure 2. Many observations cluster around the line of equality reflecting the linear association between the two measures.

This strong association, however, does not mean that the two measures are interchangeable. In terms of figure 2, the actual linear association (identified by the dashed line) varies significantly in a statistical sense from the line of equality.[14] Consequently, one measure is not a reliable proxy for the other when used in statistical studies.

## CONCLUSION

Despite some improvement in available information on state export activity in recent years, the two existing state export series are deficient in several ways. Their most important limitation is that they both measure the value of shipments and not the extent of a state's economic activity (value added) related to manufactured exports. Nonetheless, as general indicators of export activity across all states, the two measures provide similar information. Despite this overall similarity, the two series can lead to substantially different conclusions when used for some states. Furthermore, the *OMC* series, which is available on a more timely basis, is not a satisfactory proxy for the more accurate *EME* data on export shipments according to the criterion used in this article.

The estimate of a state's export value added generated in this article is inherently superior to the existing measures available for assessing state export performance. This new measure can produce different conclusions than shipments-based data when used for some states or when used in statistical studies. Consequently, users should reconsider their use of the existing export series when they desire an accurate measure of a state's value added related to manufactured exports.

The evidence presented here on export value added and its deviation from the *EME*-based export shipments measures is for one year only, however. The behavior of this discrepancy over time is unknown. This reinforces the importance of developing historical data on state export value added for analyses involving state export activity.

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[14] The dashed line indicates that a state's value added tends to be higher than its shipments. In particular, each dollar increase in state export shipments in 1986 was associated with a $1.36 rise in export value added, on average.

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# Appendix A
# Interchangeability of Alternative Measures

The existence of alternative export measures raises the issue of the extent to which the measures are interchangeable. In other words, do these measures provide virtually identical information about state export performance? Different criteria exist for assessing this issue.

Three criteria are used here: 1) rank correlation criterion; 2) simple correlation criterion; and 3) orthogonal regression criterion. The rank correlation criterion focuses on the degree to which measures have identical rankings for corresponding observations. As a first step, states (including the District of Columbia) are ranked from 1 (the state with the largest value of exports) to 51 (the state with the smallest value of exports) for each export measure. To make pairwise comparisons of the rank-order, a Spearman rank correlation coefficient, $R_s$ is calculated as follows:

$$(1)\ R_s = 1-[6/N(N^2-1)] \sum_{i=1}^{N} (0_i - A_i)^2,$$

where i is a subscript denoting specific states (i = 1, 2,. . ., 51); $0_i$ is the rank of the ith state using one measure; $A_i$ is the rank of the ith state using the alternative measure; and N is the sample size.

If the rank-orders of the two measures are identical, then $R_s = 1$. For example, using one measure and assuming that three states—A, B and C—had export values of 300, 200 and 100, the states would be ranked 1, 2 and 3. If, using the other measure, states A, B and C had export values of 5, 4 and 1, then an ordering of the states based on the two export measures would be identical and the Spearman rank correlation coefficient is one. A rank-order of zero means that the rank-orders of the two measures are not related. A rank-order of minus one means that the rank-orders are the reverse of each other. Thus, the closer $R_s$ is to one, the more similar the rank-orders and the more interchangeable the measures for ranking purposes.

As indicated in the text, the Spearman rank correlation coefficient was approximately one for the comparison of the 1987 export measures in *EME* and *OMC* (.96) and the 1986 measures in *EME* and our export value added (.98). Consequently, the measures provide highly correlated rankings. These results suggest that, as a summary indicator of states' relative export performance, the measures provide roughly identical information. Satisfying this criterion, however, does not preclude large differences in a specific state's rank across the measures. For example, recall that the state of Washington dropped from fifth place using the shipments-based data in the *EME* for 1986 to 12th place using our export value added measure.

A stronger condition than rank correlation involves the simple correlation of the levels of the alternative measures. The simple correlation coefficient provides information concerning the extent of a linear relationship between the alternative measures. The simple correlation coefficient is calculated as follows:

$$(2)\ r = \Sigma(x-\bar{x})(y-\bar{y}) / \sqrt{(\Sigma(x-\bar{x})^2\ \Sigma(y-\bar{y})^2)},$$

where $\bar{x}$ and $\bar{y}$ are the sample means of the alternative export series, x and y.

For any given state, if the value of exports using one measure exceeds the mean of this measure based on all states by a certain amount and the value of exports using the other measure also exceeds (or falls below) its series mean by a set amount, then a perfect linear correlation exists. The value of the correlation coefficient will equal one (or minus one in the event of a negative relationship). For example, as in the numerical example above, assume states A, B and C had export values of 300, 200 and 100 using one measure. Using the other measure, assume states A, B and C had export values of 450, 250 and 50. Thus, A's exports exceed the first series mean of 200 by 100 using one measure, and exceeds the second series mean of 250 by 200 using the other measure. For a perfect linear correlation, C's exports (which are 100 less than the first series mean) must be 200 less than the second series mean (that is, equal 50). Since this is the case, the correlation equals one. A correlation coefficient of zero means that no linear relationship between the measures exists.

As indicated in the text, the linear relationship between both sets of measures is strong. For the 1987 measures in *EME* and *OMC*, the correlation coefficient is .95. For the 1986 measures in *EME* and of export value added, the correlation coefficient is also .95. Since these coefficients are virtually one, the measures can be viewed as interchangeable using this criterion.

When using a more stringent criterion, however, this is not the case. This criterion for interchangeability requires that the measures are not only highly correlated, but that they consistently differ by a constant, possibly zero. Once again, assume states A, B and C had export values of 300, 200 and 100 using one measure. Using the other measure, assume state A had exports of 350. For "difference preservation," states B and C's exports must be 250 and 150. In this case, the two measures differ by 50 for each state. This difference preservation is known as an orthogonal regression criterion.[1]

Jackson and Dunlevy (1982) illustrate this criterion, in a time-series context, by a simple example of estimating a consumption function with different permanent income measures. Assume perfect correlation between two income measures $y_1$ and $y_2$, so that:

$$(3)\ y_1 = a + by_2,$$

where a is the intercept and b is the slope. Suppose the following consumption function is estimated:

$$(4)\ c = d + ey_1 + \varepsilon,$$

where d is the intercept, e is the slope and $\varepsilon$ is the random disturbance term. The slope is called the marginal propensity to consume and is the change in consumption associated with each $1 change in income. If $y_2$ is used rather than $y_1$, however, the consumption function becomes:

$$(5)\ c = (d+ea) + eby_2 + \varepsilon.$$

The two measures of income will yield the same estimate of the marginal propensity to consume only if b equals one.

Using orthogonal regression, we generated estimates of b for the alternative export measures discussed in the text. Specifically, we estimated two equations similar to equation 3. In one regression, the 1987 measures of state exports in *OMC* and *EME* were used as $y_1$ and $y_2$, respectively. In the other regression, the 1986 measures of state exports based on our calculations of export value added and in *EME* were used as $y_1$ and $y_2$, respectively.

The orthogonal regression criterion is not satisfied by alternative export measures. For the 1987 measures in *EME* and *OMC*, the or-

[1]In contrast to simple regression, the fitted line in orthogonal regression is the one that minimizes the mean square of the perpendicular (rather than the vertical) deviation of the sample points from the fitted line. See Malinvaud (1980), for a thorough discussion of the differences between orthogonal and simple regression.

thogonal least squares estimate of b equals 1.37. A t-statistic can be used to test the null hypothesis that b equals one.[2] The critical t-value for a 5 percent significance level with 49 degrees of freedom is 2.01, which is far below the actual t-value of 7.03. Consequently, the null hypothesis is rejected. Similarly, the 1986 measures in *EME* and of export value added produce an orthogonal least squares estimate of b (1.36), which yields a rejection of the null hypothesis that b equals one; the critical t-value of 2.01 at the 5 percent level of significance is far less than the actual t-value of 6.35.[3]

The implication of this analysis is that the levels of alternative export measures are not interchangeable using this criterion and their use would generate different regression results in otherwise identical estimations. Specifically, the coefficient estimates for the impact of a change in state exports on some variable of interest, say state economic growth, would differ depending on the measure used.[4]

[2]Because of random variation in the data it is unlikely that b exactly equals one. Therefore, the t-statistic is used to test whether we can reasonably infer that the estimated value of b equals one. See Jackson and Dunlevy (1981) for additional details on hypothesis tests involving the orthogonal least squares slope estimator.

[3]A related issue involves whether the two measures are consistently proportional to one another, that is, whether they tend to differ by a given percentage. This is investigated by testing whether the orthogonal least square slope estimator between the logarithms of the two measures significantly differs from one. Using the logarithms of the 1987 measures in *EME* and *OMC*, the slope estimate equals 1.01. The associated t-statistic is 0.109, which is less than the critical t-value of 2.01 (5 percent significance level). Consequently, the null hypothesis that the slope equals unity cannot be rejected. These results suggest that the logarithmic forms of the two 1987 export measures in *EME* and *OMC* are interchangeable. On the other hand, the logarithmic forms of the 1986 measures in *EME* and of export value added yield an orthogonal least squares slope estimate of 0.892. Because the associated t-statistic of 2.95 exceeds the 2.01 critical value, the null hypothesis is rejected, suggesting that the two measures of 1987 exports are not interchangeable.

[4]See Coughlin and Cartwright (1987) for an empirical examination of the effect of manufacturing exports on employment for individual states. This is an example of a study where the regression results could be altered by using different export series.

# Appendix B
# Estimating Value Added Related to Manufactured Exports by State

In this appendix, we identify the data and methodology used to calculate the value added related to manufactured exports by state. We begin by identifying the variables used in the calculations and the data sources.

Various employment, shipments and gross state product data are essential for our calculations. Manufacturing employment (ME), export-related manufacturing employment (XME) and export-related nonmanufacturing employment (XNME) for each state are published in *Exports from Manufacturing Establishments: 1985 and 1986*, U.S. Department of Commerce (1989).[1] ME is reported by respondents in the U.S. Census Bureau's Annual Survey of Manufactures, while XME and XNME are calculated by the Census Bureau.

Three other series are used. The first is unpublished data from the U.S. Department of Commerce (1991) on nonmanufacturing employment (NME). The second data series, which is published in *Exports from Manufacturing Establishments: 1985 and 1986*, is total state employment. The third data series, which is published by the U.S. Department of Commerce (1989), is gross state product (GSP). GSP is the

[1]For a detailed explanation of how these data were developed, see this publication's Introduction and Appendix C.

market value of the goods and services produced within a state during a year and is the state analog of U.S. gross domestic product. GSP data for individual manufacturing and nonmanufacturing industries were used.

## *Methodology: Calculating Export Value Added*

To calculate total value added related to manufactured exports in state s ($XTV_s$), we summed estimates of value added within the state's manufacturing sector ($XMV_s$) and value added in nonmanufacturing sectors related to the export of manufactured goods ($XNMV_s$). That is,

$$(1)\ XTV_s = XMV_s + XNMV_s.$$

Because identical data were not available for each manufacturing sector, the components of $XMV_s$ were calculated in one of two ways.[2] For industries in which export-related data are published, $XMV_s$ was estimated by applying the following equation:

$$(2)\ XMV_{si} = (GSP_{si}/ME_{si})(XME_{si}).$$

As defined above, GSP is gross state product, ME is manufacturing employment and XME is export-related manufacturing employment. The subscript i designates the different SIC manufacturing industry groups. In our calculations, we used the two-digit manufacturing industry group so i ranged from SIC 20 to SIC 39. This method implicitly assumes, for each industry, that output per worker in the production of export goods ($XMV_{si}/XME_{si}$) is the same as output per worker in the production of all goods ($GSP_{si}/ME_{si}$). Equation 2 was applied using data for individual industries rather than for total manufacturing, because this assumption is more plausible for each industry than for manufacturing as a whole.

For those manufacturing sectors with no published export-related employment at the two-digit industry level, $XMV_s$ was estimated using the following equation:

$$(3)\ XMV_{sm} = (GSP_{sm}/ME_{sm})(XME_{sm}),$$

where the m subscript refers to the total of those sectors not reported. For example, to compute a state's total unreported export-related manufacturing employment ($XME_{sm}$), we simply subtracted the amount reported from the total export-related manufacturing employment. Consequently, $XMV_s$ is the sum of the estimates for the reported industries ($XMV_{si}$) plus the single estimate for the missing industries ($XMV_{sm}$).

To compute a state's value added in its nonmanufacturing sectors related to manufactured exports ($XNMV_s$), we first estimated the following measure for each of a state's four nonmanufacturing industries [where j=1, trade; j=2, business services; j=3, transportation, communication and utilities; and j=4, other]:

$$(4)\ XNMV_{sj} = (GSP_{sj}/NME_{sj})\ (XNME_{sj}),$$

where GSP for the "other" sector is calculated as total state GSP minus manufacturing and minus the three nonmanufacturing industries, (j=1...3); $NME_{sj}$ is nonmanufacturing employment in industry j; and $XNME_{sj}$ is export-related nonmanufacturing employment in sector j.[3] "Other" employment is total state employment minus employment in manufacturing, trade, business services and transportation, communication and utilities.

The state total for the value added in these nonmanufacturing sectors, $XNMV_s$, is simply the sum of the value added in the four nonmanufacturing sectors. The accuracy of this calculation, similar to the calculation for the manufacturing sectors, rests on the degree to which the productivity of export-related workers in sector j ($XNMV_{sj}/XNME_{sj}$) is equal to the productivity of all workers in that sector ($GSP_{sj}/NME_{sj}$).

[2] In some states, export-related manufacturing employment data were not published for certain industries either to avoid disclosing data for individual companies or because the estimate did not meet publication standards. Summing over all states, unpublished export-related manufacturing employment accounts for 1.8 percent of total 1986 export-related manufacturing employment.

[3] Export-related nonmanufacturing employment in the "other" sector accounts for 31.8 percent of the 1986 national total for such employment.