Middle States Geographer, 1999, 32: 11-17

DETERMINANTS OF US REGIONS' CAPITAL GOODS EXPORT PERFORMANCE

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ABSTRACT: *The bulk of US manufactures exports are capital goods (SIC35, SIC36, SIC 37 less SIC371, and SIC38). By 1995 the share of US capital goods production that was exported reached 45%, up from less than 30% in 1985. During that time, the share of manufacturing output in US GDP fell below 20%, down more than 9 percentage points. Thus, while the manufacturing sector has declined as whole, there has been an important shift toward capital goods production, especially for export markets. This shift has been uneven across US regions in terms of both intensity and timing.*

Export performance is directly tied to the productivity of inputs. This paper tests for differences across six US regions in the determinants of capital goods export performance. A standard Ricardian export model is extended to directly estimate the relationship between regions' capital goods exports and the productivity of labor and capital in capital goods production. Results are inconsistent across regions in terms of the signs and significance of factors determining capital goods export performance. Alternative explanations for this are considered after a discussion of results for two regions with similar capital goods export profiles and reversed signs for significant coefficients. Those results are discussed in terms of regional differences in firms' business investment and joint-production strategies for meeting expected demand, especially for computer hardware and telecommunications and instrument controls.

INTRODUCTION

Capital goods exports -industrial machinery and computers (SIC35), electrical and electronic equipment (SIC36), transport equipment except automobiles (SIC37 less SIC 371) and instruments and related equipment (SIC38)-lie at the center of changes in US regions' industrial composition and US trade performance. Between 1967 and 1990, the share of manufacturing output in total GDP declined from 27.5% to 19.1% while the share of capital goods production in total manufacturing rose from 28.3% to 38.0%. During that same time, the share of US capital goods production that was exported rose from 20% to 45%. Thus, while the manufacturing sector has declined as whole, there has been an important shift toward capital goods production, especially for export markets (CEA, 1994)

Capital goods dominate US export performance. Capital goods accounted for fully 78% of the increase in exports between 1993 and 1997 (Koretz, 1997). The growth of capital goods exports has outpaced that of every other export category each year since 1987 (Warner, 1994). More than one-half of the fifty leading US industrial exporters are capital goods companies. The implication is clear: capital goods exports lie at the heart of America's ability to compete in global markets and are central to the economic well-being of American communities.

Competition in global markets is won or lost on the basis of three conditions: rising (or falling) productivities of factor inputs, relative movements in currency values, and rates of economic growth in global markets. Declining relative currency values are no guarantee of export success. American manufactures have lost world market share despite the fact that the dollar has been on a long-term decline against trade-weighted averages of foreign currencies. This is due in part to unevenness across sectors and markets in the sensitivity of exports to changes in currency values. Growth in global markets does not always ensure export success, especially when growth in foreign markets is the result of export-promoting trade policies (Porter, 1990).

Export performance is directly related to productivity, which is the major source of exporters' competitive position in international trade (Shetty and Buehler, 1991, Baumol, et al., 1989). Massive changes in the volume and composition, the geography of international trade, largely reflected realignments in the competitive position of countries (Porter, 1990). The success of US exporters after 1992 is due largely to the increased productivities of inputs to US manufacturing production (DeVoss, 1997).

METHODOLOGY

This paper uses a factor productivities model of exporting to reveal sources of capital goods export performance. The model has been used previously to reveal sources of manufactures export performance for individual states when export data are not available at any more discrete spatial scale (Lewandowski, 1996). While that was useful, it is probably more appropriate to estimate regional sources using constituent MSAs since they often disregard state boundaries and more than 90% of exported goods are issued from metropolitan areas (Department of Commerce Exporter Location Series, 1998).

Constructing the model begins with a two-country two-commodity Ricardian model of trade in which comparative labor productivities determine the composition and direction of trade. The model assumes that each commodity uses a single factor (labor); that competition ensures that output prices are directly related to wage rates; and that internal mobility ensures the same wage rate for each commodity such that in any country producing both commodities, their relative price must equal the ratio of unit labor producitivities. This initial model is written:

$$\frac{m_{L1}}{m_{L2}} > \frac{g_{L1}}{g_{L2}} \qquad (1)$$

where m and g designate the two trading countries, the subscript L denotes labor productivity, and subscript numbers identify the commodity.

The equivalence of equation 1 is:

$$\frac{m_{L1}}{g_{L1}} > \frac{m_{L2}}{g_{L2}} \qquad (2)$$

Equation 2 asserts that the commodity composition of trade between two countries is determined by differences in comparative labor productivities.

A two country multi-commodity factor productivities model, under the same assumptions, can be written as a chain of decreasing comparative labor productivities. It is written as:

$$\frac{m_{L1}}{g_{L1}} > \frac{m_{L2}}{g_{L2}} > \frac{m_{L3}}{g_{L3}} > \ldots \frac{m_{Lk}}{g_{Lk}} > \ldots \frac{m_{Ln}}{g_{Ln}} \qquad (3)$$

Equation 3 embodies the proposition that if commodities are ranked by their comparative labor productivities, a country first exports the commodity in which its comparative labor productivity is highest, then exports the commodity in which its comparative labor productivity is next highest, and so on until the ratio reaches unity.

This model can be recast to reveal the factor determinants of places' comparative advantage by generalizing labor productivity (L) to any factor (F), in which case it is read as portraying the "chain" of comparative productivities among factors. This final model is written as:

$$\frac{m_{F1}}{g_{F1}} > \frac{m_{F2}}{g_{F2}} > \frac{m_{F3}}{g_{F3}} > \ldots \frac{m_{Fk}}{g_{Fk}} > \ldots \frac{m_{Fn}}{g_{Fn}} \qquad (4)$$

This final model embodies the proposition that if factors are ranked by their comparative productivity ratios, a country first exports the commodity in which its comparative factor productivity is highest, then exports the commodity in which its comparative factor productivity is next highest and so on. This hypothesis is verified if there is a positive relationship between the rankings of a factor's productivity and the rankings of commodities exported.

This hypothesis contains the assumption that commodities use most intensively that factor whose productivity is highest. This assumption does not present a serious problem, because it is the central element of the Heckscher-Ohlin theorem of international trade which has been shown to be essentially equivalent to the Ricardian model used here (Ford, 1985).

From equation 4 it can be proposed that the factor whose commodity-specific ranking of

Table 1

Constituent MSAs, Fischer's US Manufacturing Regions and
Rank by Capital Goods Exports per Capital Goods Sector Manufacturing Worker:
statistical areas for which export data are available

Region		**MSA #**
Bos-Wash Corridor		
Bergen-Passaic, NJ PMSA	5602	17
Boston, MA-NH PMSA	1122	5
Middlesex-Somerset-Hunterdon, NJ PMSA	5602	30
Nassau-Suffolk, NY PMSA	5602	23
New York, NY PMSA	5602	6
Newark, NJ PMSA	5602	22
Philadelphia, PA-NJ PMSA	6162	16
Stamford-Norwalk, CT PMSA	6840	37
Washington, DC-MD-VA-WV PMSA	8872	34
Wilmington-Newark, DE-MD PMSA	6162	10
South Atlantic		
Atlanta, GA MSA	0520	24
Greensboro-Winston Salem-High Point NC MSA	3120	42
Memphis, TN-AR-MS MSA	4920	39
The Heartland		
Chicago, IL PMSA	1602	2
Cincinnati, OH-KY PMSA	1642	27
Cleveland-Lorain-Elyria, OH MSA	1692	25
Dayton-Springfield, OH MSA	2000	40
Detroit, MI PMSA	2162	11
Indianapolis, IN MSA	3480	28
Kansas City, MO-KS MSA	3760	33
Milwaukee-Waukeesha, WI PMSA	5082	19
Minneapolis-St. Paul, MN-WI MSA	5120	10
Pittsburgh, PA MSA	6280	29
Rochester, NY MSA	6840	38
St. Louis, MO-IL MSA	7040	31
South Central		
Austin-San Marcos, TX MSA	0640	18
Brownsville-Harlingen-San Benito, TX MSA	1240	36
Dallas, TX PMSA	1922	13
El Paso, TX MSA	2320	21
Fort Worth-Arlington, TX PMSA	1922	32
Houston, TX PMSA	3362	4
Miami, FL PMSA	4992	8
New Orleans, LA MSA	5560	35
California		
Los Angeles-Long Beach, CA PMSA	4472	3
Oakland, CA PMSA	7362	14
Orange County, CA PMSA	4472	7
San Diego, CA MSA	7320	12
San Francisco, CA PMSA	7362	9
San Jose, CA PMSA	7362	1
Northwest		
Portland-Vancouver, OR-WA PMSA	6442	15
Seattle-Bellevue-Everett, WA PMSA	7602	26

productivity is most strongly and positively associated with the commodity's export ranking is the determinant of export performance.

Data for testing this factor productivity hypothesis are taken from the 1992 Economic Census that reports the output, labor hours, total midyear employment, labor wages and capital expenditures by SIC. Factor productivities are measured as output per unit factor input. The export data are taken from the Department of Commerce Exporter Location Series that reports the volume of exports by 2-digit SIC for 43 MSAs. The export data are averaged from 1994-5. Export performance is measured as exports per manufacturing worker. Table 1 lists the 43 MSAs used in the study, grouped according to manufacturing regions constructed by Fischer (1996)

RESULTS AND DISCUSSION

Table 2 shows the Spearman rank correlation coefficients, the number of observations and the level of significance generated for the association between the rank of a regions capital goods exports and the output per unit capital and labor and wages for each region. In general, the results are fairly good estimates of the importance that factor productivity has in capital goods export performance. The pattern of coefficients' values, signs and significance is uneven and inconsistent. This may reflect, in part, intrasectoral differences in capital goods production, which is comprised of vastly different goods presumably with different mixes of factor inputs and with different spatial arrangements across regions (Lewandowski, 1996). Other, alternative, explanations for this unevenness are presented after a discussion of two regions, Bos-Wash and California, that share similar capital goods export profiles and have results that are significant but reversed.

The most striking results are found in the signs and significance of coefficients estimated for the Bos-Wash and California regions. For the Bos-Wash corridor, the signs of capital and labor coefficients are reversed -positive and significant for capital, negative and nearly significant for labor. For the California region, the signs are transposed -negative and significant for capital, positive and nearly so for labor. These results reflect regional differences in capital investment and restructuring strategies of firms within SIC35, especially those firms that produce computer hardware and chips in telecommunications and machine control industries that export the largest shares of capital goods from the two regions (Electronic News, 1995). These differences were in response to explosive growth in global demand in 1989-1993. Briefly, east coast producers engaged in strategic alliances with foreign firms during periods of growing demand. In California, firms increased capital equipment purchases.

As demand rose, east coast producers, particularly those in the Boston area, pursued market strategies of alliance with foreign producers to increase capacity rather than large-scale capital investments in new plants and equipment (Brickates, 1997). These firms exported nearly 80% of their output, with the largest portion by far headed to European markets. Digital Equipment, based in Maynard exported 58% of its output to Europe: Wang about 46%, Cognex more than 53%, and Stratus almost 60%. Several firms established alliances for foreign production. Digital, for example contracted with plants in Canada, Scotland and Brazil: Stratus in Ireland. Later, as global demand began to stagnate, and then in response to the emerging crises in Asian markets, these producers responded by reducing prices, thereby lowering profits, rather than reducing output (DeVoss, 1997).

In California, firms attempted to meet current and projected production volumes by expanding plants and purchasing equipment (Fishman,1995). At its Santa Clara, California plant, Analog Devices' capital spending increased from less than $65 million in 1990 to more than $175 million by 1994. Analog Devices also purchased and upgraded, spending more than $150 million, an existing 6-inch wafer lab from Performance Semiconductor in Sunnyvale, California which was retrofitted to replace digital IC production with advanced linear technology for low-cost mixed signal parts and bipolar/CMOS handlers (Fishman, 1995). VSLI Technology, based in San Jose, California, added 40% more capacity via capital equipment spending, fueled largely by international demand from telecommunications markets (Fishman, 1995). As part of this investment program, VSLI purchased steppers, etchers and other equipment to expand 0.35-micron production.

As demand slowed, especially in Asian markets,

Table 2

Spearman's Rank Correlation Coefficients:
export performance with factor productivity,
by region by factor

Region	Capital	Labor Hours	Labor Wages
Bos-Wash Corridor	.3704 n = 30 p = .049	-.2663 n = 30 p = .077	-.1075 n = 30 p = .286
South Atlantic	-.2143 n = 9 p = .305	-.3810 n = 9 p = .176	.0714 n = 9 p = .433
The Heartland	.2379 n = 36 p = .091	.2031 n = 36 p = .130	.0451 n = 36 p = .403
South Central	.2648 n = 30 p = .077.	-.4109 n = 30 p = .012	-.4274 n = 30 p = .011
California	-.5117 n = 18 p = .011	.3312 n = 18 p = .091	.3117 n = 18 p = .114
Northwest	.4857 n = 6 p = .164	.1429 n = 6 p = .394	-.3143 n = 6 p = .272

California firms discarded labor to reduce costs. The San Jose metropolitan area alone lost tens of thousands of jobs (BJSSJSV, 1996). Commitments to capital expenditures, and the idea that demand would pick up again, delayed but did not stop firms' spending on equipment and facilities (Electronic News, 1995).

Some words of caution are in order here. Capital investment strategies are mirrored by data reported in the economic census, but the timing of consequent output may not correspond to that of the census (Agrawal and Findlay, 1996). California firms actively pursued capital investments as a means for meeting expected demand, but this entailed outlays that preceded output by a significant period of time (Fishman, 1995). Thus the California region may differ from Bos-Wash in part because relative values of capital and labor captured by the census at 5-year intervals probably do not closely correspond to cycles of investment. California firms, then, would have reported huge volumes of spending on plants and equipment, most not yet in production at the time of census, without concatenate increases in labor. Nor would they have reported increases in output other than that from existing plants. The data would thus emphasize capital spending values that are not directly linked to reported production volumes. Yet labor productivity would be accurately captured because existing output matches existing labor volumes. In that sense, the results may be considered something of a statistical artifact from data that do not correctly reflect the productivity of currently productive capital, but rather aggregate capital expenditures.

The results could just as easily be considered a statistical artifact generated because long-range business strategies have not been fully realized (Vos, 1998). Clearly, California firms invested in capital equipment to meet future demand (Fishman, 1995). The equipment was not on line at the time of the census. This suggests that a time-oriented test be done, perhaps matching changes in export performance to changes in productivities over a longer period. Data to do this are not currently available, and when yearly data for post-1992 are released, it is done so through the Annual Survey of Manufactures, which provides data for only a sample of firms and which has more strict disclosure limits. Still, further testing of California firms' data from later years, when they become available, may produce somewhat different results.

Firms in the Bos-Wash corridor, on the other hand, reported far less capital spending because they chose a business strategy based on increasing capacity by forming alliances with foreign firm, especially in Europe where their largest market lay (Brickates, 1997). Purchases of shares in foreign producers and royalties paid for shared technologies or output are not reported to the census as capital equipment investment yet yield output increases. As before, the consequent under-reporting of spending on capital equipment by Bos-Wash firms may be considered a statistical artifact of census data collection methods. It may also be considered a good measure of capital productivity under certain business strategies, in part because amortization and tax rates differ for capital equipment and investment spending (Vos, 1998). Firms may well be matching break-even points for spending to market conditions, in this case for Europe, when those break-even points are unbalanced due to tax structures. While regional differences in the source of capital goods exports are strong and consistent with differences in the business strategies of regions' firms, the data from which these results are generated may need to be reexamined as they become available for later years.

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