A DESCRIPTION AND IDENTIFICATION OF TENNESSEE'S MAJOR MANUFACTURED EXPORTS

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Introduction

A nation's manufactured exports emanate from its regions. Just as specialization in manufacturing is to be expected among nations, specialization in manufacturing is to be expected among a nation's regions. Moreover, the causes of, or explanation for, the international specialization of nations as reflected in the characteristics of manufactured goods exported by a nation should be reflected also in the characteristics of the manufactured goods exported by a nation's regions.

The purposes of this study are to describe the characteristics and to identify the major exporting manufacturing industries within the State of Tennessee. A twofold process will be employed in order to accomplish these purposes. Ordinary least squares (OLS) regression analysis will be used to describe the characteristics of Tennessee's manufactured exports in terms of both traditional and industrial organization (IO) determinants of the state's comparative advantages. OLS regressions also will be used to confirm the intuitive expectation that the characteristics of Tennessee's manufactured exports conform with the characteristics of the manufactured exports of the U.S. as a whole.

Frequency distributions of relevant ratios will be used to identify the industries that constitute the state's primary manufacturing exporters. The statistical procedures used will be explained and rationalized after briefly discussing the historical developments that describe the characteristics of Tennessee's manufacturing exports.

Background Studies

Leontief's (1953) unexpected finding that the U.S. exports labor-intensive goods and imports capital-intensive goods precipitated a number of excellent studies whose purposes were to verify and clarify Leontief's results and to identify additional characteristics of the goods that enter the exports and imports of the U.S. (For classifications and bibliographies of these studies through 1970, see Bhagwati, 1969; Hufbauer, 1970; and Morrall, 1972.)

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In an historically important paper, Baldwin (1971, pp. 141-143) rejects the adequacy of a traditional Heckscher-Ohlin two factor (capital and labor) model to explain the pattern of U.S. trade. In its stead, he advocates a model that includes relative differences in human capital,[1] natural resource conditions, technological differences, transportation costs, commercial policies, and other variables.

Stern and Maskus (1981) employ a model containing three factors, *viz.*, skilled labor, unskilled labor, and capital, and a number of technological variables in a regression analysis of the structural determinants of U.S. trade in manufacturing industries through time.[2] Their most important conclusion is that the Leontief paradox held for 1958, but not for 1972.

Industrial organization (IO) factors such as economies of scale, absolute cost advantages, and product differentiation are found to be significant determinants of trade in earlier empirical studies by Esposito and Esposito (1973) and Finger (1975). Subsequent theoretical justification for the inclusion of such factors is provided by the papers of Dixit and Stiglitz (1977), Krugman (1979), and Lancaster (1980). In combination, this literature has compelled an extension of the hypotheses to be tested regarding the theoretically justifiable characteristics of goods that enter trade. Consequently, Marvel (1980) finds a positive correlation between imports and domestic concentration (a proxy for the degree of competition) in his inquiry into the interrelationship between imports and domestic profits, which, in turn, is correlated positively with R&D (a proxy for growth) and managerial input variables (proxies for efficiency).

Aiginger and Breuss (1988), in an attempt to identify the sources of intraindustry trade (IIT)[3] among Western European countries, include proxies that represent such nontraditional IO determinants as economies of scale based on size (physical-capital intensive production), market structure, product heterogeneity, economies of scale based on experience (human-capital intensive production), and infor-

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[1] Contemporary studies that empirically test the relationship among labor skills, capital, and trade patterns for the United States include those by Keesing (1971), Branson and Junz (1971), Branson (1971), Fareed (1971), Weiser and Jay (1971), and Morrall (1972).

[2] Following Hufbauer and Childas (1974, pp. 35-38), Stern and Maskus (1981) attempt (unsuccessfully for the most part) to analyze separately goods produced primarily using natural resources, goods produced using standardized technology, and goods using advanced technology in order to isolate human capital and technological determinants.

[3] Intraindustry trade (IIT) occurs when commodity groups appear simultaneously in the exports and in the imports of the same country. For three digit product groups, such overlap trade accounted for about 44 percent of U.S. trade in 1975 (Finger, 1975).

mational costs. Their results are mostly negative. The lack of positive results is attributed appropriately, in our opinion, to the use of proxies that can not discriminate among causes (Aiginger and Breuss, p. 34). The authors of this paper more recently achieved modest success in several less ambitious studies that use a multidimensional theoretical approach (Daniel and Reid, 1993a, 1993b, and 1994).

At the regional and state level the empirical literature seems not to have been influenced profoundly by the developments in trade theory of the 1980s and early 1990s.[4] T. Smith (1989), using data similar to ours, did identify regional manufactured exports in accordance with their durable or nondurable goods characteristic. To the authors' knowledge, however, no one has attempted to describe the manufactured exports of a region or state in terms of both traditional and IO determinants of its comparative advantages.

Methodology

It is assumed here that some domestic or foreign industries exhibit a comparative advantage that is attributable to either natural resource endowments or an abundance of labor, human or physical capital, or advanced technology. Other domestic or foreign industries exhibit a cost advantage due to conventional (long-run) increasing returns to scale or economies external to the firm due to Vinerian external technological and pecuniary economies (Viner, 1931) and to "an inability of innovative firms to appropriate fully the knowledge they create" (Krugman, 1987, p. 137). Finally, the participation of still other domestic and foreign firms in foreign trade is attributable to product innovation, which entails new, improved, and diverse products (Vernon, 1966); process innovation, which lowers costs; and the desire for (utility of) variety (Linder, 1961). It is assumed also that the effects of these causes are reflected in various kinds of available data.

The 140 three digit SIC industries for which data are reported in the U.S. Bureau of the Census' "Exports for Manufacturing Establishments, 1987," *Analytical Report Series* (1991) and its *1987 Census of Manufactures* (1991),[5] constitute the subject population for the U.S. Relevant data from these sources are used to generate proxies to identify the characteristics of the manufactured goods that enter the U.S.

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[4] For example, Couglin and Fabel's (1988) well-written paper is based on a traditional Heckscher-Ohlin three factor model, *viz.*, physical capital, human capital, and labor.

[5] The industry export data from the *Analytical Report Series* are not subject to the objections of Leamer and Bowen (1981) and Aw (1983) regarding a discrepancy between place of origin and place of export. (See *Analytical Report Series*, 1991, pp. 3, 5.)

merchandise accounts as direct exports.[6] Three of the 140 observations of U.S. data are deleted due to internal inconsistencies, resulting in less than a 0.02 percent change in any of the estimates.

Presumably, if an industry operated in Tennessee, at least some data would have been reported in the *1987 Census*. The population for the Tennessee data therefore is considered to be the 103 industries for which at least partial data are available. Complete information is reported for only 42 state industries. Accordingly, the sample size in the Tennessee regressions varies from 42 to 103, depending upon the variables used.

Using models of the authors cited above, 27 variables are generated and tested using U.S. data. Only the seven listed in Table 1 are significant at a level of less than .05, i.e., at $\alpha < .05$. The difference between the number of significant explanatory variables here and in our earlier studies may be attributable to the availability of more sensitive four digit SIC data for the earlier studies. All data refer to the year 1987.

Three sets of OLS regressions are run. One set relates to exports of manufacturing establishments in the U.S.;[7] and the other two sets relate to exports of manufacturing establishments in the State of Tennessee. Each set of dependent variables is important both theoretically and practically, and the findings for each set tend to be complementary.

The dependent variables are, in the first set of regressions, total exports (USX), exports per dollar of shipments (USXPDS), and exports per establishment (USXPEST) for manufactures in the U.S. The two other sets consist of corresponding variables for manufacturing establishments in Tennessee, *viz.*, TNX, TNXPDS, and TNXPEST. Two sets are run for Tennessee because not all of the arguments in the first set are significant at an acceptable probability level. As suggested previously, the purpose of the Tennessee regressions is to specify and estimate the impact of factors that explain the level of exports in Tennessee.

Three frequency distributions are examined. The first, RX, is the ratio of Tennessee industry exports to U.S. industry exports, i.e., RX = TNX/USX. The second frequency distribution is the ratio of Tennessee exports per dollar of industry sales to U.S. exports per dollar of industry

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[6] Direct exports are exports of manufactured goods that are reported by manufacturers or estimated by the Bureau of the Census.

[7] The purpose of the U.S. regressions in this study is to test the conformity of the U.S. results using three digit SIC data to those of the earlier studies that use four digit SIC data and to test the conformity of the Tennessee results with the three digit U.S. results. As stated above, the characteristics of U.S. exports should be reflected in the characteristics of exports somewhere within the U.S.

sales, i.e., RXPDS = TNXPDS/USXPDS. The third frequency distribution is the ratio of Tennessee exports per establishment to U.S. exports per establishment, i.e., RXPEST = TNXPEST/USXPEST.

Each of the ratios represents a measurement of the relative importance as an exporter, both nationally and statewise, of each industry within Tennessee. Moreover, the distributions of these ratios indicate the degree to which, if any, an industry operating within Tennessee specializes in exports.

Characteristics of Exported Manufactured Goods

The results of the OLS regressions are presented in Table 2. The two tailed level of significance, α, is given in parentheses below each estimated coefficient. The adjusted R^2, $\bar{R}^2$, the F-statistic of each regression, and the number of observations for each regression are given below each equation.

For the U.S. regressions, the coefficients of all explanatory variables are significant at $\alpha < 0.01$, and the levels of significance of all F-statistics are below 1 percent. The $\bar{R}^2$ is acceptable for the USX equation, low for the USPDS equation, and extraordinarily high for the USXPEST equation.

The story told by the regressions is that U.S. manufacturing industries that are mature, employ skilled labor, technologically advanced, and produce products that are highly valued export more than others, as evidenced by the positive values of EMP, SPCE, PPE, CEPDP, and VAPEST. Moreover, in the U.S. overall, industries where the establishments are of absolutely large scale do not compete for, and industries that are profitable domestically tend to avoid, overseas sales, as indicated by the negative values of LAR and PMPDS. These results are consistent with the earlier studies by the authors in which a different data set is used (Daniel and Reid, 1993a, 1993b, 1994).

The results of the regressions performed using the corresponding dependent variables and the same set of regressors with the Tennessee data are reported in Table 2 as initial regressions on TNX, TNXPDS, AND TNXPEST. Although the F-statistics of the TNX and TNXPEST equations in the initial set of Tennessee regressions are significant at $\alpha < 0.01$, the F-statistic of the TNXPDS equation is not significant at $\alpha < 0.88$; the $\bar{R}^2$ of the TNXPDS equation is negative. Thus, the TNXPDS equation lacks statistical credibility. Moreover, the coefficients of CEPDP in the initial TNX and TNXPEST equations are insignificant at $\alpha < 0.48$ and $\alpha < 0.49$, respectively.

The $\bar{R}^2$s of the initial TNX and TNXPEST equations are much less than the $\bar{R}^2$s of the USX and USXPEST equations. Nevertheless, their explanatory powers are not negligible. The signs of all of the significant coefficients and all but one of the insignificant coefficients in the initial

Tennessee regressions conform with the signs of the corresponding coefficients in the U.S. regressions.

In the second set of regressions using the Tennessee data where the variables whose coefficients are not significant in the initial set are eliminated, the F-statistics of all equations are significant at $\alpha < 0.02$. The level of significance of the coefficients of only one argument exceeds 0.02, and the level of significance of that coefficient is less than 0.09. The $\bar{R}^2$s of the second TNX and TNXPEST equations are as good as in the initial set; and the $\bar{R}^2$ of the second TNXPDS is positive, albeit small. The signs of the coefficients of all of the explanatory variables in the second set of regressions using the Tennessee data are the same as the signs of the coefficients of the corresponding regressors in the U.S. equations.[8]

Thus, the explanation for exports of manufactured goods that are made in Tennessee, insofar as an explanation is revealed by these data, is not unlike the explanation for exports of manufactures from elsewhere in the U.S.

Identification of Tennessee's Major Manufactured Exports

Specialization in exports by industry by state, of course, is to be expected. A distribution of comparative advantages, whether caused by traditional or IO variables, by states is suggested by the fact that only six of Tennessee's largest dollar-volume exporting industries are among the top 20 dollar-volume exporting industries in the U.S.

Some of the parameters of the three frequency distributions generated to identify Tennessee industries that specialize in exportation of their output are given in Table 4. The variables whose distributions are described in Table 4 are the ratio of Tennessee industry exports to U.S.

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[8] Because only about 2 percent of the values of the dependent variables in the U.S. equations and less than 10 percent of the values of the dependent variables, except the second TNX, in the Tennessee equations (10 percent is considered a small fraction; cf. Greene, 1993, p. 691) are zero, only the coefficients of the second TNX equation are tested for limited dependent variable bias using maximum likelihood (ML) estimates. The differences among the OLS and ML estimates of the second TNX equation of less than 15 percent seem not to warrant adjusting the OLS estimates in the second TNX equation alone, as the conclusions of this study would not be affected. Note that an examination of the residuals of each of the U.S. and Tennessee regressions does not reveal a heteroskedasticity problem in any. Moreover, multicollinearity does not appear to be major problem, as the $\bar{R}^2$s of the simple regressions of the arguments in both the U.S. and Tennessee regressions are less than 15 percent in all cases except for LAR and EMP, where the $\bar{R}^2$s are 0.60 in the U.S. data and 0.63 in the Tennessee data. The coefficients of both are significant at a level of less than 1 percent, nevertheless.

industry exports (RX), the ratio of Tennessee industry exports per dollar of shipments to U.S. industry exports per dollar of shipments (RXPDS), and the ratio of Tennessee industry exports per establishment to U.S. industry exports per establishment (RXPEST). Table 5 gives the covariances and correlation coefficients of RX, RXPDS, and RXPEST for the 77 possible observations.

Of the 107 observations of RX, 30 are zero and 16 are greater than one standard deviation from the mean. Of the 77 observations of RXPDS, none are zero and 7 are greater than one standard deviation from the mean. Of the 96 observations of RXPEST, 19 are zero and 11 are greater than one standard deviation from the mean.

A zero value for a ratio means that none of the industry's establishments are located in Tennessee or that the exports of the industry's establishments in Tennessee are nil. The industries in Tennessee whose ratios exceed the mean of their distribution by one standard deviation are listed in Table 6. If the mean values are viewed as estimates of expected values even though these distributions are skewed, then the exports of these industries are greater than expected. In any event, the industries listed in Table 6 represent less than 15 percent of the observed values within each set of ratios. Thus, these are the manufacturing industries in Tennessee that can be identified as specializing, by virtue of a comparative advantage in either the traditional or IO senses, in exporting internationally.

Summary

Tennessee's industries that are mature, employ skilled labor, and produce products that are more highly valued export their products internationally more than do other Tennessee industries. Illustrative of the industries in Tennessee that specialize by virtue of a comparative advantage (in either the traditional or the IO senses) in exporting their products are beverages, glass and glassware, and ship and boat building and repair.

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Table 1—Definitions and Interpretations of Independent Variables Used in Regressions

CEPDP	=	(Capital Expenditures/Payroll). A proxy for marginal changes in the capital-labor ratio, i.e., in technology.
EMP	=	Numbers employed in an industry. A proxy for the size of the industry.
LAR	=	Number of establishments with 20 or more employees. A proxy for the absolute scale of the firms within an industry.
PMPDS	=	[(Value of Shipments - Payroll - Cost of Material)/Value of Shipments]. A measurement of the profitability of an industry.
PPE	=	(Payroll/Employment). A proxy for the level of skills (human capital) per employee.
SPCE	=	(Value of Shipments/Capital Expenditures). A proxy for the *inverse* of growth, i.e., for the lack of growth, in an industry.
VAPEST	=	(Value Added/Number of Establishments). A proxy for the average productivity of the input combination used by the firm.

Table 2—OLS Regressions

Regressions on USX, USXPDS, and USXPEST

$$USX = -841095.58 - 2183.85LAR + 26746.91EMP + 4200038.7CEPDP$$
$$\quad (0.015) \quad (0.000) \quad (0.000) \quad (0.005)$$

$\bar{R}^2 = 0.615$ F = 73.52 Observations = 137

$$USXPDS = -0.0639420 - 0.0430831PMPDS + 0.0000053PPE$$
$$\quad (0.023) \quad (0.000) \quad (0.000)$$
$$+ 0.0006981SPCE$$
$$(0.000)$$

$\bar{R}^2 = 0.222$ F = 13.97 Observations = 137

$$USXPEST = -1159.39 + 0.0001112VAPEST + 10878.813CEPDP$$
$$\quad (0.032) \quad (0.000) \quad (0.000)$$

$\bar{R}^2 = 0.908$ F = 669.52 Observations = 137

Initial Regressions on TNX, TNXPDS, and TNXPEST

$$TNX = 13929.767 - 1968.41LAR + 14.763912EMP + 35130.930CEPDP$$
$$\quad (0.205) \quad (0.000) \quad (0.000) \quad (0.481)$$

$\bar{R}^2 = 0.340$ F = 15.11 Observations = 83

$$TNXPDS = 0.0289454 - 0.0177198PMPDS + 0.0000008746PPE$$
$$\quad (0.424) \quad (0.628) \quad (0.531)$$
$$- 0.00002735SPCAP$$
$$(0.932)$$

$\bar{R}^2 = -0.061$ F = 0.210 Observations = 42

$$TNXPEST = 599.585 + 0.0974430VAPEST - 1955.637CEPDP$$
$$\quad (0.248) \quad (0.000) \quad (0.492)$$

$\bar{R}^2 = 0.123$ F = 6.76 Observations = 83

Table 2 (cont.)—OLS Regressions

Second Regressions on TNX, TNXPDS, and TNXPEST

TNX = 10787.926 - 1906.2LAR + 15.0473EMP
(0.170) (0.000) (0.000)

$\bar{R}^2$ = 0.354 F = 28.91 Observations = 103

TNXPDS = 0.015362 - 0.036695PMPDS + 0.000001534PPE
(0.248) (0.087) (0.015)

$\bar{R}^2$ = 0.067 F = 4.15 Observations = 88

TNXPEST = 388.74 + 0.0934044VAPEST
(0.369) (0.000)

$\bar{R}^2$ = 0.131 F = 14.07 Observations = 88

Table 3—Tennessee's Top 20 Dollar-Volume Exporting Industries* (Industries in bold type are also in the top 20 U.S. exporting industries)

Industry	Exports in Thousands
Plastic Materials and Synthetics	$501,200
Industrial Inorganic Chemicals	326,900
Motor Vehicles and Equipment	280,500
Industrial Organic Chemicals	217,800
Household Audio and Video Equipment	217,300
Fats and Oils	157,000
Refrigeration and Service Machinery	72,500
Household Appliances	72,000
Nonferrous Rolling and Drawing	69,400
Measuring and Controlling Devices	67,100
Miscellaneous Manufactures	55,400
Miscellaneous Plastic Products, N.E.	52,900
Men's and Boys' Furnishings	47,200
Electrical Industrial Apparatus	47,100
Beverages	44,500
Miscellaneous Fabricated Metal Products	40,500
Pulp Mills	37,900
Industrial Machinery	35,600
Miscellaneous Textile Goods	35,400
Ship and Boat Building and Repairing	34,600

*The top ten industries export over 55.6 percent of Tennessee's total dollar exports, and the top 20 industries export 67.6 percent of its exports. The corresponding percentages for the U.S. are 51.3 percent and 65.4 percent

Table 4—Parameters of Frequency Distributions

Variable	Mean	S.D.	Maximum Value	Minimum Possible Value	Number Of Obs.
RX	0.0331170	0.0343006	0.1525983	0.0007965	107
RXPDS	0.9515032	0.9613977	4.8720110	0.0671611	77
RXPEST	1.4284033	1.3646037	5.9270080	0.0505905	96

Table 5—Covariances and Correlation Coefficients of RX, RXPDS, and RXPEST

	Covariance	Correlation
RX, RXPDS	0.0189681	0.5827665
RX, RXPEST	0.0371913	0.8050259
RXPEST, RXPDS	1.0733398	0.8289050

Table 6—Ratios Greater Than Mean Plus One Standard Deviation (Industries in bold type are in both Tennessee's and the U.S.'s first 20 dollar-volume exporters. Industries in italicized type are in the Tennessee but not the U.S. first 20 dollar-volume exporters.)

	RX	RXPDS	RXPEST
Fats and Oils	0.073		
Beverages	0.074	2.78	3.99
Men's and Boys' Suits and Coats	0.096		4.03
Men's and Boys' Furnishings	0.118		
Women's and Misses' Outerwear			2.95
Wood Buildings and Mobile Homes	0.069	2.42	
Household Furniture	0.087		
Manifold Business Forms		4.11	
Printing Trade Services	0.083	4.87	5.31
Industrial Inorganic Chemicals	0.107		3.62
Plastic Materials and Synthetics	0.092		3.39
Hose and Belting and Gaskets and Pking.			3.78
Glass and Glassware, Pressed or Blown	0.068	4.73	5.93
Household Appliances	0.067		
Household Audio and Video Equipment	0.153		
Motor Vehicles and Equipment	0.015		
Ship and Boat Building and Repairing	0.108	3.36	5.44
Pens, Pencils, Office, and Art Supplies	0.102		3.57
Miscellaneous Manufactures	0.083	2.41	3.83