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# Accounting for Changes in Manufactured Exports at the State Level: 1976-86

THE RAPID INTERNATIONALIZATION of the U.S. economy in recent years has spread unevenly across regions and states. For example, while the real value of direct manufactured exports rose 25 percent in the nation between 1976 and 1986, it actually declined slightly in the Middle Atlantic and Upper Midwest regions of the United States.[1] Coughlin and Fabel (1988) have demonstrated that some of the variation in state export levels can be explained by differences in their endowments of productive resources. According to these authors, states with relatively more capital, both human and physical, have higher export levels and, thus, higher shares of U.S. exports.

This paper extends the research in Coughlin and Fabel by examining the change in export levels across states between 1976 and 1986. We explore the factors that potentially caused the varied growth in states' export sectors. Using a technique called shift-share analysis, we isolate two influences on state export growth—industrial composition and relative export growth of the same industry at the state and national levels—and compare their relative importance. Next, we examine the relationship between export growth and resource endowments at the state level to see if we find results consistent with those of Coughlin and Fabel.

## FACTORS INFLUENCING THE SHIFT OF EXPORTS AMONG STATES

Table 1 contains the basic export and resource endowment data used in this study for the 48 states in the continental United States.[2] A look at the export data columns shows the tremen-

[1]This comparision uses U.S. Census regions. The Middle Atlantic Census Region consists of New York, New Jersey and Pennsylvania; the Upper Midwest is actually the East North Central Census Region, which consists of Ohio, Indiana, Illinois, Michigan and Wisconsin. The value of direct manufactured exports is the plant value of manufactured exports (U.S. Department of Commerce, 1981 and 1989). In 1986, the port value of U.S. manufactured exports was $182 billion; the plant value of exports, $159.4 billion, is obtained by removing transportation and insurance costs.

[2]Our analysis excludes the District of Columbia, Alaska and Hawaii because their export values are small and their exports are not disaggregated by industry, a deficiency that precludes meaningful interpretation of the shift-share analysis that we present later.

Table 1

## Direct Manufactured Exports, Human Capital and Physical Capital

| | Direct Exports | | Human Capital | | Physical Capital | |
|---|---|---|---|---|---|---|
| | 1986 level ($ millions) | Percent change 1976-86 | 1986 level ($1000/worker) | Percent change 1976-86 | 1986 level ($1000/worker) | Percent change 1976-86 |
| Alabama | $ 1684.9 | 102.5% | $ 91.4 | 140.4% | $ 56.3 | 130.2% |
| Arizona | 1755.8 | 174.7 | 97.5 | 114.2 | 40.0 | 95.4 |
| Arkansas | 1065.4 | 63.6 | 63.7 | 380.2 | 41.1 | 148.2 |
| California | 17216.4 | 113.3 | 135.5 | 173.2 | 36.3 | 129.6 |
| Colorado | 1477.7 | 139.8 | 117.6 | 128.4 | 43.2 | 118.2 |
| Connecticut | 3996.4 | 104.1 | 122.0 | 138.9 | 30.3 | 113.5 |
| Delaware | 429.5 | 128.0 | 195.1 | 133.2 | 48.4 | 78.1 |
| Florida | 3372.6 | 147.5 | 98.5 | 124.1 | 38.6 | 100.5 |
| Georgia | 2826.7 | 107.2 | 74.5 | 177.5 | 40.2 | 136.4 |
| Idaho | 502.6 | 197.6 | 82.0 | 118.9 | 50.3 | 136.3 |
| Illinois | 7209.2 | 8.3 | 123.8 | 158.6 | 44.3 | 125.6 |
| Indiana | 4787.4 | 69.3 | 131.2 | 134.2 | 57.9 | 119.8 |
| Iowa | 1932.4 | 28.8 | 100.1 | 206.9 | 54.8 | 159.4 |
| Kansas | 1835.0 | 188.9 | 88.7 | 137.2 | 41.8 | 136.7 |
| Kentucky | 1939.8 | 70.6 | 102.1 | 423.8 | 51.3 | 150.6 |
| Louisiana | 3020.3 | 118.3 | 125.3 | 164.5 | 167.4 | 204.5 |
| Maine | 800.6 | 214.1 | 88.0 | 138.7 | 60.1 | 188.5 |
| Maryland | 1740.5 | 171.7 | 128.6 | 143.8 | 45.7 | 102.1 |
| Massachusetts | 5513.8 | 120.3 | 115.7 | 131.4 | 30.4 | 146.7 |
| Michigan | 10878.0 | 57.9 | 164.7 | 200.5 | 47.4 | 122.7 |
| Minnesota | 3691.9 | 135.6 | 116.2 | 175.3 | 35.6 | 152.2 |
| Mississippi | 1337.1 | 91.6 | 69.2 | 197.1 | 46.5 | 191.0 |
| Missouri | 4267.9 | 163.1 | 107.3 | 112.7 | 35.7 | 146.5 |
| Montana | 101.2 | 132.1 | 31.0 | −30.9 | 71.4 | 67.9 |
| Nebraska | 753.3 | 143.6 | 82.0 | 146.0 | 35.9 | 108.0 |
| Nevada | 167.1 | 514.3 | 100.4 | 275.6 | 43.9 | 94.7 |
| New Hampshire | 892.6 | 206.6 | 86.2 | 98.1 | 31.6 | 136.6 |
| New Jersey | 3548.1 | 33.4 | 127.9 | 101.9 | 34.5 | 89.8 |
| New Mexico | 177.7 | 156.8 | 88.2 | 704.9 | 57.0 | 158.3 |
| New York | 9412.4 | 76.9 | 134.8 | 162.4 | 33.7 | 131.3 |
| North Carolina | 5260.8 | 138.9 | 66.9 | 175.1 | 37.6 | 127.9 |
| North Dakota | 214.7 | 154.1 | 68.6 | 234.2 | 55.7 | 170.1 |
| Ohio | 10653.0 | 83.9 | 131.1 | 147.9 | 45.6 | 108.9 |
| Oklahoma | 1084.6 | 87.4 | 111.4 | 166.7 | 52.1 | 181.3 |
| Oregon | 1862.7 | 126.0 | 90.8 | 182.8 | 43.7 | 102.9 |
| Pennsylvania | 6026.6 | 28.1 | 107.3 | 130.0 | 42.1 | 113.1 |
| Rhode Island | 481.9 | 79.3 | 89.8 | 109.6 | 22.6 | 106.6 |
| South Carolina | 2398.0 | 156.4 | 80.5 | 464.6 | 53.6 | 159.5 |
| South Dakota | 212.7 | 211.4 | 73.2 | 261.0 | 30.0 | 142.3 |
| Tennessee | 2910.4 | 132.3 | 87.9 | 154.9 | 40.5 | 121.1 |
| Texas | 10981.5 | 111.2 | 121.5 | 193.6 | 81.5 | 150.6 |
| Utah | 668.5 | 199.0 | 102.1 | 240.1 | 39.1 | 110.8 |
| Vermont | 384.0 | 92.2 | 90.5 | 72.8 | 55.7 | 259.6 |
| Virginia | 2704.0 | 75.1 | 80.9 | 166.6 | 43.7 | 133.6 |
| Washington | 9862.8 | 204.9 | 141.6 | 166.7 | 55.0 | 99.9 |
| West Virginia | 983.2 | 119.9 | 155.2 | 215.1 | 68.1 | 85.2 |
| Wisconsin | 3313.5 | 50.0 | 100.1 | 231.8 | 39.9 | 143.0 |
| Wyoming | 19.1 | 85.4 | 56.9 | 45.9 | 102.1 | 114.4 |

dous diversity across these states in both the level of exports and their growth over the decade. In 1986, for example, the value of direct manufactured exports ranged from $19.1 million in Wyoming to $17.2 billion in California. While direct exports rose 91.2 percent in the continental United States between 1976 and 1986, state growth rates ranged from 8.3 percent in Illinois to 514.3 percent in Nevada. States with relatively high growth rates captured larger shares of U.S. exports over time, while those with lower growth rates saw their export shares diminish.

These changes in export shares can be examined by a technique called shift-share analysis. This method, an accounting technique, is described in detail in the appendix. Basically, the technique calculates each state's net relative change over the period; states in which exports grew more rapidly than the national average between 1976 and 1986 have a positive net relative change and vice versa. The figures in the first column in table 2 show these net relative changes in exports across states. These changes and their individual components (also in table 2) are expressed as percentages of the export levels that would have been achieved in 1986 had their exports grown from 1976 to 1986 at the national rate. Thus, for example, Arizona's exports in 1986 were 36 percent higher than if its exports had grown at the national rate from 1976 to 1986.

The shift-share method divides a state's net relative change (NRC) in exports among three components: the industrial mix effect (IME), the competitive effect (CE) and the allocative effect (AE). Each state's IME, CE and AE sum to its NRC.

## The Industry Mix Effect

During any period, exports of some of the nation's goods will grow faster than others. Those states whose exports are more heavily concentrated in these faster-growing export sectors will find their share of the nation's total exports rising, other things the same. The opposite relationship holds true as well: states whose exports are more heavily concentrated in goods whose export sales are growing relatively slowly at the national level will find their share of the nation's export sales declining. Discussions of regional export growth frequently focus on the region's industrial mix as a key determinant of its export performance. For example, Hervey (1986) attributed the Midwest's slow export growth throughout most of the 1970s and early 1980s to its "traditional" industry composition.[3]

Table 3 shows 1976-86 annual growth rates of U.S. exports from the 20 major industry groups. The industries are listed in declining order of their export growth rates over the 10-year period. The last column in table 3 shows the composition of U.S exports in 1976. If the composition of a state's exports was identical to that of the nation's exports, its IME would equal zero. If a state had a favorable (unfavorable) mix of exports, that is, if it had high (low) concentrations of its 1976 exports in industries experiencing rapid national export growth over the 1976-86 decade, its IME would be greater (less) than zero. The magnitude of IME indicates how much higher or lower the state's exports were in 1986 than they would have been if the state's export composition were identical to the nation's. This value is expressed as a percentage of the level of 1986 total state exports that would have resulted if they had grown at the national rate in the 1976-86 period.

The IME values listed in table 2 range from 99 percent for North Dakota to −29 percent for Nevada. Thus, the industrial mix effect, *ceteris paribus*, contributed to a 99 percent increase in North Dakota's exports relative to what they would have been otherwise, while contributing to a 29 percent reduction in exports in Nevada.

## The Competitive Effect

The CE figures listed in table 2 indicate the influence of the relative export growth of a state's industries, assuming its industry mix of exports is identical to the nation's. A positive (negative) CE indicates how much higher (lower) a state's exports were in percentage terms in 1986 solely because exports from individual state industries grew at a faster (slower) rate than the corresponding national industries over the 1976-86 period. This value is expressed as a percentage of total state exports that would have been achieved in 1986 had they grown at the national rate over the 1976-86 period.

[3]More recently, Smith (1990) concluded that a region's industrial mix was an important factor in distinguishing its relative export performance during 1987 and 1988.

## Table 2
## Shift-Share Components for State Export Growth, 1976-86

| | Net Relative Change | Industry Mix Effect | Competitive Effect | Allocative Effect |
|---|---|---|---|---|
| Alabama | 20.7% | 15.8% | 30.0% | −25.1% |
| Arizona | 36.1 | 3.8 | 36.3 | −4.0 |
| Arkansas | −10.6 | 0.2 | 92.6 | −103.4 |
| California | 14.0 | 6.0 | 11.2 | −3.3 |
| Colorado | 23.4 | 5.1 | 50.0 | −31.7 |
| Connecticut | 7.7 | 7.0 | 18.2 | −17.4 |
| Delaware | −7.2 | 13.3 | 249.2 | −269.7 |
| Florida | 31.5 | 4.2 | 61.3 | −34.0 |
| Georgia | 4.6 | 0.5 | 16.1 | −12.0 |
| Idaho | 57.3 | 13.8 | 83.0 | −39.4 |
| Illinois | −42.4 | −2.6 | −27.6 | −12.1 |
| Indiana | −9.7 | 3.8 | 5.0 | −18.5 |
| Iowa | −30.4 | −2.7 | −12.8 | −15.0 |
| Kansas | 56.9 | 10.9 | 53.4 | −7.4 |
| Kentucky | −10.0 | 3.3 | −11.4 | −1.9 |
| Louisiana | 19.1 | 13.6 | 8.8 | −3.3 |
| Maine | 86.0 | 38.0 | 181.0 | −133.0 |
| Maryland | 34.7 | −3.8 | 206.3 | −167.7 |
| Massachusetts | 18.7 | 4.3 | 24.8 | −10.4 |
| Michigan | −15.9 | 3.8 | −9.3 | −10.3 |
| Minnesota | 27.5 | −2.0 | 11.4 | 18.1 |
| Mississippi | −1.4 | 0.5 | 7.4 | −9.3 |
| Missouri | 40.6 | 7.1 | 20.0 | 13.5 |
| Montana | 50.2 | 76.5 | −7.8 | −18.5 |
| Nebraska | 29.6 | 0.5 | 46.0 | −16.9 |
| Nevada | 209.0 | −29.0 | 1902.7 | −1664.7 |
| New Hampshire | 64.8 | 0.3 | 45.8 | 18.8 |
| New Jersey | −28.6 | 8.9 | −34.4 | −3.1 |
| New Mexico | 36.9 | −15.9 | 800.7 | −747.9 |
| New York | −5.4 | 0.4 | 0.2 | −6.0 |
| North Carolina | 26.8 | −3.2 | 80.8 | −50.8 |
| North Dakota | 161.5 | 99.0 | 104.6 | −42.1 |
| Ohio | −2.7 | 0.6 | 4.4 | −7.6 |
| Oklahoma | 0.6 | −3.9 | 17.0 | −12.5 |
| Oregon | 21.9 | −6.9 | 131.3 | −102.5 |
| Pennsylvania | −33.3 | −4.5 | −22.2 | −6.6 |
| Rhode Island | −2.3 | −12.5 | −6.5 | 16.7 |
| South Carolina | 37.6 | −2.4 | 59.7 | −19.7 |
| South Dakota | 64.2 | 31.6 | 287.4 | −254.7 |
| Tennessee | 20.9 | −1.5 | 46.3 | −23.9 |
| Texas | 12.5 | 6.6 | 6.9 | −1.0 |
| Utah | 52.5 | −8.7 | 433.0 | −371.8 |
| Vermont | 37.7 | 21.8 | 270.7 | −254.8 |
| Virginia | −6.7 | 3.1 | 24.2 | −34.0 |
| Washington | 61.4 | 0.9 | 305.6 | −245.0 |
| West Virginia | 23.6 | 5.5 | −1.0 | 19.0 |
| Wisconsin | −20.2 | −2.8 | −9.8 | −7.5 |
| Wyoming | 7.8 | 7.6 | 67.5 | −67.3 |

NOTE: See appendix for definitions of components.

Table 3

## Growth and Composition of U.S. Exports

| SIC | Industry Group | Compounded annual growth rate, 1976-86 | Percent of total 1976 exports |
|---|---|---|---|
| 29 | Petroleum and coal products | 10.5% | 1.4% |
| 25 | Furniture and fixtures | 10.3 | 0.2 |
| 30 | Rubber and miscellaneous plastics | 8.8 | 1.5 |
| 38 | Instruments and related products | 8.5 | 4.5 |
| 28 | Chemicals and allied products | 8.5 | 11.2 |
| 37 | Transportation equipment | 8.1 | 20.0 |
| 27 | Printing and publishing | 7.4 | 0.7 |
| 31 | Leather and leather products | 7.3 | 0.3 |
| 21 | Tobacco products | 7.1 | 1.2 |
| 36 | Electrical equipment | 7.1 | 11.1 |
| 23 | Apparel and textile products | 6.7 | 0.9 |
| 20 | Food and kindred products | 6.4 | 6.9 |
| 26 | Paper and allied products | 6.0 | 2.7 |
| 32 | Stone, clay and glass products | 5.6 | 1.1 |
| 35 | Machinery, except electrical | 5.5 | 23.0 |
| 22 | Textile mill products | 3.8 | 1.5 |
| 24 | Lumber and wood products | 3.4 | 2.2 |
| 34 | Fabricated metal products | 3.4 | 4.5 |
| 39 | Miscellaneous manufacturing | 2.1 | 1.6 |
| 33 | Primary metal industries | 1.5 | 3.6 |
| | Total Exports | 6.7 | 100.0 |

Regardless of its export composition, a state's overall exports could grow more rapidly than the national average if its individual sectors sufficiently outpaced the national industry average. In other words, a state can experience rapid export growth not only by exporting those goods that grew rapidly at the national level, but also by relatively rapid growth of exports from industries displaying little national export growth.

South Carolina's pattern of export growth exemplifies this possibility. The state, as reflected in its negative IME, has an unfavorable mix of exports. This mix is characterized by a relatively large export share in the textile mill products sector, whose exports had grown slowly nationally, and low concentrations in the chemicals and transportation equipment sectors, among the more rapidly growing export sectors nationally. Despite this industrial mix, exports from South Carolina grew faster than the national average because, as the positive CE shows, it had relatively rapid export growth in individual sectors. Exports of South Carolina's textile mill products, for example, grew at a 6.2 percent annual rate between 1976 and 1986; at the national level, in contrast, they grew at a relatively slow 3.8 percent rate.

### The Allocation Effect

The allocation effect reflects differences between a state and the nation in both industrial mix and relative industry export growth. Unfortunately, unlike the IME and CE terms, there is no clear-cut interpretation of the AE.[4] In 43 of the states, the AE component was negative. For most states, then, those sectors for which 1976 exports accounted for a small share of total state exports relative to the national export composition tended to grow more rapidly than at the national level between 1976 and 1986. In addition, those sectors that were relatively large in 1976 grew more slowly.

Returning to the South Carolina example, one reason that the state's AE was negative stems

[4]According to Esteban-Marquillas (1972), p. 252, the allocative effect "will show us if the region is specialized in those sectors in which it enjoys better competitive advantages" as evidenced by faster-than-national growth. Since our analysis is restricted to exports rather than production, this terminology is inappropriate.

from its transportation sector. Exports of transportation equipment accounted for less than 1 percent of the state's exports in 1976 compared with 20 percent nationally, while the state's 1976-86 annual growth rate of transportation equipment exports was approximately double the national rate. This combination of small relative size and rapid growth contributed to the state's negative AE.

### The Relative Influence of IME, CE and AE

To evaluate the contribution of industry mix, industry growth and allocation effect for each state, each component was ranked by its importance in influencing the state's net relative change. Using the figures from table 2, the component with the smallest absolute value for each state—and thus the state's least important factor—was ranked 1, while the state's largest component in absolute value—its most influential component—was ranked 3. The results of this exercise, shown in table 4, clearly indicate that the IME was least important for most states, while the CE was most important.[5] The IME was ranked as the least important component in 37 states, while the CE was ranked as most important in 34 states.

The relative influence of each of the three components also can be evaluated by comparing each component's percent share of the sum of the absolute values of the three components. In California, for example, the IME value of 6.0 represents 29.3 percent of the total effect [{6.0/(6.0 + 11.2 + 3.3)}x100 = 29.3]. As table 4 shows, on average, IME, CE and AE account for 12.6 percent, 49.7 percent and 37.7 percent, respectively, of the total influence on NRC.

Correlations between NRC and each of the three components reinforce the notion that a state's CE is the primary influence on NRC. The simple correlations across states between NRC and the IME, CE and AE components were .32, .68 and −.62, respectively. While all three coefficients are significantly different than zero at the 0.5 percent level, the NRC-CE correlation is substantially larger than the NRC-IME relationship, and, unlike the NRC-AE correlation, indicates a positive relationship.

Table 4

**Relative Importance of Shift-Share Components**

| | Number of states in which component was ranked | | | Average percentage share of total effect |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| Industry mix effect | 37 | 9 | 2 | 12.6% |
| Competitive effect | 4 | 10 | 34 | 49.7 |
| Allocative effect | 7 | 29 | 12 | 37.7 |

NOTE: A rank of 1 indicates a component was the smallest in absolute value of the three components for a state, while a 3 rank indicates it had the largest absolute value.

The strongly negative NRC-AE relationship suggests that, in general, those states with faster-than-national export growth managed this growth despite having relatively small shares of their 1976 exports in industries in which the state's exports subsequently outgrew the national industry average. Rather, their rapid export growth was the result of faster-than-national growth of individual industries, even though the rapid growth from these industries tended to account for a relatively small share of their 1976 exports. While states with rapid export growth tended to have favorable industry mixes, this factor is less important than the relatively fast growth of state exports from these industries.

In summary, across all states, the IME appears to be relatively unimportant in determining whether a state's exports grew faster than the national average. For the most part, it is the relative export growth of a state's individual industries that determines whether the state's export performance is superior to the nation's.

## WHAT ARE THE SOURCES OF A STATE'S COMPARATIVE EXPORT ADVANTAGE?

To explain the relative export performance of states, Coughlin and Fabel applied the Heckscher-

[5]This result corroborates Bauer and Eberts' (1990) finding that a state's growth rate of exports between 1980 and 1986 cannot be explained by the mix of industries in the state.

Ohlin theory of international trade. The Heckscher-Ohlin approach highlights the importance of a country's productive resources in determining its pattern of trade. One reason for international trade is differences in production costs across countries. These differences depend on what proportions various factors of production exist in different countries (that is, the relative factor endowments) and how the factors are combined in producing different goods (that is, the relative factor intensities).

Assuming a world consisting of two factors of production, two goods and two countries, the essence of the Heckscher-Ohlin theory can be explained simply. In a two-factor world, a country is relatively capital-abundant (labor-abundant) if it has a higher (lower) ratio of capital to labor than the other country. In a two-good world, a product is capital-intensive if its production requires a higher ratio of capital to labor than the other good. The Heckscher-Ohlin theory predicts that a country will export the good that uses its abundant factor intensively, while importing the other good. For example, if the United States is relatively capital-abundant and Mexico is relatively labor-abundant, the United States will export capital-intensive products and import labor-intensive goods, while Mexico would do just the opposite. The reason for this trade pattern hinges on the relative production costs. A country should be the lower-cost producer of goods that use relatively larger amounts of its more abundant resource.

The Heckscher-Ohlin approach allows for predictions about trade patterns based on a knowledge of countries' factor supplies. Since the services of factors of production are embodied in exports and imports, international trade may be viewed as the export of the services of the country's relatively abundant factor in exchange for the services associated with its scarce factor.

The preceding idea can be applied to states within a country.[6] Relative state export performance depends on state advantages; however, the specific advantages must also be defined in the context of the world economy. For example, if a state is relatively well-endowed with a resource that is scarce in the United States relative to other countries, then its resource advantage will not necessarily translate into superior export performance. Rather, the resource may simply allow increased production of an import-competing good. States that are better endowed with the characteristics that are associated with comparative advantage at the national level, however, should display relatively better export performance.

Numerous empirical studies suggest that the United States' primary source of international comparative advantage is its abundance of human capital.[7] In addition, as Coughlin and Fabel found, physical capital is a significant determinant of relative state export performance. To further explain the interstate differences in export growth rates, we examine the link between states' export growth and their changing endowments of physical and human capital.

## The Relationship between Changes in State Exports and Endowments

The connection between state export growth and endowment changes is explored by testing whether there is a statistically significant relationship across states between measures of export growth for the 1976-86 period and the percent change in human and physical capital per manufacturing worker for the same period.

Two measures of export growth are used in the statistical analysis: a state's NRC and its CE. Over any given period, a state's export growth relative to the nation (expressed by its NRC) is influenced by both the export growth of its individual industries (measured by CE) and the state's industrial mix at the beginning of the period. While a state's human or physical capital growth might be expected to stimulate the export growth of its individual industries (and, thus, increase its CE), there is no reason to think that the state's capital growth would be linked to the industry mix of its exports at the beginning of any period. Thus, a state's capital growth should be more closely linked to its CE

[6]Neither Coughlin and Fabel (1988) nor the present study are tests of the Heckscher-Ohlin theory of trade. See Bowen et al. (1987) for a rigorous examination. In the present case, the Heckscher-Ohlin theory provides a well-known framework in which to analyze the factors that contribute to a state's relative export performance.

[7]Keesing (1966), Balassa (1979), Branson and Monoyios (1977) and Stern and Maskus (1981) are a few of the studies that have emphasized the impact of human capital on U.S. international trade.

than to its NRC; by definition, the former measure is purged of the irrelevant and possibly confounding effects of a state's industrial mix that is included in the latter measure.

For our analysis, a state's human capital per manufacturing worker is measured using the difference between the state's average wage for manufacturing workers and the average wage of unskilled manufacturing workers in the state.[8] This difference, which is assumed to persist indefinitely, is viewed entirely as a return to human capital. This flow of returns is converted to a stock of human capital by dividing by an interest (discount) rate. Physical capital per manufacturing worker is measured by depreciable assets per manufacturing employee in the state.[9]

Table 1 shows the 1986 levels of the capital measures and their percent change since 1976. Montana has the dubious distinction of having the slowest growth in both human and physical capital. The change in human capital ranges from −30.9 percent in that state to 464.6 percent in South Carolina with a mean of 182.7 percent. The change in physical capital ranges from 67.9 percent in Montana to 259.6 percent in Vermont with a mean of 132.3 percent.

The relationships between state-level changes in exports and endowments were explored by first regressing NRC, and then CE, against the percent change in human and physical capital in a cross-sectional framework. The regression analysis shows whether variations across states in human or physical capital are closely linked to variations in CE or NRC among states.

The results of this analysis are shown in table 5.[10] Overall, neither the changes in human capital nor those in physical capital explain, in a statistical sense, differences in net relative change across states. We do, however, find that changes in human capital endowments explain differences in the competitive effect across states. Specifically, we find that, *ceteris paribus*, states with larger increases in human capital endowments per manufacturing employee had larger values for their competitive effect. Changes in physical capital endowments, however, do not explain differences in the competitive effect.

The difference in explanatory power of human capital between the two regressions is not surprising. A state's relative export growth is affected by a variety of factors besides changes in resource endowments. A list of reasonable determinants includes resource changes in the rest of the world, demand changes in both the United States and the rest of the world and promotional expenditures by state governments.[11]

By focusing on the competitive effect, some of the potentially confounding effects associated with a state's industry mix are eliminated. For example, foreign demand shifts toward certain industries would result in rapid export growth (and large positive NRCs) in states that happened to have relatively large export concentrations in those industries. Conversely, in states that had relatively small shares in the rapidly growing industries, we might find NRCs that are negative even though many of their industries may have experienced faster-than-national export growth.

## CONCLUSION

A shift-share analysis reveals that the differing growth of state exports relative to the national average was due primarily to the "competitive effect," that is, faster-than-national or slower-than-national export growth in individual indus-

[8]Following Hufbauer (1970), this method of calculating human capital has been used frequently in international trade studies. Average manufacturing wages for 1976 and 1986 are from the U.S. Department of Commerce (1981 and 1988). Unskilled manufacturing wages were from the Current Population Survey-BLS Microdata File. A 10 percent discount rate was used for all states. This value affects the levels of human capital per worker, but does not affect the statistical results.

[9]Data for depreciable assets are from the *Annual Survey of Manufactures*. Data represent the gross book value of depreciable assets at year's end, 1975 and 1985.

[10]Nevada was excluded from the reported regressions because an examination of the residuals indicated that it was an outlier.

[11]Evidence is presented in Coughlin and Cartwright (1987) and Coughlin (1988) that export promotion expenditures by state governments alter the export performance of states. We also recognize that the rest of the world does not consist of identical countries, a fact that creates numerous empirical issues. States export their products to different mixes of foreign countries. Thus, each state's exports are affected by specific foreign supply and demand changes to varying degrees. Primarily because of the volatility of exchange rates in the 1980s, the different regional effects of exchange rate changes is a topic that has received increasing attention. See Cox and Hill (1988) and Carlino et al. (1990) for attempts to identify the differential output effects across states of exchange rate changes.

## Table 5
## State Export Growth and Change in Endowments[1]

| Dependent Variable | Constant | Independent Variables: Human Capital | Independent Variables: Physical Capital | $\bar{R}^2$ |
|---|---|---|---|---|
| Net Relative Change | −1.41 | −0.01 | 0.18 | −0.02 |
| | (−0.07) | (−0.22) | (1.14) | |
| Competitive Effect | −36.29 | 0.69* | −0.06 | 0.25 |
| | (−0.49) | (4.07) | (−0.11) | |

NOTE: The value of the t-statistics are in parentheses. An asterisk denotes significance at the 5 percent significance level using a two sided hypothesis test. $\bar{R}^2$ is the adjusted coefficient of determination.

[1]Human capital is the percent change of a state's human capital per worker between 1976 and 1986, while physical capital is the percent change of a state's physical capital per worker between 1976 and 1986. The dependent variables are measures of export growth. See the appendix for additional details.

tries in the state. The industrial composition of exports in a state and the concentration of a state's exports in industries that grew relatively rapidly in the state were both found to be less influential in determining why a state's export growth diverged from that of the nation. Thus, our analysis suggests that a state's industrial structure does not always provide useful information in accounting for its export growth.

Since previous research has established that capital abundance—in particular, human capital—is the United States' primary source of international comparative advantage, the link between a state's 1976-86 export growth and its change in physical and human capital abundance was examined. No link was found between a state's export growth relative to the nation (that is, its net relative change) and the growth of either its human or physical capital. When differences in industrial mix among states were eliminated, however, a positive association was found between a state's export growth and the growth of its human capital. In other words, a state's competitive effect was related to its human capital growth.

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# Appendix
# Using Shift-Share Analysis To Analyze State Export Growth

Two important factors that determine whether a state's foreign exports grew at a different rate than the national average over a given period are the state's industrial mix of exports compared with the national mix (the industrial mix effect) and the differential growth rate of exports from individual state industries relative to their national counterparts (the competitive effect). Shift-share analysis enables these two factors to be separated and evaluated. The Esteban-Marquillas (1972) shift-share model makes the competitive effect completely independent of industry mix by calculating a third factor, called the allocative effect, which accounts separately for the covariance between the industry mix and the competitive effect (Kochanowski, et al. 1989).[1]

Let $S_{is}$ and $S_{in}$ denote proportions of total direct exports represented by the ith industry in state s and the nation, n, respectively; $G_s$ and $G_n$ are the 1976-86 growth rates of total exports in s and n, respectively; $G_{is}$ and $G_{in}$ the 1976-86 growth rates of exports in the ith industry in s and n, respectively; and $E_s$ the 1976 level of direct exports in state s.[2]

For the 1976-86 study period, the difference between the state's actual 1986 exports and what its 1986 exports would have been if state exports had grown at the national rate between 1976 and 1986 is called the Net Relative Change (NRC). In symbols,

$$(1)\quad NRC_s = E_sG_s - E_sG_n.$$

This is equivalent to:

$$(1')\quad NRC_s = \Sigma\,(E_sS_{is}G_{is} - E_sS_{in}G_{in}),$$

where the summation in this equation, as well as those in the following equations, are over all manufacturing industries. Exports were not reported for some industries for one of the required years, so the two equations yielded different values of NRC for some states. Equation 1' was used for our calculations.

A state's export growth relative to the nation, as reflected in its NRC, is due to its industrial mix effect (IME) and its competitive effect (CE)—which identifies the extent that exports of individual state industries grew at rates different from their national counterparts. There is an additional factor, called the allocative effect (AE), which can be interpreted as a measure of the degree to which a state's exports were concentrated in industries at the beginning of the study period that grew faster than the national industry average. Thus, for a given state,

$$(2)\quad NRC = \Sigma\,IME_i + \Sigma\,CE_i + \Sigma\,AE_i.$$

The industry mix effect is measured by first calculating what the state's 1986 exports would have been if, given its actual 1976 industrial mix of exports, a state's exports for each industry grew at the national industry rate. The IME is the difference between this hypothetical level and the level of 1986 exports the state would have had if (1) it had the same export

[1]Esteban-Marquillas (1972) and Kochanowski, et al. (1989) show that the traditional shift-share model fails to isolate the competitive and industry mix effects.

[2]Direct export data for some industries in some states were not disclosed by the U.S. Department of Commerce to ensure confidentiality. To impute this data, which accounted for less than 3 percent of the 1976 or 1986 continental U.S. direct exports totals, other available indicators of state export activity, such as total export-related shipments and export-related employment, were used.

## Values Used in Shift-Share Example (dollar amounts in millions)

| | State S | | | | | Nation N | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1976 Exports | 1986 Exports | $G_S$ | $S_{iS}$ | $G_{iS}$ | 1976 Exports | 1986 Exports | $G_N$ | $S_{iN}$ | $G_{iN}$ |
| Total | $10 | $17.6 | 1.76 | | | $100 | $158 | 1.58 | | |
| Industry 1 | 4 | 5.6 | | 0.4 | 1.4 | 20 | 30 | | 0.2 | 1.5 |
| Industry 2 | 6 | 12.0 | | 0.6 | 2.0 | 80 | 128 | | 0.8 | 1.6 |

mix as the nation and (2) its exports had all grown at the corresponding national rate. A state's IME is calculated by the following:

$$(3)\ \text{IME} = \Sigma\, E_s(S_{is} - S_{in})G_{in}.$$

The competitive effect, which examines the differential industry growth rates of state vs. national exports, is calculated by first calculating the level of exports that the state would have achieved in 1986 if each of its industry's exports had grown at its actual rate, but assuming that the state had an industrial structure identical to the nation. The CE is simply the difference between this level and the state export level that would have existed in 1986 if the state's industrial mix of exports and export growth had been identical to the nation's. Thus, the competitive effect is calculated as:

$$(4)\ \text{CE} = \Sigma\, E_s S_{in}(G_{is} - G_{in}).$$

Finally, the allocative effect is calculated as follows:

$$(5)\ \text{AE} = \Sigma\, E_s(S_{is} - S_{in})(G_{is} - G_{in}).$$

The allocative effect indicates the degree to which a state's exports are concentrated in industries whose exports have grown more rapidly than at the national level.

To facilitate meaningful comparisons among states, each state's shift-share components reported in table 2 were divided by the level of state exports that would have resulted in 1986 if such exports had grown at the national rate between 1976 and 1986. That is, each state's components are divided by actual 1986 exports minus the state's net relative change. Thus, these "normalized" results indicate the percentage deviation of actual 1986 state exports from the level that would have resulted from export growth at the national 1976-86 rate.

### A Numerical Example

An example may clarify the application of the shift-share technique. Suppose 1976 and 1986 exports in state S and nation N are as shown in the table. $E_S$, the 1976 base period export level in S is $10 million. For each of the two industries, growth rates are simply the ratio of 1986 to 1976 exports. For example, $G_{iS} = 1.4$ (5.6/4). Export shares are each industry's share of total 1976 exports. For example, $S_{iS} = 0.4$ (4/10). S's net relative change can be calculated using equation 1:

$$(1)\ \text{NRC} = E_S G_S - E_S G_N.$$

Substituting data for S and N yields:

$$10(1.76) - 10(1.58) = \$1.8 \text{ million.}$$

Alternatively, NRC can be calculated using equation 1':

$$(1')\ \text{NRC} = \Sigma\, (E_S S_{iS} G_{iS} - E_S S_{iN} G_{iN}).$$

Substituting data for S and N yields:

for i=1: $10(0.4)(1.4) - 10(0.2)(1.5) = \$2.6$ million
for i=2: $10(0.6)(2.0) - 10(0.8)(1.6) = -0.8$

Total NRC = $1.8 million

The industrial mix effect for S is found using equation 3:

$$(3)\ \text{IME} = \Sigma\, E_S(S_{iS} - S_{iN})G_{iN}.$$

Substituting data for S and N yields:

for i=1: $10(0.4 - 0.2)1.5 = \$3.0$ million
for i=2: $10(0.6 - 0.8)1.6 = -3.2$

Total IME = −$0.2 million

S's competitive effect is calculated using equation 4:

$$(4)\ CE = \Sigma\ E_S S_{iN}(G_{iS} - G_{iN}).$$

Substituting data for S and N yields:

for i=1: $10(0.2)(1.4-1.5) = -\$0.2$ million
for i=2: $10(0.8)(2.0-1.6) = 3.2$
Total CE = \$3.0 million

Finally, S's allocative effect is computed using equation 5:

$$(5)\ AE = \Sigma\ E_S(S_{iS} - S_{iN})(G_{iS} - G_{iN}).$$

Substituting data for S and N yields:

for i=1: $10(0.4-0.2)(1.4-1.5) = -\$0.2$ million
for i=2: $10(0.6-0.8)(2.0-1.6) = -0.8$
Total AE = $-\$1.0$ million

As equation 2 shows, a region's NRC is the sum of its IME, CE and AE [\$1.8 million = (−\$0.2 million) + \$3.0 million + (−\$1.0 million)]. These results indicate that S's 1986 exports were \$1.8 million higher than if they had grown at the national rate between 1976 and 1986. S's 1976 exports were relatively more concentrated than were the nation's exports in industry 1, a comparatively slow-growing industry at the national level. As indicated by IME, this unfavorable industry mix caused S's 1986 exports to be \$0.2 million below the level it would have achieved if its 1976 export mix had been identical to that of the nation.

S's CE indicates that its 1986 exports were \$3.0 million higher because exports of its industries grew faster than the corresponding industries at the national level. Although export growth of S's industry 1 was slightly slower than the national rate, this influence was more than offset by industry 2's substantially faster-than-national growth; since industry 2 accounted for an 80 percent share of national exports and, therefore, was weighted more heavily than industry 1 in computing total CE, S's CE was positive.

The AE value, which reflects differences between S and N in both industry mix and relative industry growth, was negative. This result reflects S's relatively higher- (lower-)than-national export concentration in 1976 in industry 1 (industry 2), in which its exports grew slower (faster) than the national average in the 1976-86 period. To summarize, this example shows that S's exports grew faster than the nation's exports, despite S's unfavorable mix of export sectors; this occurred because its industries' exports grew faster than exports of the corresponding industries at the national level.

To ease comparison among states, each of S's shift-share components is expressed as a percentage of S's 1986 level of exports that would have resulted if S's 1976 exports had expanded at the national rate between 1976 and 1986. This normalizing factor is S's actual 1986 export level minus its NRC or, in the current example, 17.6−1.8 or 15.8. In percentage terms, the normalized components are NRC, 11.4 percent; IME, −1.3 percent; CE, 19.0 percent and AE, −6.3 percent. S's 1986 exports were 11.4 percent greater than if they had grown at the national rate from 1976 to 1986. Although the state industry mix depressed 1988 exports by 1.3 percent from the level that would have existed had other things been equal, its relatively fast growth of individual industries, expressed in CE, allowed S's exports to grow more rapidly than did exports at the national level.