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SOURCES OF U.S. REGIONS' MANUFACTURES EXPORT PERFORMANCE

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ABSTRACT: *Explanations of differences in U.S. regions' export performance have emphasized industries' productivity characteristics and regions' industrial mix. Export performance and productivity are themselves linked to agglomeration economies. Both location and trade theories explain industries' tendency to localize in terms of comparative factor productivities, and predict regions' differentiation along factor input lines. This paper extends a conventional multi-country, multi-commodity model of comparative advantage to yield a model suitable for directly testing hypotheses about the sources of export performance. The model is used to estimate sources of export performance for 9 U.S. regions.*

INTRODUCTION

Exports are increasingly important to the U.S. economy. More than seven million U.S. jobs were supported by exports in 1990, up from five million in 1986 (Singleton, 1990). Export performance and prosperity are closely linked. In general, increasing export volume is associated with increases in economic growth, employment, and income (Balassa, 1978).

In the United States, recent geographical differences in prosperity have been associated with differences in regional economic structure and regional export performance (Bauer and Eberts, 1990). Exports are quite important to state and regional economies (Erickson, 1989). Yet little is known about sources underlying differences among U.S. regions' export performance (Smith, 1989).

Howes and Markusen (1993) cite three factors as underpinning the trade-induced relative privation of some U.S. regions and the corresponding relative prosperity of those regions' trading partners: (1) differences in industries' potential for productivity growth; (2) regional differences in the mix of those industries; and (3) government policies promoting those industries.

Regions' industrial mix and industries' productivity growth are not only functions of industry characteristics, they are also functions of regions' development and investment histories. This means both that regions, as well as industries, have differing potential for productivity growth, and also that productivity growth can be created, augmented, stunted, or halted. Enhancing productivity growth imparts a competitive advantage to firms and regions housing them, especially in international markets. Hence, the source of a region's export performance lies in the productivities of its factor-inputs, and efforts to secure and intensify them.

Regional differences in the productivities of factor-inputs are themselves the basis for regional differences in industrial mix. This is because, in part, of differences across industries in the relative importance of particular factor-inputs to the production process.

Industries are drawn to locations according to the ratio of cost per unit of product weight moved to that of the total weight of material inputs and product moved (Weber, 1929). The product component of the total weight measure in the ratio is a relative-transportation-costs measure based on the productivities of factor inputs. These ratios differ across industries due to differing factor input requirements and product outputs and input-to-output productivities. Firms, then, are allocated to different regions based upon their industry-specific sensitivity to the ratio's components and the place-specific costs associated with each. Hence, exporting firms in different regions should have different factor-input sources for their successful performance.

This paper reveals differences in the factor-input sources of 9 U.S. regions' export performance that are consistent with trade and location theories, as well as with the literature of new industrial districts. The next section discusses explanations of regional differences in economic structure and regions' export performance. A model suitable for directly testing hypotheses about the source of export performance is constructed in Section Three. Section Four describes data, sources, and measurement issues. Results are reported in Section Five along with discussions of the region-specific industrial trends in a major exporting region. Conclusions are drawn in Section Six.

REGIONAL ECONOMIC STRUCTURE AND EXPORT PERFORMANCE

Export performance is directly related to the productivity of inputs to manufacturing. Productivity, including the comparative cost of factor inputs, is the major source of exporters' competitive position in international trade (Porter, 1990).

Export performance and productivity are themselves linked to agglomeration economies, particularly those derived from local production specialization. Both location theory and trade theory explain industries' tendency to localize in terms of comparative costs.

In location theory, industries feel the locational pull of places to the degree calculated from the ratio of cost per unit of product weight to the total weight of material and product moved from those places. In trade theory, the explanation lies in the relative abundance of productive factors, whose costs are determined by their comparative volumes and comparative ratios of output per unit input (Bhagwati, 1964). Both theories can predict the optimum location of production, the optimum production volume of many goods in many places, and the ideal level of exchange among places (Isard, 1956). The critical element in doing so is the relative productivities of location-specific inputs to manufacturing.

The issue of productivity also lies at the center of recent analyses regarding the emergence of new industrial districts. The central theme of these analyses is that systems of flexible production are associated with agglomerated concentrations of growth.

This association is the outcome of market pressures, especially increasingly differentiated demand, that create requisites of external cooperation and coordination among firms, compelling them to agglomerate so that their transactions entail limited costs. Agglomerated firms thus create network economies and accrue other agglomeration advantages from which they derive technological spillovers. The resulting agglomerative growth impels vertical disintegration, making interfirm (and interplant) coordination yet more important (Scott, 1988). In a cumulative process, then, the growth of a localized system of production creates a premium to the rate of productivity growth.

Regional differentiation is promoted by this process for several reasons: technological capabilities are localized within certain types of environments; learning and spillover economies, external to the firm, are internal to a geographically defined agglomerative production complex; and organizational and infrastructural environments conducive to further growth set places apart as locations where steady state rates of growth are higher because the technological context is different (Malecki, 1991).

Clearly, then, regions are differentiated along lines of industries' factor use and regions' factor productivities. Those regions characterized by a factor-productivity advantage will have a competitive advantage in exporting, higher export profits, and accelerated regional economic development.

To this point, research has emphasized productivity differences across regions or industries, but not productivity differences across factor inputs and regions and industries. This paper tests the hypothesis that regional differences in export performance are associated with differences in source-factor productivities. As such, it can be seen as an extension of prior research.

METHODOLOGY: AN EXTENDED RICARDIAN MODEL

Previous research into source of export performance relies upon indirect tests which infer the source's identity by regressing measures of export activity on measures of either the factor abundance of a country or the factor content of its exported commodities (Leamer, 1984).

These tests do not account for differences in export performance across firms or products. Nor do they account for differences across products in the efficiency of (any/all) factor inputs to production. Most importantly, these tests do not account for differences in the degree to which a region's firms effectively exploit region-specific factor sources. Thus, indirect tests may veil the source of export performance due to the influence of cases that are neither efficient producers nor successful exporters.

The model constructed in this paper explicitly captures these characteristics of exporters and regions. It is built so as to estimate the association between the relative success of a region's exports by product category and the relative productivity of the region's product-specific inputs. Thus, the model constitutes a direct test of an hypothesis about the regional source of export performance.

Building the model begins with a conventional Ricardian two-country two-commodity model of comparative advantage where the commodity composition of trade between two countries is determined by international differences in comparative labor productivities, and written as

$$\frac{\acute{a}_{L1}}{a_{L1}} > \frac{\acute{a}_{L2}}{a_{L2}} \qquad (1)$$

where commodities are indexed by k = 1,2; a_{Lk} is the labor requirement per unit output in sector k; and variables relating to the foreign country are denoted by ′.

From this, McGilvray and Simpson (1973) produce a two-country multi-commodity model of comparative advantage, written as a chain of decreasing comparative labor requirements. That is...

$$\frac{\acute{a}_{L1}}{a_{L1}} > \frac{\acute{a}_{L2}}{a_{L2}} > \frac{\acute{a}_{L3}}{a_{L3}} > \ldots > \frac{\acute{a}_{Lk}}{a_{Lk}} \qquad (2)$$

The hypothesis embodied by this model can be formulated as the proposition that if commodities are ranked by their comparative labor ratios, 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 sources of export performance by generalizing labor productivity (a_{Lk}) to any factor (a_{Fk}), in which case it is read as portraying progressively declining comparative productivities among factors.

$$\frac{\acute{a}_{F1}}{a_{F1}} > \frac{\acute{a}_{F2}}{a_{F2}} > \frac{\acute{a}_{F3}}{a_{F3}} > \ldots > \frac{\acute{a}_{Fk}}{a_{Fk}} \qquad (3)$$

The hypothesis embodied in this model can be formulated as the proposition that if factors are ranked by their comparative productivity ratios, a place 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 embodies the assumption that sectors most intensively use the factor whose productivity is highest (i.e. whose factor-cost is lowest). This poses no real problem. That assumption is the central element of the Hecksher-Ohlin theorem which has been shown to be essentially equivalent to the Ricardian model used here (Ford, 1985). Moreover, the assumption is consistent with the notion of regions' "locational pull" whereby firms are drawn to regions endowed with inputs to which their industries are most cost-sensitive (Weber, 1929).

A region's international export performance, then, has its source in the factor whose sector-specific ranking of productivity is most strongly and positively associated with the export performance rankings of its sectors.

TABLE 1 The Structure of U.S. Manufactures Exports: 2-digit SIC as Percent of Total U.S. Exports of Manufactures

SIC	SIC Label	% of U.S. Export	Cum % U.S. Export
20	food & kindred products	4.84885	
21	tobacco products	1.47776	6.327
22	textile mill products	1.16339	7.490
23	apparel & other textile products	0.89876	8.389
24	lumber & wood products	1.84152	10.230
25	furniture & fixtures	0.49291	10.723
26	paper & allied products	2.60791	13.331
27	printing & publishing	0.96006	14.291
28	chemicals & allied products	11.67361	25.965
29	petroleum & coal products	1.98892	27.954
30	rubber & misc. plastics products	1.91844	29.872
31	leather & leather products	0.44819	30.320
32	stone, clay, and glass products	1.10573	31.426
33	primary metals industry products	3.89464	35.321
34	fabricated metals products	3.44212	38.763
35	industrial machinery & equip.	19.69096	58.454
36	electronic & other elec. equip.	12.92937	71.383
37	transportation equipment	20.59386	91.977
38	instruments & related products	6.15461	98.132
39	misc. mfg. industry products	1.86843	100.000

TABLE 2 Regional Classification: Fischer's "Manufacturing Regions & Districts" Criteria

Region	Constituent States
North Atlantic	Maine, New Hampshire, Rhode Island, Vermont
Middle Atlantic	Connecticut, Delaware, Maryland, New Jersey, Massachusetts, Pennsylvania, New York
Central	Indiana, Illinois, Kentucky, Michigan, Ohio, West Virginia, Wisconsin
South Atlantic	North Carolina, South Carolina, Tennessee, Virginia
South East	Alabama, Florida, Georgia
Gulf	Louisiana, Mississippi, Texas
Interior	Arkansas, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota
Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	California, Oregon, Washington

DATA, SOURCES, AND MEASUREMENT

Data for this analysis are taken from University of Massachusetts' MISER which provides export data by state at the 2-digit Standard Industrial Classification level (SIC's 20 to 39), and from the Annual Survey of Manufacturers which provides manufacturers' reported labor hours, labor wages, and gross depreciable capital stock in machinery and equipment by state.

Two-digit SIC categories are far from ideal, but they are useful for tests of competitive performance (Balassa, 1989), and they are the most discrete scale at which comprehensive export data are available. Table 1 lists the twenty 2-digit manufactures SIC's used in the analysis and their export volume as share of total U.S. manufactures exports averaged over four years, 1987 to 1990.

Labor productivity is measured as dollar volume of output per labor hour. Labor wages productivity is measured as dollar volume of output per dollar value of labor wages. Capital productivity is measured as dollar volume of output per dollar volume of gross depreciable capital stock in machinery and equipment. Data are taken from the Annual Survey of Manufactures, and averaged over 4 years (1987-1990).

Regions are constructed from Fischer (1988) who maps U.S. manufacturing regions and districts. Table 2 lists Fischer's 9 U.S. regions and their constituent states.

To calculate export performance, a "shares" measure is constructed from Balassa's Index of Revealed Comparative Advantage. Balassa (1989) defines the Export Index of Revealed Comparative Advantage (XRCA) as the ratio of a country's portion in exports of a particular commodity to its share in total merchandise exports.

$$\frac{(\sum_j X_{ijk} / \sum_j \sum_k X_{ijk})}{(\sum_j \sum_k X_{ijk} / \sum_i \sum_j \sum_k X_{ijk})} \qquad (4)$$

where X = export volume, i = origin, j = destination, and k = commodity.

Balassa's XRCA is essentially a measure of a country's exporting success in a particular commodity as compared to its exporting success in general. In effect, the XRCA is a location quotient that identifies industrial sectors in a particular country having some advantage relative to other industrial sectors in that same country.

Balassa's XRCA can be modified to measure export performance by rewriting it as the ratio of a region's share of a particular commodity's exports to its share in the total production of that commodity,

$$\frac{(\sum_j X_{ijk} / \sum_i \sum_j X_{ijk})}{(P_{ik} / \sum_i P_{ik})} \qquad (5)$$

where X = export volume, i = exporter, j = destination country, k = product category, and p = production. In this study, each exporter (i) is a 2-digit SIC manufactures sector in each constituent state of the defined regions.

This measure has the same basic form as the XRCA but with a different emphasis. Rather than revealing which industry in a particular country has a comparative advantage relative to that country's other industries, it reveals which region's producers of a particular good enjoy an exporting edge relative to all other regions' producers of that good.

The new measure reveals export performance in the same fashion as Balassa's XRCA: against an idealized world norm in which no exporter has any advantage in any commodity. In such a world, exports are proportional to production (UNIDO, 1986). This is represented by a value of 1.0. A value greater than 1.0 indicates the producer has a greater than proportional export performance.

Shares-of-production terms have been used before (Webster, 1990), but until now only with reference to industries in a single geographical unit. This paper extends that use to measure a region's export performance in a good against other regions' producers of that same good.

TABLE 3 Rank Correlations: Export Performance and Factor Productivity, by Region by Factor

Region (per Fischer)	n size	labor hours	labor wages	capital stock
1. North Atlantic	60	0.074	0.031	-0.300*
2. Middle Atlantic	114	0.086	0.029	-0.256**
3. Central	109	-0.023	0.130	0.389**
4. South Atlantic	69	0.013	-0.078	-0.183
5. South East	48	-0.259	-0.311*	0.166
6. Gulf	51	0.310*	0.339*	-0.115
7. Interior	115	0.211*	0.194*	-0.054
8. Mountain	112	-0.023	0.066	0.102
9. Pacific	53	0.247	0.208	0.276*
Total	731			

* statistically significant at 0.05 level

** statistically significant at 0.01 level

RESULTS

Results of the model's estimations are listed in Table 3. Table 3 lists the region, the number (n) of 2-digit manufactures SIC categories exporting from constituent states of the region that are used in the tests, and the Spearman's coefficient calculated for the rankings of performance and different factor productivities.

In general, the tests' results support location and trade theories' postulate of regional differences in sources of export performance: the Pacific and Central regions' export performance is linked to the productivity of capital; that of the Gulf and Interior regions is tied to labor productivity; the productivity of capital in the North and Middle Atlantic regions is not, apparently, exploited adequately by the regions' exporters.

These results are consistent with regionally specific industrial trends. The following subsections focus on the findings with respect to industry trends in the Central Region because of space limitations. Analyses of other regions' trends are available from the author upon request.

THE CENTRAL REGION

Table 3 shows that the performance of exporters in the Central region is tied to the productivity of its capital. Midwest manufacturing productivity can be traced directly to major modernization efforts in several key industries.

During the study period, capital was used intensively and upgraded rapidly in attempts to improve the region's competitiveness. Aggressively focused on modernization efforts, the region's capital investments yielded strong productivity growth (Israilevich et al., 1993).

This is especially true for the region's mature industries. Significant productivity gains in manufacturing were recorded to the extent that the Central region outpaced the nation in the late 1980's. By 1990, production in the Midwest had outperformed the national average in 12 of 17 industries (Bergman and Schnorbus, 1992). Leading the way were the region's primary and fabricated metals sectors.

These capital improvements were directed mainly towards the region's mature industries. Thus, productivity gains from capital were not necessarily associated with new production

techniques, namely flexible methods. Knudsen (1992) reports that two-thirds of the 220 Midwest non-electrical machinery plants surveyed still had no flexible manufacturing capability. Nor was capital productivity the result of R&D spending. During the late 1980's, capital spending was oriented towards the more basic industries in which the Great Lakes Region specializes (Allardice, 1992).

Capital investment in basic industries, and its resulting productivity gains, thus formed the basis for successful exports of such capital goods as electrical and nonelectrical industrial machinery, and primary and fabricated metals products, all of which grew nearly 25% (Israilevich et al., 1993).

Increasing capital productivity did not lead to a demand for labor, which lagged behind the national levels. Rather, capital seems to have been substituted for labor because of high wages (Israilevich et al., 1993). During the study period, the Central region was characterized by falling levels of manufacturing employment. This was especially true for the region's primary and fabricated metals sectors (Singer, 1993).

Given these trends, the findings support the notions that regions' export performances are linked to specific factor-sources and that regional productivity growth is tied to regions' development and investment histories.

CONCLUSIONS

The industrial composition of regions is a critical aspect of their export performances. Exporting success cannot be understood simply in terms of a region's industrial mix however. In part, this is because it leads to solutions for a region's lagging export performance, changing its industrial mix and protecting its inefficient producers, that have historically exacted huge costs in terms of employment and income and productivity growth (Salvatore, 1993).

Solutions are available which focus upon the underlying components of firms' sources of export performance: the productivity of place-specific factor inputs. As described above, policies and practices emphasizing factor-productivity have facilitated the success of exporting firms in the Central region of the U.S. These solutions are not without their own costs, also in terms of employment and income. These costs are difficult to quantify, in part because the solutions have not always been implemented until after regions' suffered exporting losses. Nonetheless, regions' historical experiences with investment in, and development of, factor productivities has been largely favorable. Those experiences, when coupled to the underlying agglomerative reason for a region's industrial mix, can produce substantial results.

The competitive factor of agglomeration affects the exporting success of an industry's firms, and also firms in associated industries insofar as they are related vertically. Agglomeration economies are themselves built upon shared and/or complementary input characteristics across industries. Hence, regions that are home to successfully exporting firms in a particular industrial sector, or group of related sectors, can be expected to be differentiated along factor-input characteristics from those regions home to successful exporting firms insofar as they are unrelated. By targeting for investment and development those region-specific factor-sources underpinning successfully exporting firms, regions can promote export performance for all firms in all related sectors. The first step in doing so is to reveal those region-specific factors of production that constitute the source of firms' export performance.

This study has shown that regions' industrial mix and industries' characteristics are related to region-specific factors of production, whose productivities can be enhanced, and which are critical to export performance. It has revealed differences across 9 U.S. regions in the source of export performance.

This study has also shown that the web of region-specific factors, industry characteristics, regions' industrial mix, and export performance is structured such that regions' are differentiated by factor-sources, as predicted by trade and location theories and also by the literature of new industrial districts; that a regions' firms exploit region-specific factor-sources in order to be successful exporters; and that regions' industrial productivity is related to their development and investment histories.

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