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EXPORT PERFORMANCE AND REGIONAL SPECIALIZATION: TRADE-THEORETIC TESTS OF THE DIVERGENCE PRINCIPLE

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ABSTRACT: Ricardian trade theory states that the relative productivity of factor inputs, specifically labor, determines the commodity composition of trade. From this, a convergence principle has been stated which asserts that the more similar places' aggregate capital-to-labor ratios are, the more similar are their trade patterns. This implies that the more similar regions' industry-specific factor productivities are, the more similar are their production structures and export performances.

Prior research has produced mixed results when testing this implication. The analysis in this paper differs from that research by incorporating the effects of distance, acknowledging that markets are protected by transportation costs to the extent that they exceed productivity differences. Hence, this paper tests the hypothesis that the differences between the Pacific, Central, South Atlantic and Gulf regions' export performances of SIC's 35 and 37 are a function of absolute differences in the productivities of their labor and capital inputs to those manufactures. Results indicate that productivity differences and export performance differences are associated.

INTRODUCTION

Exports are important to nations' economic prosperity. In general, increases in a country's volume of exports are associated with increases in economic growth, employment, and income (Cordon, 1980; Balassa, 1989; Bhagwati, 1989; Krueger, 1978; Dietrick, 1993). Exported commodities contribute to economic growth in different degrees (UNIDO, 1986). Hence the structure of exports is also an important aspect of economic fortunes.

Despite the importance of exports to state and regional economies (Erickson, 1989, Noponen, et.al., 1993), less is known about sources and structures underlying differences among U.S. regions' export performance than about that of the U.S. as a whole (Smith, 1989). This paper addresses that particular gap by focusing its analysis at the regional scale. The analysis has its conceptual foundation in the convergence and divergence principles of classical trade theory.

The following section details the convergence and divergence principles. Section 3 reviews prior research. Section 4 defines the regions and briefly describes the regions' export performance in SIC's 35 and 37. In section 5, a suitable measure of export performance is devised. The results are reported in section 6.

THE CONVERGENCE AND DIVERGENCE PRINCIPLES

In the Ricardian model of international trade, the composition of exports is determined by the productivity of labor inputs. The model has been extended to assert that the determinant is the relative productivities of factors, expressed as capital-to-labor ratios (Deardorff, 1984). From this comes a convergence principle which states that the more similar places' aggregate capital-to-labor ratios are, the more similar are their trade patterns (Dollar, Wolf and Baumol, 1988). This implies that the more similar regions' industry-specific factor productivities are, the more similar are their export patterns and production structures (Dollar and Wolf, 1993). Conversely, then, regional differences in export patterns and production structures are associated with regional differences in industry-specific factor productivities. This is the divergence principle. In this context, export 'pattern' is the label given to relative commodity-specific composition and volumes of exports. Research has typically focused on the export volume aspect (Balassa, 1989).

PRIOR RESEARCH AND TRANSPORTATION COSTS

Research into the divergence principle has focused on two countries' exports to third markets so as to see whether that trade could be explained in terms of the countries' relative labor requirements. The common test has been the log linear regression of the ratio of U.S. exports to U.K. exports on the ratio of U.S. to U.K. labor productivities using quantity-of-export data (MacDougall, 1951 and 1952; Stern, 1962) or the value-of-export data (Balassa, 1963). The authors report positive correlations, though not all are significant and many are weak. Bhagwati (1964) reports that no significant positive correlation between price ratios and appropriate labor productivity ratios occurs. Deardorff (1984) cautions against accepting associations produced by this ratio-to-ratio method until such time as the results can be shown to arise from no other model of trade.

Bhagwati (1964) argued that it is wrong to compare productivities ratios and export shares ratios because there is nothing in the Ricardian model to predict that a country with a greater cost advantage will export more to third markets. Deardorff (1984) responds by noting that the model has the more extreme implication that a country with the cost advantage will be the only one exporting to third markets. He goes on to note that increasing transportation costs produce an incompletely specialized world in which several different-cost suppliers export to the same market. Markusen and Melvin (1988) contend that the distortion of transportation costs is sufficient to allow the production of all goods in all places even as trade operates under Ricardian principles.

These responses are consistent with Morrill's notion of spatial equilibrium, in which markets are protected by transportation costs to the extent that they exceed price differences (Morrill, 1974). This has been recast as the assertion that markets are protected by transportation costs to the extent that they exceed productivity differences (Lewandowski, 1992).

All of this suggests that tests of association between differences in productivities and in export performance may be useful in examining the divergence principle.

The next section defines the 4 regions analyzed, and describes their export performance in SIC's 35 and 37.

REGIONS' EXPORTS OF SIC 35 AND 37

For this analysis, regions and their constituent states are defined using Fischer's Manufacturing Regions and Districts Map (Fischer, 1988). The regions are 1) the Mid-Atlantic, 2) the Central, 3) the South Atlantic, and 4) the Pacific. Table 1 lists their constituent states.

Only the top 2, by volume, exported SIC's are included in this analysis because of necessary limits on length. The chosen SIC's, then, are 35 and 37. These account for 19.691% and 20.594% of total US manufactures exports respectively. Table 2 shows the distribution of these exports among the 4 regions.

The table's first column clearly shows that these regions are the principle U.S. exporters of SIC's 35 and 37. Taken together, the regions account for more than two-thirds of all exports of these manufactures from the United States.

As shown in the Table 2, all 4 regions have significant portions of their total export activity in SIC 35. The Mid-Atlantic, Central, and Pacific regions have large shares of their export activity in SIC 37. While the leading exporter by volume shifts between the Pacific (in SIC 37) and Central (in SIC 35) regions, the last-ranked exporter in both categories is the South Atlantic.

Table 2 cannot adequately serve as an indicator of export performance, however, because of differences across regions in the scale of output from these sectors. The next section constructs a suitably scaled measure of export performance.

TABLE 1

REGIONAL CLASSIFICATION:
Fischer's "manufacturing regions & districts" criteria

1. **Mid-Atlantic**	Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania
2. **Central**	Indiana, Illinois, Kentucky, Michigan, Ohio, West Virginia, Wisconsin
3. **South Atlantic**	Alabama, Georgia, North Carolina, South Carolina, Tennessee, Virginia
4. **Pacific**	California, Oregon, Washington

TABLE 2

SIC EXPORT PROFILE: by REGION,
by VOLUME PERCENT of EXPORTS

region	% sic exports	% region's exports	% us export
	SIC 35: industrial machinery & equipment		
central	22.888	22.822	4.51
pacific	22.131	16.308	4.36
mid-atlantic	19.267	16.249	3.79
south atlantic	8.455	16.780	1.67
	SIC 37: transportation equipment		
pacific	36.760	30.323	7.57
central	30.124	24.070	6.20
mid-atlantic	13.228	16.262	2.72
south atlantic	4.652	9.391	0.96

MEASURING EXPORT PERFORMANCE

Ratios of market shares have been used as the measure of export performance in prior research (MacDougall, 1951, 1952; Stern, 1962). The ratios, however, do not account for differences in regions' size of producer.

To standardize for differences in producers' size, a 'shares' measure is constructed from Balassa's Export Index of Revealed Comparative Advantage (Balassa, 1965). Balassa's XRCA is the ratio of a country's portion in exports of a particular commodity category to its share in total merchandise exports, written as

$$\frac{\left(\sum_{j} X_{ijk} \,/\, \sum_{jk} X_{ijk}\right)}{\left(\sum_{jk} X_{ijk} \,/\, \sum_{ijk} X_{ijk}\right)} \qquad (1)$$

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

Balassa's XRCA is designed to reveal which industry within a particular country holds a comparative advantage in trade relative to that country's other industries. The XRCA is effectively a

location quotient. The XRCA is essentially a measure of a country's exporting success in a particular commodity as compared to its exporting success in general. It can be modified to measure export performance and to account for size differences in regions' producers by rewriting it as the ratio of a region's share of a commodity's exports to its share in the total U.S. production of that commodity. It is written as:

$$\frac{\left(\sum_j X_{ijk} \,/\, \sum_i \sum_j X_{ijk} \right)}{\left(P_{ik} \,/\, \sum_i P_{ik} \right)} \qquad (2)$$

where X = export volume, i = exporter, j = destination country, k = product category, and p = production.

This measure differs from the XRCA in that it reveals which region's producers of what good enjoy an exporting edge relative to all other places' producers of that good, rather than revealing relative inter-country differences among sectors. The measure has the form of a location quotient, but differs from it in one critical aspect. Location quotients have no theoretical basis for their construction or form (Krikelis, 1992), and so do not have any underlying concept that explains why the values it generates would arise. By contrast, the new measure is squarely positioned in trade theory which classically views exporting as a vent for surplus production (Johns, 1985).

Just like Balassa's XRCA, the measure shows export performance against an idealized world in which producers' autarkic prices are equal, and countries are identical in terms of their consumer preferences and relative factor supplies and technology (Kunimoto, 1977). A commodity's exports in such a world are proportional to its scale of 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 performance. A value less than 1.0 indicates a lesser than proportional performance.

Table 3 shows the regions' export performance values calculated using the new measure. These values differ significantly from the simple unscaled volume measures in Table 2. In SIC 35, the Pacific region is the leading export performer, the South Atlantic climbs to second from last, and the Central region falls from first to last. SIC 37 finds the Mid-Atlantic as leading export performer, while the Pacific and Central each drop one place.

METHODOLOGY AND DATA

A series of correlation coefficients is calculated across regional differences. Regional differences are simply all differences between all possible pairs of each region's states in their export performance as indicated using the above measure, and in the productivities of their labor and capital.

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

TABLE 3

EXPORT PERFORMANCE VALUES

	Mid-Atlantic	Central	South Atlantic	Pacific
SIC 35	0.8722	0.6757	1.0159	1.4899
SIC 37	0.9378	0.6885	0.5348	0.8745

RESULTS

The validity of divergence principle is confirmed and/or contradicted by the pattern of coefficients, rather than by particular coefficient values that would be produced from region-specific production arrangements (MacDougall, 1951).

Table 4 shows the correlation coefficients for associations between regions' differences in export performance with their differences in labor and capital productivities. Five of 12 region-pairs have significant coefficients, with a total of 7 significant coefficients. For 6 pairs, the signs of labor and capital coefficients are for the most part opposite, as would be expected if capital and labor were substitutes in one region's production processes.

In SIC 35, where the Pacific leads by far, the export performance difference of the Pacific-Central pair can be considered to be associated with the productivity of labor. The Pacific also out-performs the South Atlantic, but by much less. Still, what difference there is in performance is strongly associated with differences in the productivities of both labor and capital, which is consistent with the notion of labor and capital as substitutes in one of the two regions' production processes.

In SIC 37, where performance differences are far less, the Pacific Region exhibits positive, very strong, and significant coefficients for differences with the South Atlantic Region. These indicate that factor productivity differences across these regions are associated with differences in their export performances. Taken together, the tests have supported the divergence principle insofar as it applies to the Pacific and South Atlantic regions. This support is significant because it concerns the two largest, by volume, categories of the regions' exports, and because the regions' differences span the range of performances and productivities. Whether this holds true for other SIC categories is the subject of other research.

TABLE 4

Correlation Coefficients: export performance differences and factor productivities differences, by SIC by Region

SIC 35: industrial machinery & equipment

reg	Central		S.Atlantic		Pacific	
	labor	capital	labor	capital	labor	capital
Mid-Atlantic	.1140	-.1344	.1385	.0541	-.3338	-.3139
	n=42	n=4	n=36	n=36	n=18	n=18
	P=.236	P=.198	P=.210	P=.377	P=.088	P=.102
Central			-.0736	.2542	.4569	-.1580
			n=42	n=42	n=21	n=21
			P=.322	P=.052	P=.017	P=.247
S.Atlantic					.4559	.8125
					n=18	n=18P=.000P=.000

SIC 37: transportation equipment

reg	Central		S.Atlantic		Pacific	
	labor	capital	labor	capital	labor	capital
Mid-Atlantic	-.3277	-.1529	-.1807	.1540	.0523	-.2347
	n=42	n=42	n=30	n=30	n=12	n=12
	P=.017	P=.167	P=.170	P=.281	P=.436	P=231
Central			-.0052	-.3867	-.4059	.2176
			n=42	n=42	n=14	n=14
			P=.487	P=.006	P=.075	P=.227
S.Atlantic					.7497	.8153
					n=12	n=12
					P=.002	P=.006

CONCLUSION

This paper has incorporated the role of transportation costs into earlier tests of the divergence principle, in which the ratios of exporters' market shares were explained in terms of the ratio of their labor productivities. As a consequence, the divergence principle was recast so as to assert that differences in exporters' performances were a function of the degree to which differences in their factor productivities exceeded transportation costs. This required that the operational form of previous tests be adjusted. This was also done in the paper. As part of the adjusted test, a new measure of export performance was derived that accounted for differences in the scale of output from regions' producers. The test was executed across 4 regions and 2 2-digit manufactures SIC's exports.

These tests of the divergence principle have produced significant results, although not across all regions nor across both SIC's. As such, the incorporation of transportation costs into orthodox, and more comprehensive, analyses of regional export performance differences should prove useful. A larger version of this paper, covering 5 regions and 8 2-digit manufactures SIC's is available upon request.

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