Vertical Specialization with Developed and Developing Countries

Don P. Clark

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VERTICAL SPECIALIZATION WITH DEVELOPED AND DEVELOPING COUNTRIES

Don P. Clark
University of Tennessee-Knoxville, USA

ABSTRACT

This paper investigates country and industry-level determinants of vertical specialization-based production and trade between the United States and both developed and developing countries. Industries engaged in vertical specialization are identified through their use of offshore assembly provisions in the U.S. tariff code. The main difference between developed and developing countries is that educational attainment of the workforce exerts a positive effect on vertical specialization with developed countries and a negative effect with developing countries. Most industry-level determinants exert similar influences on the decision to conduct vertical specialization with developed and developing countries. Global firms must choose between developed and developing countries when deciding where parts and components will be produced and where final products will be manufactured.

JEL Classifications: F0, F1
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Corresponding Author's Email Address: dclark3@utk.edu

INTRODUCTION

Integration of the world economy through trade has encouraged firms to adopt new production strategies. Rather than producing in a single country, stages of vertically integrated production processes are performed in multiple countries to exploit inherent locational advantages such as low cost labor, proximity to markets, or favorable government regulations. This strategy gives rise to a sequential pattern of production and trade in which one country exports parts and components to another country that produces a product which is subsequently returned to that country or is exported to other countries. Hummels et al. (1998, 2001) calls the use of imported inputs in goods that are exported "vertical specialization." According to Hummels et al. (2001), vertical specialization has grown almost 30 percent between 1970 and 1990.

The commonly held view that vertical specialization across national boundaries is dominated by low-wage assembly conducted in developing countries is a misconception. According to Yeats (2001), the largest markets for OECD countries' exports of parts and components are other OECD countries. Eight industrial nations accounted for more than half of parts and component imports in 1995.[1] Hummels et al. (2001) found the most common geographical pattern of vertical specialization involved industrial nations' imported inputs being used to produce goods that are exported to other industrial nations. For example, more than 40 percent of the share of total U.S. vertical specialization con-

sisted of imports originating from other OECD nations. North-North vertical specialization orientation ratios were even higher for eight other OECD nations. Global firms must choose between developing and developed countries when deciding where parts and components will be produced and where final products will be manufactured. An interesting question is whether the same factors influence the extent of vertical specialization with developing and developed countries.

The present study identifies country and industry-level determinants of the decision to conduct vertical specialization-based production and trade with developed and developing countries. Industries engaged in production sharing activities across national boundaries are identified through their use of the offshore assembly provisions (OAPs) in the U.S. tariff code.[2] OAPs enable firms to transfer production processes to developed or developing countries, export parts and components for assembly, and subsequently import more advanced stages of the product. OAPs are the only official source of information on the use of U.S.-made parts and components in foreign assembly. Findings will explain why industries engage in production-sharing arrangements and will shed light on factors that influence the decision to locate production in either developed or developing countries.

OFFSHORE ASSEMBLY PROVISIONS

Offshore assembly provisions (OAPs) in the U.S. tariff code are used to identify industries engaged in vertical specialization. OAPs refer to items HTS 9802 of the Tariff Schedule of the United States. Item HTS 9802.00.80 (formerly 807.0) provides duty exemptions for U.S.-made components returning to the U.S. as parts of goods assembled abroad. Tariff duties are levied on the value of the article less the value of U.S.-made components. Under tariff item HTS 9802.00.60 (formerly 806.3), articles of metal that have been manufactured in the U.S., exported for processing, and then returned to the U.S. for further processing, are subject to duty only on the value of foreign processing.[3]

OAP production and trade entail vertical specialization across national boundaries. A distinction is drawn between dutiable OAP imports and nondutiable OAP imports. Dutiable OAP imports represent the value associated with foreign production or assembly. Nondutiable OAP imports measure the value of U.S.-made components originally exported from the U.S. for assembly in either developed or developing countries that are returned to the U.S. embodied in more advanced stages of the good. The distinction between dutiable and nondutiable OAP imports will allow us to identify U.S. production activities that engage in vertical specialization across national boundaries. Measures of vertical specialization activity will include the total value of U.S. OAP imports, value added associated with foreign assembly in coproduction activities (dutiable OAP imports), and the value of U.S.–made components returned to the U.S. embodied in more advanced stages of products (nondutiable OAP imports), each expressed as a share of U.S. imports from a trading partner. The nondutiable OAP trade share conforms most closely to the vertical specialization definition used by Hummels et al. (1998, 2001) that includes the value of imported inputs embodied in goods that are exported back to the U.S.

COUNTRY DETERMINANTS OF VERTICAL SPECIALIZATION

Country-level determinants of vertical specialization are characteristics that influence the attractiveness of foreign countries as potential locations for offshore production. Many of these characteristics are identified from surveys of actual OAP users conducted by the U.S. International Trade Commission (1988, 1998, 1999). Included here are factor endowment differences between the U.S. and a foreign country, workforce availability, foreign market size, proximity to other countries, trade orientation, exchange rate distortion, and political environment in the host country.

Grunwald and Flamm (1985) and Dunning (1993) remind us that an educated workforce with management, technical, language, and quantitative skills can make a country an attractive location for offshore production. According to Yeats (2001) and Hummels et al. (2001), most vertical specialization involves industrial nations' imported inputs being used to produce goods that are exported to other industrial nations. Here, skilled labor intensive products would be produced in developed countries using skilled labor intensive components from the United States. When skilled labor abundance constitutes a locational advantage, as is the case with coproduction arrangements among developed countries, measures of vertical specialization should be positively correlated with educational attainment of the workforce.[4]

Factor endowment differences influence the decision to engage in vertical specialization across national boundaries. The U.S. relative factor abundance, and hence comparative advantage, lies in skilled labor. Unskilled labor is the relatively scarce U.S. factor. The U.S. has a pronounced comparative disadvantage in unskilled labor intensive activities. The traditional view of vertical specialization is that it enables U.S. firms to shift low wage, low-skilled stages of production processes to unskilled labor abundant countries while retaining high-skilled component production at home. Low skill requirements suggest U.S. firms will locate unskilled labor intensive activities in developing countries where the workforce is relatively uneducated. This leads to the expectation that measures of vertical specialization will be negatively correlated with educational attainment of the foreign workforce in developing countries.

Many countries are potential candidates for offshore production because they have low-cost labor. When deciding on locations for offshore production, an important consideration includes workforce availability. Population density is used to measure workforce availability. Measures of vertical specialization are expected to be positively correlated with population density in the foreign country.

Firms also produce abroad to gain greater access to foreign markets. Motives for producing and selling abroad include such factors as increasing foreign sales, avoiding import barriers, minimizing exchange risk, or gaining greater product acceptance. Regardless of the motive, the most important factor influencing the gains associated with penetrating foreign markets is market size as measured by GDP. Measures of vertical specialization are expected to be positively correlated with the foreign country's GDP.

Geographical characteristics exert important influences over production location decisions. Included here are proximity to other countries and whether they share a border. Costs associated with overcoming distance suggest countries in close proximity to the U.S. will account for more vertical specialization activity than will distant countries. This effect will be more pronounced in the case of border countries. Measures of vertical spe-

cialization are expected to be negatively correlated with distance from the U.S. and should be higher for border countries.

Trade policy orientation of the host country will influence the production location decision. Countries will grow and industrialize faster when they adopt outward-oriented trade strategies rather than using inward-oriented policies.[5] Outward oriented strategies reduce trade barriers and government regulations that favor production for the home market over production for export. Economies that are open to trade use outward-oriented policies that make them more attractive locations for assembly operations. Measures of vertical specialization are expected to be positively correlated with outward orientation of host countries.

A survey of OAP users conducted by the U.S. International Trade Commission (1988) identified two additional factors often considered when deciding among alternative production locations. Firms favor countries with a realistic exchange rate policy and a favorable political environment. The black market exchange rate reflects exchange rate distortion and macroeconomic stability in the host country. Institutions that encourage civil liberties, political freedoms, and government stability are proxied by an index of political rights. Vertical specialization should be greater for countries with low levels of exchange rate distortion and those enjoying political rights.

INDUSTRY DETERMINANTS OF VERTICAL SPECIALIZATION

Industry-level determinants of vertical specialization are well established in the literature.[6] Included here are factors related to comparative advantage, characteristics of products produced by multinationals, trade barriers, technological influences, and import competition at home.

Production cost differences across countries influence the production location decision. The U.S. has a pronounced comparative disadvantage in unskilled labor intensive activities. Labor intensive firms have reacted to this disadvantage by shifting assembly operations to countries with low labor costs. According to a U.S. International Trade Commission (1988) study, access to unskilled labor is the most influential factor shaping the decision to conduct offshore assembly. Unskilled labor intensity of an industry's output is proxied by the capital-labor ratio Measures of vertical specialization are expected to be negatively correlated with the industry capital-labor ratio.

North-South trade models differentiate products and components according to quality.[7] Fragmenting production stages enables each product and component to be made where production conditions are most favorable. High quality products and components will be produced in the United States. Lower quality versions will be made in developing countries. High quality U.S. components will be used in foreign assembly operations to produce low quality products that are returned to the U.S., and vice versa. Product differentiation and quality are proxied by the advertising-to-sales ratio. Advertising differentiates products by exploiting quality differences. Measures of vertical specialization should be positively correlated with the degree of product differentiation as measured by the advertising-sales ratio.

Fragmenting production stages enables countries to perform certain stages of production at home and shift other stages to foreign countries where they can be performed at least cost. Cost savings from foreign production must be compared to advan-

tages associated with home production. When firms enjoy scale economies in home production, they will have less incentive to locate some production stages in foreign countries than will firms without scale economies. Vertical specialization will be more attractive as scale economies become less pronounced. Such activity is expected to be negatively correlated with the degree of scale economies in U.S. production activities.[8]

Industry participation in offshore assembly production is also influenced by government imposed and natural barriers. Most notable among these barriers are tariffs and international transportation costs. Tariff duty savings are a recognized motive for conducting offshore assembly.[9] High tariff industries will have a greater incentive to take advantage of duty savings related to OAP use than low tariff industries. Foreign production and tariffs are both used to counter a comparative disadvantage in home production. International transportation costs will influence the decision to trade and engage in vertical specialization across national boundaries. Industries that manufacture products with high value-to-weight ratios will face relatively low ad valorem international transportation charges, making them likely candidates for offshore production. Measures of vertical specialization are expected to be positively correlated with the U.S. tariff rate, and negatively correlated with ad valorem international transport charges.

Firms producing technology intensive components can face intense competition in final product markets. Offshore production enables firms to retain product design and production of high technology components. Shifting final assembly operations to unskilled labor abundant countries will enhance their overall competitive position and enable them to produce and export more high-tech components than would otherwise be possible. R&D intensity is measured by R&D expenditures as a percentage of net sales. Vertical specialization is expected to be positively correlated with R&D intensity.[10]

Industries engage in offshore assembly to lower production costs in order to become more competitive at home. According to a U.S. International Trade Commission (1988) study, industries using OAPs face high levels of import penetration in the home market. Vertical specialization measures are expected to be positively related to the intensity of import competition at home as measured by the import penetration ratio.

EMPIRICAL STRATEGY AND RESULTS

This study investigates determinants of vertical specialization in coproduction activities conducted in developing and developed countries. Dependent variables include the total value of U.S. OAP imports, dutiable OAP imports (value added in foreign production), and nondutiable OAP imports (U.S. components embodied in goods returning to the U.S.), all expressed as a share of U.S. imports from a trading partner. A two-limit Tobit specification is used to estimate country and industry-level determinants of vertical specialization because dependent variables are censored at 0 and 100. Coefficients from the conventional OLS regression would be biased and inconsistent because they do not account for the difference between limit and nonlimit (continuous) observations. In the Tobit model, both the initial hurdle to a positive OAP trade share value and continuous increases in this variable are captured in the index function y* with the variable y being the observed value for the OAP trade share. The basic Tobit structure is

$$y^*_{ij} = \beta' x_{ij} + \varepsilon_{ij} \qquad (1)$$

for industry *i* and country *j*. ε_{ij} are N[0, σ_ε^2]. If left-censored, then $y^*_{ij} \leq y_{ij}$. If right-censored, then $y^*_{ij} \geq y_{ij}$. If uncensored, then $y^*_{ij} = y_{ij}$. The data sets are cross sections of 38 developing countries and 21 developed countries, with up to 377 U.S. four-digit Standard Industrial Classification (SIC) industries.[11]

Results pertaining to U.S. vertical specialization with developed countries are shown in Table 1. Marginal effects coefficients from the Tobit analysis are reported in columns 2 through 4.[12] Signs and significance for country and industry-level variables generally follow our expectations and display consistent patterns across all sets of estimates. Regardless of the OAP-based measure used, vertical specialization is found to increase with educational attainment of the workforce, foreign market size, border effects, trade orientation, political rights, product differentiation, technology intensity, and degree of import competition.[13] Vertical specialization decreases with distance, the capital- labor ratio, degree of scale economies and international transportation costs.

Most of the marginal effects coefficients reported in columns 2-4 are statistically significant, but when the scale of each variable is taken into account, variables are found to exert relatively small impacts on the predicted trade shares. Variables with the greatest impacts on the OAP trade share include transport costs and educational attainment of the foreign workforce. The change in each variable required for a one percent increase in the predicted OAP trade share is as follows: a 3.4 percent reduction in ad valorem transport costs, and a one month average increase in secondary school in the total host country population aged 15 and over. Corresponding figures for predicted dutiable and nondutiable OAP trade shares are a 5.9 and 3.1 percent reduction in ad valorem transport charges, respectively. A one-month average increase in secondary school in the total host country population aged 15 and over is required for a one percent increase in the predicted dutiable and nondutiable OAP trade shares.

Table 2 presents findings for U.S. vertical specialization with developing countries. Results show a remarkable consistency across the three sets of estimates. Regardless of the OAP-based measure used, vertical specialization is found to decrease with educational attainment of the workforce, geographical distance, degree of exchange rate distortion, industry capital-labor ratio, scale economies, and ad valorem international transport costs. The finding with respect to political rights counters our expectations. Vertical specialization is found to be greater for developing countries with fewer political rights.

Labor availability, market size, border effects, trade orientation, product differentiation, tariff rate, technological intensity, and degree of import competition in the U.S. market exert positive effects on vertical specialization. All of these findings, with the exception of the political rights variable, are consistent with information obtained from surveys of OAP users conducted by the U.S. International Trade Commission (1988) and correspond with expectations from theoretical discussions in Helleiner (1973) and Grunwald and Flamm (1985).

Variables with the greatest impacts on the predicted OAP trade share in the case of developing countries include transportation costs, geographical distance, and educational attainment. The change in each variable required for a one percent increase in the predicted OAP trade share is as follows: a 4.5 percent reduction in ad valorem international transportation costs, a 36 kilometer decline in geographical distance, and a two

TABLE 1. VERTICAL SPECIALIZATION WITH DEVELOPED COUNTRIES

Variable	Tobit Models OAP Trade Share	Dutiable OAP Trade Share	Nondutiable OAP Trade Share
Educational attainment	0.0412[c]	0.0351[c]	0.0081
	(0.0239)	(0.0195)	(0.0057)
Labor availability	-0.0004	-0.0004	-0.0001
	(0.0003)	(0.0002)	(0.0001)
Market size	3.09e-07[a]	2.44e-07[a]	6.91e-08[a]
	(0.000)	(0.0000)	(0.0000)
Distance	-0.02e-04	-0.01e-04	-0.06e-05
	(0.02e-04)	(0.02e-04)	(0.01e-04)
Border	1.5682[b]	1.3195[b]	0.3878[b]
	(0.7349)	(0.6337)	(0.1779)
Trade orientation	0.3753[a]	0.3143[a]	0.0879[a]
	(0.1262)	(0.1022)	(0.0342)
Exchange rate distortion	2.2175	1.8466	0.2544
	(1.9534)	(1.1555)	(0.4392)
Political rights	-0.2197[b]	-0.1585[b]	-0.0469[c]
	(0.0953)	(0.0774)	(0.0217)
Capital-labor ratio	-0.0007[b]	-0.0005[a]	-0.0001
	(0.0003)	(0.0002)	(0.0001)
Product differentiation	0.0599[a]	0.0496[a]	0.0092[a]
	(0.0137)	(0.0115)	(0.0029)
Scale economies	-1.4434[a]	-1.1531[a]	-3.0000[a]
	(0.5587)	(0.4612)	(0.1249)
Tariff rate	0.0054	-0.0035	-0.0049[a]
	(0.0058)	(0.0048)	(0.0017)
Transport charges	-0.0904[a]	-0.0720[a]	-0.0224[a]
	(0.0091)	(0.0077)	(0.0031)
Technology intensity	0.0506[a]	0.0398[a]	0.0106[a]
	(0.0095)	(0.0076)	(0.0025)
Import competition	0.0075[a]	0.0057[a]	0.0014[a]
	(0.0017)	(0.0014)	(0.0004)
Predicted trade share	0.3128	0.2450	0.0749
Log likelihood	-3,796.8979	-3,568.4846	-2,802.9649
N. obs.	6,445	6,445	6,445

Notes: Entries are marginal effects coefficients with robust standard errors in parentheses.
[a] Significant at the 1% level. [b] Significant at the 5% level. [c] Significant at the 10% level.

TABLE 2. VERTICAL SPECIALIZATION WITH DEVELOPING COUNTRIES

Variable	OAP Trade Share	Tobit Models Dutiable OAP Trade Share	Nondutiable OAP Trade Share
Educational attainment	-0.2000[a]	-0.0863[a]	-0.0874[a]
	(0.0316)	(0.0156)	(0.0155)
Labor availability	0.0014[a]	0.0006[a]	0.0006[a]
	(0.0003)	(0.0001)	(0.0001)
Market size	1.74e-06[a]	1.08e-06[a]	7.91e-07[a]
	(0.0000)	(0.0000)	(0.0000)
Distance	-0.0002[a]	-0.0001[a]	-0.0001[a]
	(0.0000)	(0.0000)	(0.0000)
Border	3.7071[a]	1.8201[a]	1.5307[a]
	(0.8334)	(0.4121)	(0.4157)
Trade orientation	0.9210[a]	0.4588[a]	0.5042[a]
	(0.1259)	(0.0654)	(0.0735)
Exchange rate distortion	-0.3851[a]	-0.1918[a]	-0.1599[a]
	(0.0971)	(0.0531)	(0.0439)
Political rights	0.0936[a]	0.0297[c]	0.0636[a]
	(0.0375)	(0.0176)	(0.0190)
Capital-labor ratio	-0.0139[a]	-0.0073[a]	-0.0056[a]
	(0.0018)	(0.0010)	(0.0008)
Product differentiation	0.0734[a]	0.0388[a]	0.0401[a]
	(0.0252)	(0.0147)	(0.0142)
Scale economies	-4.9965[a]	-2.4122[a]	-2.4290[a]
	(1.3699)	(0.7008)	(0.6914)
Tariff rate	0.1154[a]	0.0544[a]	0.0547[a]
	(0.0113)	(0.0070)	(0.0080)
Transport charges	-0.1606[a]	-0.0767[a]	-0.0834[a]
	(0.0153)	(0.0077)	(0.0084)
Technology intensity	0.1125[a]	0.0626[a]	0.0491[a]
	(0.0200)	(0.0110)	(0.0101)
Import competition	0.0135[a]	0.0078[a]	0.0065[a]
	(0.0032)	(0.0018)	(0.0015)
Predicted Trade Share	0.7227	0.3924	0.3155
Log likelihood	-6,474.2440	-5,858.3999	-5,737.7736
N. obs.	7,419	7,419	7,419

Notes: Entries are marginal effects coefficients with robust standard errors in parentheses.
[a] Significant at the 1% level. [c] Significant at the 10% level.

week average decline in secondary school in the total host country population aged 15 and over. Similar results are obtained for the predicted dutiable and nondutiable OAP trade shares.

Several country-level determinants exert different influences on vertical specialization with developed versus developing counties, suggesting these types of offshore assembly are imperfect substitutes for one another. Educational attainment of the work-

force in the host country is found to exert positive effects on vertical specialization with developed countries and negative effects on vertical specialization with developing countries. These findings suggest U.S. industries engage in vertical specialization with developed countries to gain access to specialized labor skills, but do so with developing countries to counter a comparative disadvantage in home production by shifting low-skill assembly operations to countries with relatively uneducated workforces. Labor availability, geographical distance, exchange rate distortion, and the U.S. tariff rate are important determinants of U.S. vertical specialization with developing countries, but not with developed countries. Tariff savings are a recognized motive for taking advantage of OAPs with developing countries.

Other country-level determinants exert similar influences on the decision to engage in vertical specialization with developed and developing countries. Included here are foreign market sizes, whether countries share a border, and host country trade orientation. Industry level determinants display a remarkable consistency across Tables 1 and 2. Regardless of whether we are looking at developed or developing countries, vertical specialization is found to be higher for industries producing differentiated products, technology intensive activities, and those facing import competition in the U.S. market. Technology intensity exerts a positive effect on vertical specialization because many high tech components are shipped overseas for assembly into products that are returned to the U.S. Vertical specialization is lower for capital intensive industries, those with scale economies, and for industries facing high transport costs.

CONCLUSIONS

This paper investigates country and industry-level determinants of vertical specialization in trade with developed and developing countries. Industries that engage in vertical specialization are identified through their use of offshore assembly provisions in the U.S. tariff code. Results explain why industries engage in production-sharing arrangements and shed light on factors that influence the decision to locate production in either developed or developing countries.

Most industry-level determinants exert similar influences on the decision to engage in vertical specialization with developed and developing countries. Included here are capital intensity, product differentiation, extent of scale economies, international transport costs, technological intensity, and the degree of import competition in the home market. Tariff rate savings influence the decision to engage in vertical specialization with developing countries.

Country-level determinants of vertical specialization in both developed and developing countries are host country educational attainment, market size, whether countries share a border, trade orientation, and political rights. Additional determinants in the case of developing countries include labor availability, geographical distance, and the degree of exchange rate distortion. Vertically specialized production in developed and developing countries are imperfect substitutes. The main difference between developed and developing countries is that educational attainment of the workforce exerts a positive effect on vertical specialization with developed countries and a negative effect with developing countries.

These findings indicate the motive for engaging in vertical specialization with developed countries is to gain access to labor skills. An educated workforce, with management, technical, language, and quantitative skills can make a country an attractive location for vertically specialized production activities. U.S. industries move stages of vertically integrated production processes to developing countries to counter a comparative disadvantage at home by gaining access to relatively uneducated, low labor cost, workforces. Global firms must choose between developed and developing countries when deciding where parts and components will be produced and where final products will be manufactured.

ENDNOTES

[1] The relatively large amount of vertical specialization with developed countries may be due to the ease with which these countries can establish relationship-specific investments and enforce contracts. See Grossman and Helpman (2005), and Antras and Helpman (2004).
[2] Clark (2006), Swenson (2005), Clark, Marchese, and Zarrilli (2000), and Clark, Sawyer and Sprinkle (1989) investigate determinants of OAP activity.
[3] OAP activity is a subset of all U.S. production sharing activities. Four types of production activities use the OAPs. Included here are foreign based manufacturers that use U.S.-based components, U.S. producers that move assembly operations to low-wage countries, U.S. companies that produce abroad to expand export markets but send some goods back to the U.S., and companies that process metals. HTS 9802.00.80 accounts for 99% of all U.S. OAP imports. See U.S. International Trade Commission (1988).
[4] According to Barro and Lee (1996, p. 218), a large share of the labor force in developing countries is much younger than age 25. For this reason, educational attainment is measured as the average years of secondary school in the total population aged 15 and over.
[5] See Dunning (1979), Dollar (1992), and Clark (1997).
[6] See Helleiner (1979), and Grunwald and Flamm (1985).
[7] See Vernon (1974).
[8] See Helleiner (1973).
[9] See Grunwald and Flamm (1985, p. 240).
[10] See Markusen (1995) and Helleiner and Lavergne (1979).
[11] Variable definitions are presented in the Appendix.
[12] Likelihood ratio tests are used to compare random effects models with models that do not include random effects. We could not reject the hypothesis that random country and industry effects do not contribute to the model at all standard levels of significance.
[13] Barro and Lee's (1994) index of political rights varies from 1 to 7 with 1 indicating "most free." A negative coefficient is consistent with the hypothesis that greater political rights will increase vertical specialization.

APPENDIX

Data Definitions and Sources

Offshore assembly provision (OAP) imports, dutiable OAP imports, and nondutiable OAP import values for 1992 are expressed in millions of U.S. dollars. These figures are taken from a U.S. Bureau of the Census (1995) publication. Educational attainment of the workforce, measured by average years of secondary school in the total population aged 15 and over, is from Barro and Lee (1994). Population density, expressed in people per square kilometer, is taken from a World Bank (2001) publication. Figures on Gross Domestic Product (GDP) in millions of U.S. dollars pertain to 1992 and are taken from United Nations (1997). Distance, in kilometers, is from Fitzpatric and Modlin (1986). Following Stone and Lee (1995), trade orientation is proxied by the residuals from a regression of per capita merchandise trade (exports plus imports) on per capita income and population. Data are from United Nations (1997). Exchange rate distortion is measured by the black market premium exchange rate that expresses the deviation of the black market exchange rate from the official rate. Black market rates, from Barro and Lee (1994), are averaged over the 1985-98 period. The index of political rights is also from Barro and Lee (1994).

The industry capital-labor ratio is expressed in millions of dollars of capital per worker. The advertising-sales ratio pertains to 1987 and is calculated from a U.S. Department of Commerce (1994) publication. Minimum efficient scale, the scale economy measure, is defined as average sales per firm for firms in the midpoint class size (defined by product shipments) as a percent of shipment values. These figures pertain to 1992 and are from a U.S. Bureau of the Census (1994) publication. Ad valorem tariff rates are from the U.S. Bureau of the Census (1993). Ad valorem international transportation charges and the total value of U.S. imports are from the U.S. Bureau of the Census (1993). R&D expenditures as a percentage of sales in 1992 are reported in a National Science Foundation (1993) publication. These figures are available only at the two and three-digit SIC levels. Import penetration expresses the 1992 total value of imports as a share of total domestic market supply (shipments plus imports).

Developed countries included in the study are Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. Developing countries are Algeria, Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Guatemala, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Jamaica, Korea Rep., Malaysia, Mauritius, Mexico, Pakistan, Panama, Peru, Philippines, Poland, Singapore, Sri Lanka, Taiwan, Thailand, Trinidad and Tobago, Turkey, Uruguay, and Venezuela.

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