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6 Measures of Openness

Edward E. Leamer

Which countries are most open to international trade?

Tariff averages have frequently been used to measure the height of trade barriers, but the rise in the relative importance of nontariff barriers has made tariff averages increasingly suspect as overall measures of barriers. Coverage ratios for nontariff barriers, such as those in Nogues, Olechowski, and Winters (1986), are suggestive of the severity of nontariff barriers, but not all nontariff barriers can be measured, and not all barriers are equally restrictive. Furthermore, it is unclear how tariff averages and nontariff coverage ratios should be combined. In selected cases such as Pryor (1966), Sampson and Yeats (1977), and Cline et al. (1978), tariff equivalents of nontariff barriers can be formed by comparing the foreign with the domestic price of goods. But data for forming tariff equivalents are very limited, and tariff equivalents are accurate indicators of the height of barriers only for the competitive case in which the product is standardized and there is no market power.

An alternative approach is to examine trade data for circumstantial evidence of barriers. In the traditional small-country micromodel, trade in particular products is a function of resource supplies, prices of products in international markets, technology, tastes, natural barriers to trade, and artificial barriers. When studying trade patterns for evidence of artificial barriers it is therefore important either to assure that the other determinants of trade are relatively constant or to control statistically for their variability. For example, changes over time of the ratio of imports to domestic consumption (or production) can properly be attributed to changes in artificial barriers only if resource supplies,

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product prices, technologies, tastes, and natural barriers to trade are adequately constant. Differences among countries in the level and commodity composition of trade can be attributed to barriers if the countries are sufficiently similar in terms of resources, tastes, and natural barriers to trade, or if these effects are otherwise controlled.

The goal of this chapter is to compare the levels of trade barriers of different countries at the same point in time, using trade data as circumstantial evidence. The basic measure of openness is the trade intensity ratio: exports plus imports divided by GNP. Data on the supplies of productive resources are used to remove the component of variability of the trade intensity ratio associated with observable variability in resource supplies. Data on distance to markets are used to remove the component of variability of the trade intensity ratio associated with natural barriers. No attempt is made to supplement these data formally with direct measures of trade barriers such as tariff levels or indicators of nontariff barriers, but the results are assessed to some extent according to how well they reveal the best-known trade barriers.

Import penetration ratios, especially their variability over time, have previously been used to suggest the levels of trade barriers by many authors, including, for example, Balassa and Balassa (1984). In one sense, this chapter is an extension of Saxonhouse's (1983) comment that Japan's low ratio of imports to consumption in manufactures is not due to high protection, but rather to resources suited to manufacturing.

In this chapter I have taken the approach of finding a model that provides an adequate, even convincing, explanation of trade at the three-digit SITC (Standard International Trade Classification, Revision 2) level of disaggregation, and then attributing the estimated residuals of the model to the trade barriers. Implicitly, trade barriers are assumed to be (*a*) the only important omitted variables and (*b*) uncorrelated with the included variables. Both of these assumptions are suspicious.

The assumption that the only omitted variables are trade barriers is doubtful. There is of course no formal way to verify this hypothesis. Here I study the patterns of residuals in the hopes that peculiar residuals will suggest important omitted variables. When the model can no longer be criticized for failing to account for significant features of the data, I proceed as if all the remaining variability were attributable to trade barriers. Of course it is a matter of art, not science, when I conclude that there are no further meaningful criticisms.

The assumption that the barriers are uncorrelated with the included variables is clearly violated, possibly in a serious way. The included variables are resources that can otherwise account for trade, and if countries that are similar in their resources adopt similar levels of barriers, the resource variables in the model will soak up some of the effect of the barriers. One might hope that the structure of protection is uncorrelated with the resource variables, but Godek (1986) finds in a sample of fifteen developed countries that the overall level of tariffs in 1974 declined with per capita GNP. The best that can be said is that the measures of openness in this paper account only for those barriers that are uncorrelated with other variables in the model, in particular, uncorrelated with the stage of development.

Though these criticisms are serious, they need to be considered in the proper context. The question is not whether a particular method produces perfect measures of openness, since none will. The real question is which method seems likely to produce the best measures. The alternatives to the measures reported here are either unadjusted trade intensity ratios or averages of directly measured barriers. Measures of openness that use trade intensity ratios without any adjustments can conclude that countries with unusual supplies of resources are the most open, merely because these countries have the highest levels of trade in the absence of any barriers at all. Tariff averages seem like appealing indicators of openness, but these averages make the implicit assumption that import elasticities are the same on all commodities. More importantly, tariffs are no longer very high in comparison with the tariff equivalent of many nontariff barriers. Tariff averages accordingly tell only part of the story, and to be very meaningful they need to be combined with measures of the restrictiveness of nontariff barriers. But the tariff equivalents of nontariff barriers can be difficult to compute, especially for the many nontransparent barriers such as administrative paper work, threats of tariffs, health regulations, and so forth.

The approach I use here employs the trade data implicitly to determine the relative restrictiveness of barriers, which seems essential, but the attribution of the total unexplained component to trade barriers is suspicious for the two reasons discussed above. A better approach might be to include measures of tariff and nontariff barriers in the equation, and to measure their restrictiveness in terms of their contributions to the determination of trade. This seems simple enough, but the data problems and the model construction problems are formidable. At the outset my modest hope is that I can do better than merely use trade intensity ratios as measures of openness.

Section 6.1 of this chapter contains a simple general equilibrium model that serves as a backdrop for the data analysis. This model does indicate that, in the absence of trade barriers, the trade intensity ratio is a measure of the peculiarity of the resource supply vector. But barriers to trade that raise the internal prices of commodities have very complex effects on the trade intensity ratio, and there seems to be no guarantee that the trade intensity ratio declines with increases in tariff barriers.

The model outlined in section 6.1 suggests a very complicated data analysis with variables measured subject to multiplicative measurement errors. For computational ease, I opt instead for the traditional linear regression model as an adequate approximation.

Measures of openness and measures of peculiarity are discussed in section 6.3. The openness measures are (1) the ratio of actual to predicted trade and (2) an adjusted trade intensity ratio that allows for differences in resource supplies. One measure of peculiarity is an R^2 that compares the size of the residuals with the size of the observed trade variances. Another measure of peculiarity is the size of residuals relative to other residuals.

Estimates of a factor-analytic model with the resources treated as unobserved variables are reported in section 6.4. These estimates are computed using a 1982 data set on trade of 183 commodities at the three-digit SITC level of aggregation. This factor-analytic model stands up relatively well to criticism, but its measures of openness are suspicious since the factor-analytic method seems likely to remove most of the effects of barriers.

Results based on a model with measured values for the resources are reported in section 6.5. This estimated model does not survive as well the criticism that there are important omitted variables, and its openness measures have also to be viewed with suspicion. This suspicion can probably only be relieved by combining the trade and resource data with direct measures of trade barriers.

6.1 A Theoretical Model

The difference between the "predicted" and the actual trade intensity ratios will be used as an indicator of the level of trade barriers. Obviously, a carefully formulated model is needed both to determine the conditions under which trade intensity ratios can serve as indicators of trade barriers and also to determine the nature of the adjustments to the trade intensity ratios that are needed to account for determinants of trade other than barriers. A particularly convenient model of the determinants of production and trade is the traditional general equilibrium model with identical homothetic tastes, constant returns to scale, equal numbers of goods and factors, and with sufficient similarities in factor endowments that countries are all in the same cone of diversification. No real commitment is made to this model; it is only a useful starting point for thinking about the problems.

6.1.1 The Trade Intensity Ratio without Trade Barriers

Assume initially that there are no barriers to trade. Then the production side of the model can be summarized by the system of equations:

(1) $$\mathbf{Q} = \mathbf{A}^{-1}\mathbf{V},$$

(2) $$\mathbf{w} = \mathbf{A}'^{-1}\mathbf{p},$$

(3) $$\mathbf{A} = \mathbf{A}(\mathbf{w},t),$$

where **Q** is the vector of outputs, **V** is the vector of factor supplies, **A** is the input-output matrix with fixed elements equal to the amount of a factor used to produce a unit of a good, **p** is the vector of (internal) commodity prices, and **w** is the vector of factor returns. Equation (1), which translates factor supplies **V** into outputs **Q**, is the inverted form of the factor market equilibrium condition equating the supply of factors **V** to the demand for factors **AQ**. Equation (2), which translates product prices into factor prices, is the inverted form of the zero-profit condition equating product prices **p** to production costs **A'w**. Equation (3) expresses the dependence of input intensities on factor prices **w** and on the state of technology t, $\mathbf{A}(w,t)$ being the cost-minimizing choice of input intensities at time t.

In the absence of barriers to trade, all individuals face the same commodity prices, and if they have identical homothetic tastes, then they consume in the same proportions:

(4) $$\mathbf{C} = s\mathbf{C}_w = s\,\mathbf{A}^{-1}\mathbf{V}_w\,,$$

where **C** is the consumption vector, $\mathbf{C}_w$ is the world consumption vector, $\mathbf{V}_w$ is the vector of world resource supplies, and s is the consumption share. Thus trade is

(5) $$\mathbf{T} = \mathbf{Q} - \mathbf{C} = \mathbf{A}^{-1}\,\mathbf{V} - s\,\mathbf{A}^{-1}\,\mathbf{V}_w = \mathbf{A}^{-1}\,(\mathbf{V} - s\,\mathbf{V}_w).$$

The trade balance condition $\pi'\mathbf{T} = 0$, with π the vector of prices, implies that the consumption share is the ratio of GNP to world GNP:

(6) $$s = \pi'\mathbf{A}^{-1}\,\mathbf{V}/\pi'\,\mathbf{A}^{-1}\,\mathbf{V}_w = \mathrm{GNP}/\mathrm{GNP}_w\,.$$

Using this value for the consumption share and dividing equation (5) by GNP, we obtain

$$\mathbf{T}/\mathrm{GNP} = \mathbf{A}^{-1}\,([\mathbf{V}/GNP] - [\mathbf{V}_w/GNP_w]).$$

Finally, premultiplying by $\mathbf{\Pi}$, a diagonal matrix with prices down the diagonal, and using **W**, a diagonal matrix with wages down the diagonal, we find the trade vector in value terms:

$$\begin{aligned}\Pi\mathbf{T}/\mathrm{GNP} &= \mathbf{\Pi}\mathrm{A}^{-1}\mathbf{W}^{-1}\,([\mathbf{WV}/GNP] - [\mathbf{WV}_w/GNP_w]) \\ &= \mathbf{\Theta}\,([\mathbf{WV}/GNP] - [\mathbf{WV}_w/GNP_w]) \\ &= \mathbf{\Theta}\,(\boldsymbol{\lambda} - \boldsymbol{\lambda}_w),\end{aligned}$$

where $\mathbf{\Theta}$ is the inverse of the matrix of input shares, and $\boldsymbol{\lambda} = \mathbf{WV}/GNP$ is the vector of earnings shares.

The trade intensity ratio (*TIR*) thus becomes a measure of the difference between the vector of earnings shares of the world and the vector of earnings shares of the country:

$$TIR = |\Pi \ \mathrm{T/GNP}| = |\Theta \ (\lambda - \lambda_w)|, \tag{7}$$

where $|\mathbf{T}|$ indicates the sum of absolute values of the elements of $\mathbf{T}$, and Π is a diagonal matrix with prices on the diagonal. Thus in this model with no differences in technologies or tastes, and no trade barriers, the trade intensity ratio is a measure of resource distinctiveness. The more unusual is the country's vector of earnings shares, the greater is the trade intensity ratio.

Other Assumptions

This model is based on a long list of suspicious assumptions; consequently there is great concern that some minor changes in the model would imply that the trade intensity ratio is not an indicator of resource peculiarity. Four that come to mind are nontraded goods, intermediate goods, nonproportional consumption, and trade imbalance. The trade intensity ratio might be expected to be high for countries with small nontraded goods sectors, for countries that import great amounts of intermediate inputs, for countries that consume large proportions of certain goods, and for countries that have large trade imbalances. Actually, as is shown in Leamer (1984), the model summarized by equation (5) remains basically intact if it includes some forms of nontraded goods, intermediate inputs, and nonproportional consumption. Trade imbalance, alone, and nonproportional consumption together with nontraded goods alter the model in such a way that the trade intensity ratio is not a good indicator of resource peculiarity. What is essential for the empirical work in this chapter, however, is not that the trade intensity ratio is an indicator of resource peculiarity, but that the trade equations are linear in resources. The residuals can then be attributed to trade barriers.

Nontraded goods and intermediate inputs are discussed separately in Leamer (1984, 23 and 33). Consider here the possibility of both intermediate inputs and nontraded goods. Let $\mathbf{Q}_t$ and $\mathbf{Q}_n$ stand for vectors of final outputs of traded and nontraded goods respectively. Let the intermediate inputs required to produce $\mathbf{X}$ be $\mathbf{BX}$, leaving as final output $\mathbf{Q} = (\mathbf{I} - \mathbf{B})\mathbf{X}$ where $\mathbf{B}$ depends on factor prices and technology, $\mathbf{B}(\mathbf{w},t)$. The condition for equilibrium in the factor markets is $\mathbf{A}_t\mathbf{X}_t + \mathbf{A}_n\mathbf{X}_n = \mathbf{V}$. Substituting into this equation the condition $\mathbf{X} = (\mathbf{I} - \mathbf{B})^{-1}\mathbf{Q} \equiv \mathbf{DQ}$, we can solve for final output of the traded goods as a function of final output of nontraded goods, $\mathbf{EQ}_t = \mathbf{V} - \mathbf{FQ}_n$, where $\mathbf{E} = \mathbf{A}_t\mathbf{D}_{tt} + \mathbf{A}_n\mathbf{D}_{nt}$, and $\mathbf{F} = \mathbf{A}_t\mathbf{D}_{tn} + \mathbf{A}_n\mathbf{D}_{nn}$. Furthermore, assume identical homothetic tastes to obtain $\mathbf{C}_t = s\mathbf{Q}_{tw}$, and

$\mathbf{C}_n = s\mathbf{Q}_{nw}$, where the w subscript refers to world totals and s is the consumption share. Then the trade equations analogous to equation (5) are

$$\begin{aligned}\mathbf{ET} &= \mathbf{EQ}_t - \mathbf{EC}_t = \mathbf{EQ}_t - s\mathbf{EQ}_{tw} = \mathbf{V} - \mathbf{FQ}_n - s(\mathbf{V}_w - \mathbf{FQ}_{nw}) \\ &= \mathbf{V} - s\mathbf{FQ}_{nw} - s(\mathbf{V}_w - \mathbf{FQ}_{nw}) = \mathbf{V} - s\mathbf{V}_w .\end{aligned}$$

Thus all that changes when intermediate inputs and nontraded goods are included in the model is that **E** replaces **A** in equation (5).

Leamer (1984, 39–40) shows that essentially the same conclusion applies if consumption is income-dependent: trade depends linearly on excess factor supplies. But it is not possible to have both income-dependent consumption and nontraded goods since, for example, a preference for nontraded goods at low levels of income would imply that the trade intensity ratio would increase in response to a proportional increase in the supply of all resources.

Trade imbalance will also affect the trade intensity ratio. Let B be the trade surplus, $B = \pi'\mathbf{T}$, and $b = B/\text{GNP}$. Then the net export vector relative to GNP can be written as

$$\Pi\mathbf{T}/GNP = \mathbf{\Theta}\,(\boldsymbol{\lambda} - \boldsymbol{\lambda}_w) + b\,\mathbf{\Theta}\,\boldsymbol{\lambda}_w .$$

The trade intensity ratio then becomes a function of the trade balance b and attains a minimum in general at some value of balance other than zero.

6.1.2 The Trade Intensity Ratio with Trade Barriers

Trade barriers are another major determinant of trade intensity ratios. To model the effects of trade barriers it is necessary to make assumptions about the elasticities of supply and demand. A convenient way to do that is to use Cobb-Douglas utility functions and Cobb-Douglas production functions. On the consumption side, this amounts to the statement that the budget shares are fixed parameters:

$$p_c\, C_c = \alpha_c\, Y, \tag{8}$$

where C_c is consumption of commodity c, p_c is the internal (tariff inclusive) price, α_c is the fixed expenditure share, and Y is total expenditure. In words, the value of consumption is equal to the consumption share times total expenditure. Then using the identity that trade is the difference between production and consumption, we can solve for the trade equations as

$$\mathbf{T} = \mathbf{A}^{-1}\,\mathbf{V} - \mathbf{P}^{-1}\,\alpha\, Y,$$

where **P** is a diagonal matrix with internal prices on the diagonal.

For purposes of discussion, let us proceed as if all barriers amount to a tax on the international exchange of goods at a preset ad valorem rate. These taxes will conveniently be called "tariffs," though they can represent a wider set of trade impediments. The level of a tariff on commodity c will be denoted by τ_c and the corresponding external price by π_c. Then the internal price of the commodity is[1]

$$p_c = \pi_c (1 + \tau_c).$$

Premultiplying the trade vector by the external prices π and imposing the trade balance condition $0 = \pi'\mathbf{T}$, we can calculate the expenditure level:[2]

$$(9) \qquad Y = (\pi'\mathbf{A}^{-1}\mathbf{V})/(\pi'\mathbf{P}^{-1}\alpha) = GNP\,(1 + \tau.),$$

where GNP is the value of output at world prices $\pi'\mathbf{A}^{-1}\mathbf{V}$, and $\tau.$ is an index of trade barriers overall:

$$(10) \qquad (1 + \tau.) = (\Sigma\, \alpha_c/(1 + \tau_c))^{-1}.$$

Incidentally, the summation in this expression extends over all commodities, including export items. For example, if tariffs are uniformly set to τ for all import commodities, then $(1 + \tau.) = (1 + \tau)/\alpha_m$ where α_m is the share of imports in consumption.

Cobb-Douglas (log-linear) production functions and cost minimization imply fixed factor shares: $\theta_{fc} = w_f A_{fc}/p_c$ where θ_{fc} is a technologically fixed parameter, w is the factor return, p is the product price, and A is the input-output ratio. In matrix form this becomes

$$\mathbf{\Theta} = \mathbf{W}\,\mathbf{A}\,\mathbf{P}^{-1},$$

where $\mathbf{\Theta}$ is a matrix of technologically fixed factor shares and where notation indicating the dependence of all of the variables on time is suppressed. Substituting this into equation (1) yields the production relationships

$$\mathbf{\Theta}\,\mathbf{P}\,\mathbf{Q} = \mathbf{W}\,\mathbf{V}.$$

In words, the product of the value of output $\mathbf{PQ}$ times the input share $\mathbf{\Theta}$ is equal to the value of the input $\mathbf{WV}$.

The Stolper-Samuelson mapping of commodity prices into factor prices given this Cobb-Douglas technology can be found by substituting the cost minimization condition for selecting the amount of input f in commodity c, $V_{fc} = \theta_{fc}/w_f$, into the unit *value* isoquants in logarithmic form

$$0 = ln(p_c) + ln\,(\alpha_c) + \Sigma_f\, \theta_{cf}\, ln(V_{fc})\ , \ c = 1, 2 \ldots$$

to obtain the system

$$(11) \qquad \Theta' ln(\mathbf{w}) = ln(\mathbf{p}) + ln(\mathbf{k}),$$

where $ln(\mathbf{w})$ is a vector of logarithms of factor returns, $ln(\mathbf{p})$ is a vector of logarithms of prices, and $ln(\mathbf{k})$ is a vector of constants. In a more direct notation, the return to factor f as a function of the product prices can be written as

$$w_f = \prod_c (k_c p_c)^{\theta^{cf}},$$

where θ^{cf} is the (c,f) element of the inverse of Θ.

Under these assumptions the trade vector satisfies

$$(12) \quad \mathbf{PT} = \mathbf{\Theta}^{-1}\,\mathbf{W}\,\mathbf{V} - \boldsymbol{\alpha}\,Y = \mathbf{\Theta}^{-1}\,\mathbf{W}\,\mathbf{V} - \boldsymbol{\alpha}\,GNP\,(1 + \tau.),$$

where the internal factor prices $\mathbf{W}$ are functions of the product prices according to the log-linear relationship (11). In words, the net export vector evaluated at internal prices is a function of factor supplies evaluated at internal prices and the product of GNP times an index of trade barriers.

Estimates of GNP will usually evaluate output at internal prices. This level of nominal GNP will be denoted by

$$\text{GNP}^* = \mathbf{p}'\mathbf{P}^{-1}\,\mathbf{\Theta}^{-1}\,\mathbf{W}\,\mathbf{V} = \mathbf{1}'\mathbf{\Theta}^{-1}\,\mathbf{W}\,\mathbf{V} = \mathbf{1}'\,\mathbf{W}\,\mathbf{V}.$$

Some of the trade flows are evaluated at external prices and some at internal prices. Trade data collected on an f.o.b. basis would exclude tariff receipts and transportation charges, but would include the effects of various nontariff barriers such as voluntary export restraints and quotas administered by the exporting country. Nonetheless, it is probably a good approximation to assume that the trade flows are evaluated at external prices. The trade intensity ratio accordingly becomes

$$\begin{aligned}(13) \quad TIR &= |\mathbf{\Pi}\,\mathbf{T}/\text{GNP}^*| \\ &= |\mathbf{\Pi}\mathbf{P}^{-1}\,[\mathbf{\Theta}^{-1}\,\boldsymbol{\lambda} - \boldsymbol{\alpha}\,(1 + \tau.)\,(GNP/GNP^*)]| \\ &= |(\mathbf{1} + \boldsymbol{\tau})^{-1}\,[\mathbf{\Theta}^{-1}\,\boldsymbol{\lambda} - \boldsymbol{\alpha}\,(1 + \tau.)\,(GNP/GNP^*)]|,\end{aligned}$$

where $\boldsymbol{\lambda}$ is the vector of earnings shares and $(\mathbf{1} + \boldsymbol{\tau})$ is a diagonal matrix with one plus the tariff rate on the diagonal.

From equations (12) and (13) it is clear that the assumptions of constant expenditure shares and constant input shares limit the effects that trade barriers can have if inputs and outputs are evaluated at internal prices. In fact the principal influence of barriers is to alter the internal rewards to factors and the internal valuation of commodities. If commodities and factors are evaluated at internal prices, barriers have their only other effect through the term $(1 + \tau.)(\text{GNP}/\text{GNP}^*)$.

In the absence of trade barriers, the trade intensity ratio (7) is a measure of the difference in earning shares of the country and the world as a whole. Trade barriers obviously have an influence on the trade intensity ratio, as is apparent from equation (13). The precise effect is however not so transparent. When the trade intensity ratio is used as an indicator of trade barriers, an implicit assumption is made that the ordering of countries by trade intensity replicates the ordering of countries by trade barriers, other things like resources held constant. We need now to inspect equation (13) to determine if this inference is legitimate. One restriction that we might expect equation (13) to satisfy is that the derivative of the trade intensity ratio with respect to any single barrier is negative. This restriction is not a necessary property of equation (13), which is not surprising since complementarities among products could easily lead to greater trade intensity overall as the barrier is raised on a single product. A weaker restriction on the function (13) is that proportional increases in all barriers on imports would necessarily lower the trade intensity ratio. Instinctively, one might appeal to Hicks's theorem on composite commodities, but in this case raising the level of tariffs overall may switch commodities from the import group to the export group, thereby altering the relative prices within the original classes of products. Accordingly, there appears to be no guarantee that this trade intensity ratio decreases as tariffs overall increase. Without this minimal property, the trade intensity ratio is a suspicious indicator of the level of trade barriers, even for otherwise identical countries.

6.1.3 Estimation Issues

Another reason for running this model through its paces is to make decisions about the kind of data analysis that is likely to be most fruitful. Our goal is to use a cross-country data set on resources and trade values to infer trade barriers. To do this we must assume that trade, resources, and barriers satisfy a set of relationships like that in equation (12). In addition, we must assume that the taste and technology parameters are fixed across countries, and that the trade barriers are like random draws from some probability distribution. Then we can estimate the taste and technology parameters from the cross-country data set and attribute the unexplained variability of trade to the trade barriers.

This program is not easily carried out because of the complexity of the restrictions that trade, resources, and trade barriers are likely to satisfy. A typical equation from the system (12) is

$$\pi_{ij}T_{ij} = \{\Sigma_f [\delta_{jf}\, w_{if}\, V_{if}/w_{wf}] + \Sigma_f [\gamma_{jf}\, V_{if}\,(1 + \tau_{.i})]\}/(1 + \tau_{ij}),$$

where $\pi_{ij}T_{ij}$ is the value of net exports of commodity j by country i, τ_{ij} is the tariff barrier on commodity j in country i, w_{if} is the internal reward to factor f in country i, V_{if} is the supply of factor f in country i, $\tau_{i.}$ is the tariff average, and δ_{jf} and γ_{jf} are taste and technology parameters. To make clear what is observable and what is unobservable in this relationship, we can rewrite it as

$$y_{ij} = \Sigma_f \delta_f x_{if} + \Sigma_f \gamma_f z_{if}, \tag{14}$$

where y_{ij}, x_{ij}, and z_{ij} are unobservables for which there exist the following proxy variables:

$$\begin{aligned} \pi_{ij} T_{ij} &= y_{ij}(1 + \tau_{ij}), \\ V_{if} &= x_{if}(w_{wf}/w_{if}), \text{ and} \\ V_{if} &= z_{if}(1 + \tau_{.i}), \end{aligned} \tag{15}$$

where the terms on the left are observable, and the terms in parentheses are associated with the structure of barriers and are treated as unobservables coming from some suitably selected distribution. The goal would be to use observations on the value of trade and on the supply of resources to infer the unobservable variables reflecting the barriers: $(1 + \tau_{ij})$, (w_{wf}/w_{if}), and $(1 + \tau_{.i})$. This could be called an errors-in-variable model with multiplicative measurement errors. The usual additive measurement error model consists of a linear relationship among true variables χ: $\beta' \chi_i = 0$, together with an additive measurement error process $x_i = \chi_i + \epsilon_i$ where x is the measured variable and ϵ is the measurement error. The model suggested by equation (12) has a linear relationship among the true variables, but a multiplicative measurement process: $\log(x_i) = \log(\chi_i) + \log(\epsilon_i)$. This multiplicative error model is of great interest but it presents formidable estimation problems. A linear approximation ($dxy = xdy + ydx$) to the measurement error process allows a tractable treatment of the problem:

$$\begin{aligned} \pi_{ij} T_{ij} &= y_{ij}(1 + \bar{\tau}_j) + \bar{y}_j(\tau_{ij} - \bar{\tau}_j), \\ V_{if} &= x_{if} + \bar{x}_{if}(w_{wf}/w_{if} - 1), \text{ and} \\ V_{if} &= z_{if}(1 + \bar{\tau}_.) + \bar{z}_f(\tau_{.i} - \bar{\tau}_.), \end{aligned} \tag{16}$$

where the bar over the figure denotes the average across countries.

Also for tractability, it is assumed that the cross-country variance of τ_{ij} is so much greater than the variances of (w_{wf}/w_{if}) and $\tau_{.i}$ that the latter may be treated as constants. In words, it is assumed that the cross-commodity structure of barriers varies much more than average barriers. This allows us to take the level of trade as a "dependent" variable and to ignore the "reverse" regression solutions to the usual errors-in-variables models that would have to be studied if the other variables were also measured with error. The model then becomes

$$N_{ij} \equiv \pi_{ij}T_{ij} = \beta_j{}'V_i + \epsilon_{ij}\ , \tag{17}$$

where ϵ_{ij} is attributable to the trade barriers and represents the effect of the difference between this country's tariff structure and the typical or average tariff structure $\epsilon_{ij} = \bar{y}_j(\tau_{ij} - \bar{\tau}_j)$.

After the model is estimated, we may set the estimated residuals to zero to determine the effects of the trade barriers. It is important to understand that this corrects for trade barriers only in the sense of equalizing the levels of the barriers for all countries at roughly the existing cross-country average.

6.2 Trade Intensity Ratios and Intra-Industry Trade Ratios

Trade intensity ratios and intra-industry trade indicators based on the 1982 data set are reported in table 6.1. Commodities have been divided as in Leamer (1984) into three subgroups: (R) resource trade:

Table 6.1 Trade Intensity Ratios and Intra-Industry Trade Ratios, 1982

	Trade Intensity				Intra-Industry Trade			
Country	R	A	M	O	R	A	M	O
Low-income economies								
Pakistan	.04	.04	.10	.19	.18	.14	.18	.17
Bangladesh	.02	.06	.10	.19	.13	.03	.10	.08
Ethiopia	.04	.10	.10	.25	.20	.01	.01	.04
Sri Lanka	.12	.17	.22	.51	.23	.09	.10	.13
French Guiana	.28	.28	.68	1.25	.00	.90	.06	.24
Lower-middle-income economies								
Colombia	.01	.07	.09	.18	.72	.05	.21	.19
Dominican RP	.05	.09	.06	.22	.00	.08	.22	.10
Turkey	.07	.05	.09	.22	.10	.12	.29	.18
Philippines	.07	.06	.10	.24	.02	.23	.70	.37
Peru	.09	.04	.11	.24	.05	.13	.12	.10
El Salvador	.06	.11	.11	.28	.15	.13	.44	.25
Cameroon	.07	.07	.13	.29	.02	.08	.11	.08
Ecuador	.11	.07	.11	.30	.00	.03	.03	.02
Egypt	.06	.10	.14	.30	.20	.10	.05	.10
Thailand	.09	.13	.12	.34	.04	.14	.48	.24
Nicaragua	.06	.15	.15	.36	.05	.08	.11	.09
Indonesia	.22	.04	.12	.38	.18	.15	.06	.14
Morocco	.13	.09	.15	.38	.04	.07	.15	.09
Ivory Coast	.08	.31	.15	.55	.52	.04	.42	.22
Costa Rica	.08	.32	.18	.59	.07	.11	.88	.34
Upper-middle-income economies								
Brazil	.05	.03	.02	.11	.12	.11	.93	.31
Argentina	.02	.09	.05	.17	.15	.05	.74	.28
Yugoslavia	.06	.04	.10	.21	.21	.48	1.37	.84
Greece	.08	.06	.12	.28	.10	.24	.41	.28

Table 6.1 (continued)

Country	Trade Intensity				Intra-Industry Trade			
	R	A	M	O	R	A	M	O
Israel	.08	.07	.19	.35	.04	.23	.97	.58
Panama	.11	.08	.22	.42	.10	.24	.06	.10
Portugal	.11	.11	.20	.43	.14	.22	.65	.40
Trinidad and Tobago	.24	.07	.28	.61	1.01	.18	.16	.51
Hong Kong	.07	.10	.45	.62	.25	.86	1.64	1.35
Malaysia	.18	.23	.23	.66	.37	.15	.80	.45
Jordan	.22	.14	.37	.74	.01	.53	.43	.33
Singapore	.80	.13	.68	1.62	.36	2.37	1.67	1.08
High-income oil exporters								
United Arab Emirates	.02	.03	.22	.27	.15	.38	.24	.25
Oman	.04	.06	.25	.36	.01	.12	.31	.24
Saudi Arabia	.50	.04	.21	.76	.00	.04	.04	.01
Industrial market economies								
U.S.A.	.02	.01	.03	.07	.30	.58	1.44	.92
United Kingdom	.02	.03	.05	.12	2.12	.71	3.53	2.36
France	.05	.02	.04	.12	.39	1.34	4.40	1.98
Spain	.07	.03	.06	.16	.24	.44	1.40	.70
Austria	.05	.04	.08	.18	.28	.78	3.37	1.84
Canada	.04	.06	.07	.19	.80	.37	2.24	1.25
Japan	.07	.02	.11	.20	.04	.16	.33	.21
Germany FR	.05	.02	.12	.21	.54	1.24	1.70	1.34
Australia	.05	.05	.09	.21	.24	.15	.38	.28
Sweden	.06	.06	.10	.23	.67	.32	2.47	1.37
Italy	.07	.04	.11	.23	.44	.47	1.48	.94
Switzerland	.03	.03	.17	.24	.29	.54	1.52	1.19
Denmark	.06	.10	.09	.27	.29	.63	2.18	1.11
Finland	.07	.12	.12	.32	.39	.13	1.43	.67
Norway	.17	.04	.13	.35	.40	.43	1.19	.70
Netherlands	.15	.10	.10	.35	.67	1.21	3.46	1.61
Belgium	.12	.06	.19	.38	1.11	2.22	3.28	2.39
New Zealand	.05	.17	.15	.38	.05	.16	.47	.26
Ireland	.09	.17	.21	.49	.14	.53	2.27	1.21
East European nonmarket economies								
Hungary	.01	.02	.02	.06	.13	.17	1.75	.67
Other								
Bermuda	.06	.10	.23	.40	.00	.00	.17	.10
Fiji	.08	.19	.14	.42	1.06	.18	.66	.53
French Polynesia	.06	.10	.25	.43	.00	.01	.07	.05
Martinique	.08	.14	.28	.51	.32	.24	.08	.16
Guadeloupe	.06	.18	.30	.55	.00	.13	.05	.07
New Caledonia	.17	.08	.30	.55	.00	.05	.03	.02
Cyprus	.10	.15	.31	.57	.34	.43	.36	.37
Iceland	.09	.26	.24	.59	.03	.04	.11	.07
Tonga	.08	.27	.25	.61	−0.00	.02	.11	.05
Brunei	.91	.03	.13	1.07	.00	.05	.11	.02

Notes: Trade intensity $= \Sigma|X-M|/GNP$; intra-industry trade $= [\Sigma(|X|+|M|)/\Sigma|X-M|]-1$. Sorted by overall trade intensity. R = resources; A = agriculture; M = manufacturing; O = overall.

SITC 27, 28, 32–35, 68; (A) agricultural trade: SITC 1–26, 29, 41–43, 63, 64, 94; and (M) manufactured trade: SITC 51–96 except 63, 64, 68, 94. See Leamer (1978, chapter 3) for a full description of these SITC categories. Countries have been sorted first according to the World Bank classification in the *World Development Report* and second by the overall measure of trade intensity. Table 6.2 contains ranks of the trade intensity ratios reported in table 6.1.

The overall trade intensity ratio varies from 6 percent of GNP for Hungary to 108 percent of GNP for Singapore. The upper-middle-income economies and the lower-middle-income economies have generally more intense trade than the industrial market economies. Among the industrial market economies, the United States and the United Kingdom engage in little trade, whereas Belgium, New Zealand, and Ireland have a great deal of trade.

Generally, the trade intensities of resource, agricultural, and manufacturing trade are comparable. Some exceptions apparent in table 6.2 are those countries that have one group with a much higher rank than the other two: Ethiopia, Colombia, and Argentina with relatively intense trade in agricultural products; Spain in resources; Switzerland and the United Arab Emirates (U.A.E.) in manufactures. Some other exceptions are Japan, especially, and Germany F.R. with little agricultural trade. Features like these are suggestive of trade barriers, but

Table 6.2 **Ranks of Trade Intensity Ratios, 1982 ($\Sigma|X - M|/GNP$)**

	R	A	M	O
Low-income economies				
Pakistan	12	17	15	11
Bangladesh	3	28	20	12
Ethiopia	9	42	19	24
Sri Lanka	52	55	48	50
French Guiana	62	63	65	64
Lower-middle-income economies				
Colombia	1	31	12	9
Dominican RP	19	36	8	17
Turkey	36	20	11	18
Philippines	32	24	18	22
Peru	44	16	22	23
El Salvador	24	47	23	28
Cameroon	35	33	34	29
Ecuador	50	30	26	30
Egypt	20	40	35	31
Thailand	46	49	29	33
Nicaragua	23	54	38	38
Indonesia	59	15	27	41
Morocco	54	37	40	42
Ivory Coast	38	64	37	51
Costa Rica	41	65	42	55

Table 6.2 (continued)

	R	A	M	O
Upper-middle-income economies				
Brazil	13	10	2	3
Argentina	6	38	5	7
Yugoslavia	28	13	21	16
Greece	43	26	31	27
Israel	42	29	44	34
Panama	49	35	50	44
Portugal	51	46	45	47
Trinidad and Tobago	61	32	57	58
Hong Kong	29	43	63	59
Malaysia	58	60	52	60
Jordan	60	52	62	61
Singapore	64	50	64	65
High-income oil exporters				
United Arab Emirates	4	7	49	26
Oman	10	22	56	37
Saudi Arabia	63	12	46	62
Industrial market economies				
U.S.A.	5	1	3	2
United Kingdom	7	11	6	4
France	15	5	4	5
Spain	31	9	7	6
Austria	16	14	10	8
Canada	11	25	9	10
Japan	30	3	24	13
Germany FR	14	4	30	14
Australia	17	21	14	15
Sweden	22	27	17	19
Italy	33	19	25	20
Switzerland	8	8	41	21
Denmark	26	44	13	25
Finland	34	48	28	32
Norway	57	18	33	35
Netherlands	55	39	16	36
Belgium	53	23	43	39
New Zealand	18	56	39	40
Ireland	47	57	47	48
East European nonmarket economies				
Hungary	2	2	1	1
Other				
Bermuda	21	41	51	43
Fiji	39	59	36	45
French Polynesia	25	45	55	46
Martinique	37	51	58	49
Guadeloupe	27	58	59	52
New Caledonia	56	34	60	53
Cyprus	48	53	61	54
Iceland	45	61	53	56
Tonga	40	62	54	57
Brunei	65	6	32	63

Notes: Sorted by overall trade dependence. R = resources; A = agriculture; M = manufacturing; O = overall.

the question that we attempt to answer is whether these distinctive trade patterns can be accounted for by peculiarities in resource supplies.

The trade data used in this study are collected at the three-digit SITC level of disaggregation. The measure of trade intensity reported in table 6.1 nets imports from exports at this level of disaggregation:

$$TIR = \Sigma_j \mid X_j - M_j \mid / \text{GNP},$$

where the summation is over the set of commodity classes. At the very lowest level of aggregation, we might expect commodities to be either exported or imported, but not both. But at the level of aggregation that we use, there is a substantial amount of "two-way" trade. If the linear trade model summarized by equation (12) is used as a guide, this netting out of imports from exports is an irrelevant issue of aggregation, since the trade vector can be aggregated without affecting the linearity of the model or the conclusion that the trade intensity ratio is under certain circumstances a measure of resource peculiarity. The only concern is that the trade intensity ratio (13) is a somewhat different measure of peculiarity of resource supplies at each level of aggregation. The one exception to this statement would be if the aggregation were carried to the extreme of a single commodity. Then the trade intensity ratio becomes only the ratio of the overall trade surplus to GNP.

The more traditional measure of trade intensity does not net imports from exports:

$$TIR^* = \Sigma_j (\mid X_j \mid + \mid M_j \mid) / \text{GNP}.$$

These two measures, TIR and TIR^*, would be identical if the disaggregation were fine enough that commodities were either exported or imported, but not both. A measure of the difference between these two trade intensity indicators is the intra-industry trade measure also reported in table 6.1:

$$\begin{aligned} IIT &= [\Sigma_j(\mid X_j \mid + \mid M_j \mid)/\Sigma_j \mid X_j - M_j \mid] - 1 \\ &= (TIR^*/TIR) - 1. \end{aligned}$$

This IIT measure would be zero if there were no intra-industry trade at this level of disaggregation. A value of one indicates the TIR^* is twice as large as TIR, which is a major discrepancy. Most of the large numbers for this measure of intra-industry trade occur in manufactures, and, partly for that reason, the measures are generally greatest for the industrial market economies with trade relatively concentrated in manufactures. In particular, Belgium and the United Kingdom have large amounts of intra-industry trade. Saudi Arabia, Brunei, New Caledonia, and Ecuador have hardly any.

There are some exceptions to the general rule that the IIT is greatest for the industrial market economies and for manufactures. Singapore and Hong Kong stand out among the nonindustrial market economies with much intra-industry trade. Japan, New Zealand, and Australia, though classified as "industrial market economies," have rather low levels of IIT. Some other exceptions are the large values of IIT of resource trade for Trinidad and Tobago, the United Kingdom, Belgium and Fiji, and agricultural trade for Singapore, France, Germany, the Netherlands, and Belgium.

These measures of intra-industry trade are reported in table 6.1 to suggest a potential defect in the model that is used as a foundation for forming measures of openness. This model uses the assumption of constant returns to scale and does not allow for intra-industry trade except as a consequence entirely of aggregation. One may interpret the IIT numbers in table 6.1 as suggesting that the level of aggregation is "higher" in the manufactures categories, or one may conclude that increasing returns to scale or some other phenomenon is a more significant determinant of trade in manufactures than resources or agriculture. If it is the former, the data analysis now to be discussed proceeds intact. If it is the latter, the data analysis becomes suspect. This issue will arise again when we inspect the residuals, which may also suggest economies of scale or determinants of trade not otherwise accounted for.

6.3 Measures of Openness, Interventions, and Peculiarity

Obviously, trade barriers account for only a small fraction of the variability of the trade intensity ratios. To form sensible measures of openness it is necessary to control for the other major determinants of trade intensity. The model of trade outlined previously can serve as a foundation for controlling for variability in resource supplies and other influences. Let N_{ij} be the value of net exports and $N^*_{ij} = \boldsymbol{\beta}_j'\mathbf{V}_i$ be the corresponding number "predicted" by the model where $\mathbf{V}$ is the vector of resource supplies and $\boldsymbol{\beta}$ is a vector of parameters depending on tastes, technologies, and prices. The difference between the actual net trade and the predicted net trade will be indicated by $E_{ij} = N_{ij} - N^*_{ij}$, which optimistically reflects the impact of trade barriers on trade.

The measure of openness suggested here is the difference between the actual trade intensity ratio and the trade intensity ratio predicted by the model. A country is said to be "open" if its trade is unusually great compared with the predictions of the model. This measure of openness may either increase or decrease as the residuals E_{ij} increase. Measures of the absolute size of the residuals are also of interest for two reasons. Residuals that are large in absolute value can suggest omitted variables, or they can suggest policy interventions that affect trade either negatively or positively.

6.3.1 Measures of Openness

The measure of openness used in this chapter is the adjusted trade intensity ratio

$$TIR^A{}_i = (\Sigma_j \mid N_{ij} \mid - \Sigma_j \mid N^*{}_{ij} \mid)/\mathrm{GNP}_i\ ,$$

where N^* is the trade predicted by the model. This adjusted trade intensity ratio is the actual trade intensity ratio minus the trade intensity ratio predicted by the model. The country-size effect is eliminated here by dividing by GNP.

An alternative measure of openness is the ratio of actual trade to predicted trade:

$$\mathrm{O}_i = \Sigma_j \mid N_{ij} \mid / \Sigma_j \mid N^*{}_{ij} \mid.$$

Note that these two measures are related by the expression

$$TIR^A = (\mathrm{O} - 1)\ TIR^*,$$

where TIR^* is the predicted trade intensity ratio. These two measures will differ for countries with greatly different levels of predicted trade intensity. The choice between these two measures is not entirely clear-cut. The ratio of actual to adjusted trade is analogous to a tariff average that suggests how much trade is deterred by barriers. The adjusted trade intensity ratio is analogous to a measure of welfare loss indicating the percentage of GNP lost as a result of trade barriers. The decision here to use the adjusted trade intensity ratio reflects primarily that our starting point is the trade intensity ratio. Regardless, this discussion usefully emphasizes that there are two different openness concepts. It bears repeating that the adjusted trade intensities studied here should not be expected to give the same ranking of countries when countries have very different levels of trade intensity.

6.3.2 Measures of Peculiarity

The size of the residuals $E_{ij} = N_{ij} - N^*{}_{ij}$ can be used to measure the peculiarity of trade of country i or commodity j. The traditional measures of the quality of the model in explaining the variability of the data are country and commodity R^2's. A country R^2 can be defined in the usual way as

$$R_i^2 = 1 - [\Sigma_j E_{ij}{}^2]/[\Sigma_j (N_{ij} - \bar{N}_i)^2],$$

where $\bar{N}_i = \Sigma_j N_{ij}/J$ is the average trade of country i. If trade were balanced, then the mean would be zero and the country R^2 would measure the size of the squared residuals relative to the size of squared net trade. This R^2 need not be a positive number. The model is estimated across countries for each commodity, and a commodity R^2 is necessarily between zero and one for the usual reasons. But it is possible for trade of a country to be so poorly explained for each commodity that the country R^2 is negative.

We will also need measures of peculiarity of specific observations. A measure of the peculiarity of commodity j in country i is its contribution to the total lack of fit for that country:

$$P_{ij} = E_{ij}/\Sigma_j \mid E_{ij} \mid.$$

This measure uses the absolute residual rather than the squared residual to reduce the effect of extreme values and also to make the measure more comparable with the adjusted trade dependence ratio, which uses absolute values of trade. Summing across countries produces an indicator of the overall peculiarity of commodity j:

$$P_j = \Sigma_i \mid P_{ij} \mid.$$

Generally, these measures will be large for commodities that are important in total trade and that are poorly explained by the model. These numbers differ from R^2's in using absolute, not squared, residuals and also in emphasizing those commodities that are important in total trade.

These measures of peculiarity are intended to stimulate a criticism of the model. There are a variety of reasons net exports might be judged peculiar when the linear Heckscher-Ohlin model is used as a guide. One possibility is the presence of nonlinearities in the data set. Theoretically, nonlinearities are associated with the failure of one or more assumptions on which the model is based. Two especially suspicious assumptions are incomplete specialization and constant returns to scale. Another reason for poor fits is the omission of resources that have a substantial effect on the trade of at least a few countries. A third reason for a peculiar trade structure is unusually high or unusually low barriers to trade, either natural or artificial. The approach taken here is to form measures of peculiarity for countries and commodities in the hopes that they will stimulate successful criticisms of the model, such as the presence of important nonlinearities, or omitted resources. When no further successful criticisms can be made, the residuals will be taken to be entirely a consequence of the structure of trade barriers.

6.3.3 Intervention Rates

The presumption made in calling the adjusted trade intensity ratio a measure of openness is that most policies have the effect of deterring trade and that greater trade is therefore associated with less intervention. But many policies promote trade. An alternative concept is the rate of intervention that measures the extent to which trade is distorted by policy, positively or negatively. Analogous to the two measures of openness, we propose two measures of the rate of intervention for country *i:*

$$Int_{1i} = (\Sigma_j \mid E_{ij} \mid)/GNP_i \text{ , and}$$

$$Int_{2i} = \Sigma_j \mid E_{ij} \mid / \Sigma_j \mid N^*_{ij} \mid .$$

A serious problem with these measures is that they take as a norm the average level of policy intervention, since a country with zero residuals is one with typical trade barriers, not with the absence of trade barriers. The data considered here include no information on actual policy interventions, and it is impossible to estimate the effect of eliminating the interventions that contaminate the data. Another comment is that these intervention rates are merely measures of the size of the residuals and might as well be called measures of peculiarity. The difference is only in the denominator.

6.4 Measures of Peculiarity and Openness using a Factor-Analytic Model

Initially a promising approach is to treat the resources as unobservable parameters and to estimate them jointly with the taste/technology parameters. In the statistics literature the study of this kind of model is called factor analysis. In this literature, one set of unobservables is usually treated as a set of fixed parameters and the other as a set of random variables. These random or "latent variables" are called factors, which should not be confused with our other usage of *factor* to refer to an input into a production process. Unlike the traditional approach, both sets of unobservables will be treated as fixed constants.[3]

My initial impression was that the factor-analytic approach would be useful for two reasons, but on further reflection the approach seems fundamentally flawed. I report these factor-analytic results nonetheless since they contrast in an interesting way with the results from the regression model, and since they identify commodities likely to cause great difficulties for the kind of study that attributes what is unexplained to trade barriers.

In the factor-analytic approach, the resource endowments need not be at all measurable, which seems appealing. The unscaled and scaled models we have discussed are

$$N_{ij} = \boldsymbol{\beta}_j'\mathbf{V}_i + \epsilon_{ij}, \text{ and}$$

$$N_{ij}/GNP_i = (\boldsymbol{\beta}_j'\mathbf{V}_i + \epsilon_{ij})/GNP_i \text{ .}$$

In the regression analysis in the next section, we treat the taste/technology parameters $\boldsymbol{\beta}$ as unobservables and the resources $\mathbf{V}$ as fully observable. The list of observable resources is rather brief, and there is a strong possibility that there are important omitted variables. In addition, the assumption that resources such as capital, labor, and land could be measured without error is highly doubtful. A factor-analytic approach addresses both of these problems by treating the resources as unobservables that are estimated jointly with the taste/technology parameters by minimizing either the unscaled or scaled sum of squared residuals:

$$\min_{\boldsymbol{\beta}_j, \mathbf{V}_i} \quad \Sigma_{ij}[N_{ij} - \boldsymbol{\beta}_j'\mathbf{V}_i]^2, \text{ and}$$

$$\min_{\boldsymbol{\beta}_j, \mathbf{V}_i} \quad \Sigma_{ij}[(N_{ij} - \boldsymbol{\beta}_j'\mathbf{V}_i)/GNP_i]^2.$$

The fact that there is no need actually to measure the resources $\mathbf{V}$ seems to make the factor-analytic approach very appealing. But there is one minor problem and one major problem that together make the approach questionable. First, by ignoring altogether the measurements of resources, the method is necessarily inefficient in a statistical sense, though certainly more convenient than a treatment that deals properly with the errors in variables issues.

This inefficiency seems minor compared with the more serious shortcoming of the factor-analytic approach. Since only trade data are used to infer the existence of barriers, only peculiarities in the structure of trade in comparison with other countries can give rise to the conclusion that barriers are important. Protection schemes used by a sufficient number of countries in the sample will go undetected because the structure of trade of any of these countries would not seem abnormal.

The point that many barriers will go undetected is evident from the theoretical model summarized by equations (14) and (15) which indicate that the variables in the trade equations are the resources valued at internal (local) prices. The factor-analytic estimation would impute values for the explanatory variables that would offer the best overall fits. Theoretically, these are resources evaluated at internal prices. The residual left over from the factor-analytic approach therefore does not include the effects that barriers have on internal factor rewards, or for that matter the overall tariff average τ_i.

In models other than the one summarized in equations (14) and (15), the imputed factors can be expected also to partly reflect the trade barriers. One of the imputed factors may just be the overall level of barriers, another may be the average tariff level on labor-intensive manufactures, and so forth. The assumption necessary to preclude this undesirable outcome is that the effects of the barriers ϵ_{ij} behave like a set of independent random variables with a zero mean and a common variance. Among many other things, this implies that there are no "country effects" and no "commodity effects" in the structure of protection, which seems doubtful.

Of course it is also necessary to make doubtful assumptions when doing the regression analysis with observed resources. In the spirit of this chapter, we cannot discard the factor-analytic approach merely because the method is imperfect, since all methods share that property. The argument, instead, is that the regression analysis is superior to factor analysis because the measures of openness associated with the regression method are likely to be indicative of trade barriers even when the assumptions fail, but the factor-analytic approach seems to produce residuals that are mostly unrelated to barriers.

In the regression approach, the estimated residuals include the components of the variability of (1) trade barriers and (2) unmeasured resources that are uncorrelated with the measured resources. At least we can hope that trade barriers have a substantial effect on these residuals, particularly if the major resources are observed and if the effects of barriers are substantial. This contrasts with the factor-analytic approach in which the residuals will reflect whatever variables do not have a general effect on the structure of trade. These may be partly the "random" component of trade barriers, but are likely to be dominated by unusual resources that affect the trade of a few commodities in a few countries. I am thinking here of the "specific factors" that account for such things as the Swiss export of watches or the Austrian importation of automobiles. More on this below.

Another issue that must be raised in the factor-analytic approach is how to choose the number of factors. I adopt the asymptotic Bayes criterion of Schwartz (1978) and Leamer (1978):

$$\begin{aligned}\text{Criterion} &= -(p/2)ln(n) - ln(\text{maximized likelihood})\\ &= -(p/2)ln(n) - (n/2)ln(ESS),\end{aligned}$$

where n is the number of observations, ESS is the residual sum of squares, and p is the number of parameters, which for this factor-analytic model is equal to the number of commodities times the number of latent factors. This criterion involves a specific form of penalty for the number of parameters and relates to the maximized likelihood function as the adjusted R^2 relates to the unadjusted R^2. This criterion is an asymptotic approximation to the logarithm of the marginal likelihood function from which the posterior odds ratio can be calculated. The approximate posterior odds ratio of one model, H_1, in comparison with another, H_2, is formed by exponentiating the criterion:

$$\begin{aligned}\text{Posterior Odds }(H_1 : H_2) = \exp\,&[\text{Criterion}(H_1) - \text{Criterion}(H_2)]\\ &\times \text{Prior Odds}(H_1 : H_2).\end{aligned}$$

These posterior odds ratios can sometimes be very extreme when it seems intuitively unlikely that the data admit such sharp inferences. The extreme odds are a consequence of the assumptions that lead up to them, in this case especially the assumption of normality. Normality is always a doubtful assumption, and when it leads to incredible conclusions from a data set, either the conclusions need to be "consumed with a grain of salt" or the data analysis needs to be redone with a wider class of error distributions. Here we will consume with a grain of salt.

These asymptotic Bayes criteria for the unscaled and the scaled models are reported in table 6.3. (The data set for the unscaled model has 182 commodities and 72 countries, comprising a total of $n = 13{,}104$ observations. Each factor adds $p = 182 + 72 = 254$ parameters. Because of missing GNP data, the scaled model has only 65 countries, making a total of $n = 11{,}830$ observations. Each factor adds $p = 182 + 65 = 247$ parameters.) The numbers in table 6.3 indicate a sharp preference for nine factors in the unscaled model and a slightly milder preference for seven factors for the scaled model. The scaling might in effect play the role of one of the factors, and it is thus not surprising to lose one factor in the scaled model. Possibly the loss of the other factor is related to the elimination of seven countries without GNP data.

Table 6.4 reports the ranks of the adjusted trade intensity ratios. The last column contains the ranks of the unadjusted trade intensity ratios. A comparison of this column with the adjacent one indicates that the factor-analytic approach makes dramatic adjustment in the trade intensity ratios. French Guiana, Costa Rica, Trinidad and Tobago, Hong Kong, Saudi Arabia, and Iceland, which all have very large ratios of

Table 6.3 Choice of Number of Factors (criterion defined in text)

Factors	4	5	6	7	8	9	10
Unscaled model							
ESS	.4428	.32269	.24053	.18741	.14908	.11994	.10132
n	13104	13104	13104	13104	13104	13104	13104
k	1016	1270	1524	1778	2032	2286	2540
Criterion	521	1390	2112	2543	2838	3059	2960
Odds	0.0	0.0	0.0	0.0	0.0	1.00	0.0
Scaled model							
ESS	.238543	.197649	.161047	.13219	.109752	.0929958	.0792891
n	11830	11830	11830	11830	11830	11830	11830
k	988	1235	1482	1729	1976	2223	2470
Criterion	3844	3799	3852	3861	3804	3625	3410
Odds	0.0	0.0	0.0	1.0	0.00	0.0	0.0

Table 6.4 Ranks of Openness Measures: Adjusted Trade Intensity Ratios

	Unscaled Model				Scaled Model				Unadjusted
	R	A	M	O	R	A	M	O	O
Low-income economies									
French Guiana	7	24	47	25	1	19	3	3	64
Ethiopia	8	37	14	11	19	13	8	11	24
Pakistan	42	36	51	45	29	31	49	40	11
Sri Lanka	24	58	45	58	15	60	10	42	50
Bangladesh	39	40	48	46	32	49	52	48	12
Lower-middle-income economies									
Costa Rica	1	61	3	8	14	2	5	2	55
Colombia	14	28	11	10	25	10	12	9	9
Ecuador	27	42	16	24	24	16	19	14	30
Indonesia	53	8	6	5	46	15	16	15	41
Cameroon	19	41	35	32	28	17	20	16	29
Ivory Coast	5	64	5	52	9	54	1	19	51
Egypt	29	50	50	51	33	48	14	25	31
Nicaragua	6	48	34	36	22	34	37	29	38
Dominican RP	20	47	23	34	21	45	27	31	17
Peru	63	25	19	39	63	20	22	36	23
Philippines	54	35	32	30	54	37	32	37	22
El Salvador	12	46	41	43	23	43	43	39	28
Turkey	44	34	38	35	40	35	45	41	18
Morocco	64	38	46	53	64	52	38	54	42
Thailand	55	56	40	55	50	58	48	59	33
Upper-middle-income economies									
Hong Kong	2	4	31	3	3	5	15	4	59
Trinidad and Tobago	11	3	2	2	12	9	9	6	58
Panama	22	32	56	50	20	14	30	17	44
Jordan	62	44	65	64	59	27	4	18	61
Brazil	45	26	15	21	45	24	29	23	3
Singapore	13	2	58	4	2	12	60	32	65
Portugal	38	51	28	42	34	47	23	33	47
Greece	46	45	39	44	41	40	33	35	27
Yugoslavia	56	29	43	40	52	38	56	49	16
Malaysia	51	63	9	57	61	64	2	50	60
Israel	47	39	61	59	31	41	61	51	34
Argentina	31	52	12	33	36	57	47	52	7
High-income oil exporters									
Saudi Arabia	25	9	18	9	4	1	6	1	62
Oman	26	10	52	28	8	6	21	8	37
United Arab Emirates	17	6	49	12	17	3	25	10	26
Industrial market economies									
Germany FR	41	17	21	15	35	8	7	7	14
Japan	37	14	25	13	48	11	17	13	13
U.S.A.	40	15	24	14	30	23	39	24	2
France	43	21	27	20	39	25	34	28	5
Sweden	32	20	42	27	42	39	28	30	19
Norway	61	5	20	7	58	22	35	34	35

Table 6.4 (continued)

	Unscaled Model				Scaled Model				Unadjusted
	R	A	M	O	R	A	M	O	O
Spain	50	33	36	31	44	29	44	38	6
United Kingdom	36	22	33	23	37	36	50	43	4
Austria	59	23	44	38	51	32	53	45	8
Australia	60	16	13	19	62	44	41	46	15
Italy	33	13	29	16	43	42	55	47	20
Switzerland	18	7	53	26	26	21	64	53	21
Netherlands	30	27	22	22	53	55	42	55	36
Canada	49	12	26	18	57	51	54	56	10
Denmark	52	49	37	47	49	56	58	60	25
New Zealand	10	55	8	29	47	61	57	62	40
Finland	15	18	7	6	55	59	62	63	32
Belgium	58	31	60	56	60	46	65	64	39
Ireland	57	53	30	49	56	63	63	65	48
East European nonmarket economies									
Hungary	48	19	17	17	38	28	31	27	1
Other									
Iceland	4	62	4	37	18	4	11	5	56
Brunei	3	1	1	1	16	18	13	12	63
Martinique	34	54	63	62	5	33	26	20	49
Guadeloupe	23	60	59	63	6	50	18	21	52
French Polynesia	28	43	57	54	11	26	36	22	46
Bermuda	21	30	54	48	7	30	40	26	43
New Caledonia	65	11	64	60	65	7	51	44	53
Cyprus	35	57	62	61	27	53	59	57	54
Fiji	9	59	10	41	13	62	46	58	45
Tonga	16	65	55	65	10	65	24	61	57

Notes: Seven factors in the scaled model, nine in the unscaled model. R = resource; A = agriculture; M = manufacturing; O = overall. Sorted by overall measure, scaled model.

trade to GNP, after adjustment are judged to be relatively closed countries. The United States, Hungary, and Brazil, which have low ratios of trade to GNP, after adjustment are judged to be moderately open.

Table 6.5 contains the R^2's by country. Do not be alarmed by negative R^2's, which are compatible with the method of estimation. Both the scaled model and the unscaled model fit the data rather well by conventional standards. The scaled model seems to do a bit better overall, but somewhat worse for the larger countries. This finding is not surprising since the scaled model deals with a heteroskedasticity problem that is likely to be present. Trade in resource products is very well explained but trade in agricultural products is often poorly explained. Among the industrial market economies, New Zealand stands out for

Table 6.5 Country R^2

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Low-income economies								
Bangladesh	.94	.19	.05	.26	.97	.08	.09	.25
Ethiopia	.96	.20	.44	.45	.99	.61	.68	.73
French Guiana	.97	−1.03	.13	.75	.99	.79	.93	.97
Pakistan	.99	−.05	.41	.73	.99	−.05	.37	.73
Sri Lanka	.99	.03	.57	.67	.99	.17	.70	.72
Lower-middle-income economies								
Colombia	.47	.23	.75	.36	.95	.71	.82	.75
Costa Rica	.88	.22	−.98	.26	.99	.88	.78	.89
Dominican RP	.98	.10	.08	.56	.99	.21	.68	.64
Ecuador	.99	.20	.72	.95	.99	.74	.65	.97
Egypt	.98	.20	.65	.77	.98	.07	.81	.78
El Salvador	.98	.26	.03	.73	.99	.49	.39	.82
Indonesia	.99	−.01	.67	.98	.99	.24	.56	.98
Ivory Coast	.90	.12	.03	.26	.99	.54	.47	.62
Morocco	.77	.24	.46	.70	.79	.16	.42	.70
Nicaragua	.95	.26	.14	.54	.99	.54	.61	.74
Peru	.41	.34	.85	.62	.31	.20	.81	.55
Philippines	.96	.26	.72	.85	.95	.18	.70	.83
Thailand	.96	−.01	.68	.64	.96	−.05	.50	.61
Turkey	.99	.14	.67	.93	.99	−.08	.37	.90
Cameroon	.99	.19	.68	.83	.99	.63	.82	.92
Upper-middle-income economies								
Argentina	.64	.22	.18	.36	.95	−.15	.20	.17
Brazil	.97	.48	.19	.91	.96	.39	.07	.90
Greece	.99	.08	.63	.90	.99	.14	.43	.88
Hong Kong	.88	−2.97	.59	.57	.97	−.72	.95	.93
Israel	.99	.13	.31	.80	.99	.12	.20	.78
Jordan	.93	−.94	.33	.76	.95	.37	.59	.86
Malaysia	.94	.12	.75	.65	.95	.15	.72	.67
Panama	.99	.18	.59	.89	.99	.51	.69	.92
Portugal	.99	.09	.83	.89	.99	−.00	.74	.87
Singapore	.99	−4.45	.38	.93	.99	.57	.91	.99
Trindad and Tobago	.98	−4.57	−.22	.88	.99	−1.74	.52	.95
Yugoslavia	.98	−.17	.55	.84	.97	−.02	.30	.78
High-income oil exporters								
Oman	.95	−2.81	.52	.58	.98	−.35	.74	.79
Saudi Arabia	.99	.64	.98	.99	.99	−5.53	.68	.99
United Arab Emirates	.78	−10.56	.65	.56	.94	−2.44	.63	.65
Industrial market economies								
Australia	.82	.43	.59	.67	.30	−.25	.65	.29
Austria	.96	.00	.37	.70	.90	.03	.22	.64
Belgium	.97	−.33	.36	.82	.95	−.15	.18	.77
Canada	.99	.98	.97	.98	.86	.02	−.02	.32
Denmark	.90	.19	.15	.58	.90	.04	.03	.52
Finland	.91	.55	.18	.65	.95	.00	.10	.38

Table 6.5 (continued)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
France	.99	.88	.91	.99	.99	.10	.37	.94
Germany FR	.99	.99	.99	.99	.98	−3.62	.76	.80
Ireland	.94	.40	.07	.61	.97	−.17	.17	.50
Italy	.99	.94	.98	.99	.99	−.22	.19	.85
Japan	.99	.99	.99	.99	.97	−1.98	.65	.84
Netherlands	.99	.90	.90	.98	.99	.09	−.14	.86
New Zealand	.78	.27	.36	.42	.94	−.08	.51	.24
Norway	.97	−.61	.45	.92	.98	.57	.80	.96
Spain	.99	.26	.51	.96	.99	.06	.11	.93
Sweden	.96	.67	.66	.82	.98	.13	.49	.65
Switzerland	.93	−1.74	.58	.64	.98	−.09	.16	.39
U.S.A.	.99	1.00	.99	.99	.97	−.04	.17	.74
United Kingdom	.98	.77	.88	.94	.98	−.11	.09	.65
East European nonmarket economies								
Czechoslovakia	.10	−.46	.64	.56				
Hungary	.68	−.01	.01	.24	.69	−.01	−.05	.23
Other								
Bermuda	.96	−1.12	.07	.50	.99	.61	.67	.86
Brunei	.98	−517.61	−8.04	.92	.99	.26	.98	.99
Cyprus	.98	.17	.62	.72	.99	.07	.64	.71
Faeroe Islands	.86	.08	−1.58	.17				
Fiji	.93	.01	−.89	.27	.99	.06	−.01	.34
French Polynesia	.96	−1.04	.17	.54	.99	.68	.78	.90
Greenland	.63	.08	−.57	.32				
Guadeloupe	.95	−.25	.40	.48	.99	.46	.85	.82
Iceland	.65	.11	−.18	.16	.99	.99	.96	.99
Martinique	.96	−.34	.37	.49	.98	.42	.83	.82
New Caledonia	.66	−2.48	.01	.21	.70	−.11	.17	.34
New Hebrides	.94	.22	−.12	.41				
Reunion	.94	−.16	.51	.38				
Seychelles	.95	−.60	.17	.38				
St. Pierre and Miquelon	.98	−.01	−1.73	.70				
Tonga	.96	−.14	−.09	.42	.99	.19	.59	.67

Notes: Nine factors for unscaled model, seven for the scaled model. R = resources; A = agriculture; M = manufacturing; O = overall.

its peculiar trade pattern. Other industrial countries in this group with unusual trade patterns are Australia and Switzerland. Outside of this group, Argentina, Hungary, and Bangladesh are the most peculiar countries.

The commodities that contribute most to the absolute residuals, and consequently to the measures of openness, are listed in table 6.6. The real outlier in this table is road vehicles for the scaled model. The list

Table 6.6 Influential Commodities, Factor Analytic Model ($\Sigma_j|E_{ij}|\Sigma_{ij}|E_{ij}|$)

Scaled Model		Unscaled Model	
Resources			
coal	.022	coal	.016
iron ore	.010	iron ore	.014
base metal	.009	gas	.012
petroleum products	.006	petroleum products	.009
aluminium	.005	base metal	.008
fertilizers	.005	aluminium	.007
copper	.004	copper	.006
tin	.004	tin	.005
gas	.003	electric energy	.004
other minerals	.003	other minerals	.004
Agriculture			
meat, fresh	.023	meat, fresh	.022
wheat 1	.021	coffee	.020
paper	.021	wheat, unmilled	.019
oil seeds	.014	paper	.017
maize	.013	sugar and honey	.012
wood, shaped	.012	animal food	.012
sugar and honey	.011	fruit, fresh	.012
coffee	.011	maize	.012
animal food	.011	wood, shaped	.011
alcoholic beverages	.010	wool	.011
Manufacturing			
road motor vehicles	.051	clothing	.020
machinery, nonelect.	.026	special transactions	.016
aircraft	.020	footwear	.013
special transactions	.020	ships	.013
special machines	.017	plastic materials	.013
office machines	.015	aircraft	.012
telecom equipment	.013	iron and steel shapes	.012
sound recorders	.013	universals, plates, etc.	.012
footwear	.012	organic chemicals	.011
electrical machinery	.011	power machinery	.011

of the influential commodities is about the same for the scaled and unscaled model for both the resource trade and the agricultural trade, but rather different for trade in manufactures. Some other influential commodities are coal, iron ore, meat, coffee, wheat, paper, special transactions, and footwear.

Finally, table 6.7 reports the commodities for each country with the largest estimated residuals based on the scaled model. This table seems to be ultimately destructive of the interpretation of the residuals as trade barriers. Most of the table is composed of export items that are unusual for reasons other than trade barriers. To select a few: Swiss

Table 6.7 Extreme Commodities, Scaled Factor Analytic Model (E_{ij} / $\Sigma_j|E_{ij}|$)

Resources		Agriculture		Manufacturing	
Argentina					
iron ore	−.009	wheat, unmilled	.082	machinery, nonelect.	−.030
coal	−.008	maize	.070	telecom equipment	−.023
Australia					
coal	.092	wheat, unmilled	.076	inorganic elements	.036
iron ore	.054	meat, fresh	.066	office machines	−.018
Austria					
coal	−.040	wood, shaped	.040	road vehicles	−.059
base metal	−.018	paper	.035	steel SITC 674	.043
Bangladesh					
aluminium	−.009	wheat, unmilled	−.092	textile products	.084
coal	−.006	jute	.051	woven textiles	.066
Belgium					
coal	−.040	oil seeds	−.019	steel SITC 674	.062
nonferrous metal	−.016	paper	−.016	special transactions	.059
Bermuda					
base metal	−.015	meat, fresh	−.031	pig iron	−.043
nickel	−.010	fruit, fresh	−.020	office machines	−.037
Brazil					
iron ore	.089	animal food	.087	power machinery	−.032
coal	−.016	fruit, fresh	−.045	road vehicles	.032
Brunei					
aluminium	−.031	meat, fresh	−.043	pig iron	−.029
nickel	−.013	paper	−.028	steel SITC 674	.025
Cameroon					
aluminium	.015	cocoa	.100	special transactions	.035
petroleum products	−.009	fruit, fresh	−.082	inorganic elements	−.028
Canada					
electric energy	.019	paper	.074	machinery, nonelect.	−.043
base metal	.015	wheat, unmilled	.071	road vehicles	.040
Sri Lanka					
tin	−.009	tea	.191	telecom equipment	−.040
fertilizers	−.008	rubber	.060	special transactions	−.033
Colombia					
fertilizers	−.005	coffee	.100	special transactions	.027
tin	−.004	fruit, fresh	−.097	organic chemicals	−.020
Costa Rica					
nickel	.007	fruit, fresh	.131	medicinal products	.031
base metal	.006	cocoa	−.113	pig iron	.028
Cyprus					
other minerals	.013	vegetables, fresh	.068	cement	.047
fertilizers	−.007	alcoholic beverages	.035	footwear	.037
Denmark					
coal	−.045	meat, fresh	.085	road vehicles	−.035
aluminium	−.012	meat, tinned	.042	furniture	.031

Table 6.7 (continued)

Resources		Agriculture		Manufacturing	
Dominican RP					
petroleum products	.010	sugar	.274	medicinal products	−.026
gas	−.007	fruit, fresh	−.066	pig iron	.019
Ecuador					
aluminium	−.015	fruit, fresh	.053	special transactions	.048
gas	−.008	wood, rough	−.034	machinery, nonelect.	−.023
Egypt					
aluminium	.018	wheat, unmilled	−.089	cement	−.032
coal	−.014	cotton	.057	iron SITC 673	−.022
El Salvador					
fertilizers	−.004	fruit, fresh	−.099	medicinal products	−.044
tin	−.002	cotton	.058	telecom equipment	−.031
Ethiopia					
fertilizers	−.005	fruit, fresh	−.111	machinery SITC 718	−.026
tin	−.002	coffee	.105	road vehicles	−.023
Fiji					
gas	−.010	sugar	.331	machinery, nonelect.	−.022
petroleum products	.006	coffee	−.030	woven textiles	−.022
Finland					
coal	−.030	paper	.192	ships	.064
petroleum products	.007	wood, shaped	.048	road vehicles	−.041
France					
coal	−.033	alcoholic beverages	.046	aircraft	.033
base metal	−.013	wheat, unmilled	.033	office machines	−.030
French Guiana					
base metal	−.030	alcoholic beverages	−.046	pig iron	−.078
fertilizers	−.022	wood, shaped	.035	structures	−.026
French Polynesia					
base metal	−.017	wood, shaped	−.038	electrical machinery	−.070
fertilizers	−.014	meat, fresh	−.034	war firearms	.047
Germany, FR					
iron ore	−.009	meat, fresh	−.031	road vehicles	.081
petroleum products	−.009	paper	−.024	aircraft	−.025
Greece					
aluminium	.020	meat, fresh	−.041	ships	−.056
fertilizers	−.011	fruit, fresh	.025	cement	.046
Guadeloupe					
base metal	−.012	fruit, fresh	.089	road vehicles	−.031
fertilizers	−.010	coffee	−.050	pig iron	−.029
Hong Kong					
base metal	.018	tea	−.039	pig iron	.061
nickel	.014	rubber	−.031	toys	.035
Hungary					
electric energy	−.109	animals	.203	medicinal products	.132
petroleum products	−.006	animal food	−.123	footwear	.076

Table 6.7 (continued)

Resources		Agriculture		Manufacturing	
Iceland					
tin	−.007	meat, fresh	−.115	machinery, nonelect.	.028
petroleum products	.006	cocoa	.068	steel SITC 674	.019
Indonesia					
tin	.022	rubber	.030	road vehicles	.041
base metal	.018	veneers	.027	machinery, nonelect.	−.039
Ireland					
coal	−.014	meat, fresh	.099	organic chemicals	.055
aluminium	−.011	food prep.	.035	office machines	.051
Israel					
petroleum products	.007	fruit, fresh	.032	pearl	.095
fertilizers	.005	coffee	−.027	metal manufactures	.087
Italy					
coal	−.021	meat, fresh	−.045	machinery, nonelect.	.057
petroleum products	.010	animals	−.024	footwear	.054
Ivory Coast					
petroleum products	−.007	cocoa	.192	machinery SITC 718	.017
gas	.006	fruit, fresh	−.095	road vehicles	.017
Japan					
coal	−.031	meat, fresh	−.030	road vehicles	.073
iron ore	−.020	wheat, unmilled	−.016	sound recorders	.038
Jordan					
fertilizers	.082	sugar	−.029	aircraft	−.081
tin	−.009	wheat, unmilled	−.019	special transactions	−.048
Malaysia					
tin	.055	wood, rough	.123	road vehicles	.031
petroleum products	−.012	veg. oil 2	.114	clothing	−.023
Martinique					
base metal	−.012	fruit, fresh	.079	pig iron	−.029
fertilizers	−.011	coffee	−.039	furniture	−.025
Morocco					
fertilizers	.138	wheat, unmilled	−.051	inorganic elements	.063
sulphur	−.033	fruit, fresh	.032	ships	−.031
Oman					
fertilizers	−.011	alcoholic beverages	.029	machinery SITC 718	−.058
base metal	−.009	fruit, fresh	−.023	special transactions	−.057
Netherlands					
coal	−.018	meat, fresh	.048	plastic materials	.052
petroleum products	.009	veg. materials n.e.s.	.035	road vehicles	−.049
New Caledonia					
base metal	.107	coffee	.026	pig iron	.304
nickel	.069	sugar	−.011	clothing	.050
New Zealand					
aluminium	.016	meat, fresh	.157	road vehicles	−.035
fertilizers	−.010	wool	.090	machinery, nonelect.	−.021

Table 6.7 (continued)

Resources		Agriculture		Manufacturing	
Nicaragua					
aluminium	−.005	cotton	.128	medicinal products	−.043
fertilizers	−.004	fruit, fresh	−.088	agricultural machinery	−.029
Norway					
aluminium	.079	paper	.046	aircraft	−.032
base metal	−.036	fish, tinned	.019	fertilizer, manufact.	.028
Pakistan					
aluminium	−.007	rice	.065	woven textiles	.064
fertilizers	−.006	cotton	.060	textile products	.045
Panama					
petroleum products	.015	coffee	−.047	special transactions	−.041
fertilizers	−.011	fruit, fresh	.032	road vehicles	−.039
Peru					
copper	.106	wheat, unmilled	−.033	telecom equipment	−.018
base metal	.091	animal food	.024	ships	.018
Philippines					
base metal	.062	sugar	.073	machinery, nonelect.	−.031
silver	.029	veg. oil, hard	.062	road vehicles	.026
Portugal					
fertilizers	−.011	maize	−.041	road vehicles	−.032
tin	−.007	alcoholic beverages	.033	textile products	.032
Saudi Arabia					
gas	−.014	wood, rough	−.056	special transactions	.073
coal	−.013	sugar	.036	coal	.049
Singapore					
fertilizers	−.031	sugar	.023	special transactions	.095
tin	.018	coffee	.022	coal	.066
Spain					
coal	−.024	oil seeds	−.039	iron SITC 673	.036
iron and steel	−.021	maize	−.035	machinery, nonelect.	−.033
Sweden					
iron ore	.012	paper	.098	road vehicles	.041
coal	−.009	wood, shaped	.053	telecom equipment	.029
Switzerland					
base metal	−.006	cheese	.011	watches	.076
aluminium	.005	paper	−.009	road vehicles	−.073
Thailand					
tin	.037	rice	.115	special transactions	−.035
aluminium	−.012	vegetables, fresh	.100	organic chemicals	−.021
Tonga					
other minerals	−.008	wood, shaped	−.086	structures	−.035
base metal	−.007	wheat 2	−.044	pig iron	−.021
Trinidad and Tobago					
petroleum products	.020	sugar	.038	special transactions	−.078
tin	−.018	cocoa	−.025	coal	−.047

Table 6.7 (continued)

Resources		Agriculture		Manufacturing	
United Arab Emirates					
fertilizers	−.010	meat, fresh	.021	machinery, nonelect.	−.087
silver SITC 681	−.008	alcoholic beverages	.017	steel tubes	−.060
Turkey					
other minerals	.014	animals	.044	textile yarn	.036
iron and steel	−.010	tobacco, unmanuf.	.043	organic chemicals	−.032
United Kingdom					
base metal	−.014	paper	−.045	road vehicles	−.046
copper	−.010	alcoholic beverages	.022	power machinery	.036
U.S.A.					
coal	.033	oil seeds	.037	road vehicles	−.077
petroleum products	.009	wheat, unmilled	.036	aircraft	.049
Yugoslavia					
coal	−.026	rubber	−.020	footwear	.060
aluminium	.017	cotton	−.019	organic chemicals	−.040

watches, wheat for Argentina, coal for Australia, road vehicles (−) for Austria, iron and steel for Belgium, paper for Canada, beverages for France.

For one such as myself who started this exercise with high hopes of detecting barriers in net export data, this table is sobering indeed. It now seems pretty clear that the unusual aspects of patterns of net exports occur mostly from the export side and are related to historical factors or to special resources, and not to trade barriers. It may well be that a separate study of the import side would be productive.

6.5 Measures of Peculiarity and Openness using a Regression Model

The alternative to factor analysis is a regression study in which the determinants of net exports are explicitly identified. A model of this form was used by Leamer (1984) to explain net exports in 1958 and 1975. The same model with two additions is estimated here using the 1982 three-digit SITC data. The following explanatory variables are more fully defined in Leamer (1984):

Capital: Accumulated and discounted gross domestic investment, assuming an average life of fifteen years.

Labor: Three labor variables distinguishing levels of skill. (The lowest skill category is an estimate of the illiterate work force.)

Land: Four land variables distinguishing climate types.

Oil production: Value of oil and gas production.

Coal: Value of production of coal.
Minerals: Value of production of minerals.
Distance: GNP-weighted average distance to markets. The distance between countries is the airline distance between capitals.
Trade balance: Net exports of the 183 three-digit SITC commodities.

Two new variables not used in Leamer (1984) are included in this list. The first is distance to markets, which serves as a proxy for natural barriers to trade. Distance ought to reduce net exports in absolute value, which is a feature that cannot be captured in a net export model that is easy to estimate. For ease of estimation, the distance variable is simply entered linearly in the equation. The second variable is the trade balance, which the theory in section 6.2 suggests can affect the level of trade intensity. The decision to exclude the trade balance in Leamer (1984) reflects concerns about the endogeneity of this variable, which would affect the estimation and interpretation of the other coefficients in the model. In this chapter, interest focuses on the residuals, not the coefficients, and the question of endogeneity is secondary.

A heteroskedastic model with residual standard error proportional to GNP (the scaled model) is superior to a homoskedastic model in terms of overall fit. Estimates based on both models are generally reported in the tables. Table 6.8 contains the adjusted trade intensity ratios for the set of countries for which it is possible to compile the data on the variables listed above.[4] Table 6.9 contains the corresponding

Table 6.8 **Openness Measures: Adjusted Trade Intensity Ratios; Regression Model**

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Low-income economies								
Bangladesh	−.16	−.18	−.41	−.75	−.01	−.03	−.03	−.07
Ethiopia	−.24	−.50	−1.2	−1.9	−.02	−.02	.01	−.04
Pakistan	−.04	−.01	.02	−.03	−.02	−.03	.03	−.02
Sri Lanka	−.14	−.13	−.36	−.63	.00	−.00	.01	.01
Lower-middle-income economies								
Peru	−.24	−.19	−.30	−.73	−.08	−.08	−.05	−.21
Cameroon	−.15	−.21	−.44	−.80	−.02	−.08	−.09	−.19
Colombia	−.06	−.00	−.10	−.16	−.07	−.05	−.00	−.13
Egypt	−.09	−.03	−.21	−.33	−.00	−.02	−.06	−.08
Philippines	−.01	−.04	−.10	−.15	−.03	−.03	.00	−.05
El Salvador	−.20	−.30	−.52	−1	.02	−.01	−.06	−.05
Nicaragua	−.34	−.38	−.68	−1.4	−.00	−.02	−.03	−.05
Ecuador	−.04	−.02	−.07	−.14	−.05	.01	.00	−.04
Indonesia	.04	−.02	.01	.04	.03	−.02	−.02	−.02
Morocco	.04	−.09	−.24	−.29	.00	−.01	−.01	−.02

Table 6.8 (continued)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Dominican RP	−.08	−.12	−.26	−.46	.01	.02	−.03	−.01
Thailand	.01	−.01	−.14	−.14	.01	.03	−.01	.03
Costa Rica	−.30	−.36	−.70	−1.4	−.04	.08	.01	.05
Turkey	.03	−.00	−.01	.02	.01	.01	.02	.05
Ivory Coast	−.14	.05	−.23	−.32	.02	.11	.06	.19
Upper-middle-income economies								
Panama	−.27	−.26	−.46	−.99	−.12	−.04	−.05	−.21
Argentina	−.04	−.03	−.07	−.14	−.01	−.07	−.05	−.13
Brazil	.00	−.00	−.00	.00	−.02	−.07	−.02	−.11
Portugal	−.06	.02	−.10	−.15	−.12	.05	−.02	−.10
Greece	−.02	.03	−.03	−.02	−.06	.03	−.01	−.04
Yugoslavia	.01	−.01	.00	−.00	.00	−.01	.05	.04
Israel	.02	.01	.05	.09	−.01	.02	.11	.12
Trinidad and Tobago	.04	−.16	−.09	−.21	.14	−.01	.14	.27
Malaysia	−.01	.09	−.01	.07	.04	.14	.13	.31
Hong Kong	−.05	.05	.29	.29	−.02	.06	.37	.42
Singapore	.37	−.11	−.11	.15	.32	−.03	.22	.51
High-income oil exporters								
Saudi Arabia	−.00	−.01	.00	−.01	−.04	−.05	.01	−.08
Industrial market economies								
Australia	−.01	−.00	.01	−.01	−.05	−.03	−.04	−.11
Canada	−.00	−.00	−.00	−.00	−.01	−.05	−.02	−.07
U.S.A.	.00	.00	−.00	.00	−.02	−.01	−.02	−.05
France	−.01	.01	.00	.00	−.01	−.01	−.00	−.03
Austria	−.01	.01	.04	.03	−.02	−.01	.03	.00
U.K.	.02	.02	.02	.06	−.02	.01	.01	.00
Spain	.02	.01	.01	.04	−.00	.01	−.00	.00
Japan	.00	−.00	.00	.00	.00	−.05	.04	−.00
Sweden	.01	.00	−.05	−.03	−.01	−.01	.03	.01
Germany FR	.00	.00	.01	.01	.03	−.03	.07	.07
Switzerland	−.02	.01	.12	.12	−.03	−.02	.13	.08
Italy	.01	.03	.06	.10	.02	.01	.08	.10
Norway	.10	.00	.04	.14	.05	.01	.05	.11
Denmark	.03	.07	.04	.14	.01	.06	.06	.12
Finland	.03	.07	.03	.14	−.00	.06	.06	.12
Belgium	.05	.04	.14	.22	.05	.02	.13	.20
Netherlands	.10	.06	−.02	.14	.10	.05	.05	.20
New Zealand	−.09	.02	−.03	−.10	−.00	.10	.11	.21
Ireland	.02	.03	−.05	.00	.02	.12	.12	.26
Other								
Cyprus	−.37	−.59	−.93	−1.9	−.01	−.04	−.01	−.06
Fiji	−1.7	−2.1	−3.9	−7.7	.00	−.04	−.02	−.05
Iceland	−.76	−.73	−1.3	−2.8	.02	.04	.01	.07

Notes: R = resources; A = agriculture; M = manufacturing; O = overall. Sorted by overall measure.

Table 6.9 **Ranks of Openness Measures: Adjusted Trade Intensity Ratios; Regression Model**

	Unscaled Model				Scaled Model				
	R	A	M	O	R	A	M	O	TIR
Low-income economies									
Bangladesh	10	11	10	10	25	12	9	12	13
Ethiopia	7	4	3	3	14	18	26	20	23
Pakistan	22	22	43	26	19	13	34	24	16
Sri Lanka	13	13	11	12	32	31	29	31	44
Lower-middle-income economies									
Peru	8	10	12	11	3	2	5	2	22
Cameroon	11	9	9	9	18	1	1	3	29
Colombia	18	26	21	18	4	6	23	5	8
Egypt	15	18	16	14	31	21	2	9	28
Nicaragua	4	5	6	5	29	19	10	14	35
El Salvador	9	7	7	7	42	25	3	16	26
Philippines	29	17	20	20	10	15	25	17	21
Ecuador	20	20	23	22	6	33	24	19	27
Morocco	48	16	14	16	36	24	18	23	39
Indonesia	49	21	41	40	47	20	11	25	38
Dominican RP	16	14	13	13	38	39	8	26	15
Thailand	37	25	17	21	39	42	20	33	31
Turkey	45	28	30	38	40	35	32	35	17
Costa Rica	5	6	5	6	8	49	31	36	47
Ivory Coast	12	49	15	15	44	51	42	45	45
Upper-middle-income economies									
Panama	6	8	8	8	2	10	4	1	40
Argentina	21	19	24	23	22	4	6	4	6
Brazil	34	30	33	32	16	3	14	7	2
Portugal	17	41	19	19	1	44	12	8	42
Greece	24	44	27	27	5	41	19	21	25
Yugoslavia	36	23	35	31	33	27	39	34	14
Israel	42	40	49	44	24	38	45	43	32
Trinidad and Tobago	47	12	22	17	52	29	51	50	49
Malaysia	26	53	31	43	48	53	48	51	51
Hong Kong	19	48	53	53	15	48	53	52	50
Singapore	53	15	18	51	53	14	52	53	53
High-income oil exporters									
Saudi Arabia	30	24	38	29	9	5	28	10	52
Industrial market economies									
Australia	28	27	40	28	7	17	7	6	12
Canada	31	29	32	30	23	8	15	11	9
U.S.A.	32	32	34	34	13	26	16	18	1
France	27	38	37	35	21	23	22	22	4
Japan	33	31	36	36	35	7	36	27	10
Spain	40	39	42	41	27	32	21	28	5
U.K.	41	43	44	42	12	36	30	29	3
Austria	25	37	46	39	17	28	33	30	7
Sweden	38	34	26	25	20	30	35	32	18

Table 6.9 (continued)

	Unscaled Model				Scaled Model				
	R	A	M	O	R	A	M	O	
Germany FR	35	35	39	37	46	16	43	38	11
Switzerland	23	36	51	46	11	22	49	39	20
Italy	39	46	50	45	41	34	44	40	19
Norway	52	33	47	50	50	37	38	41	33
Finland	46	52	45	47	30	47	40	42	30
Denmark	44	51	48	49	37	46	41	44	24
Netherlands	51	50	29	48	51	45	37	46	34
Belgium	50	47	52	52	49	40	50	47	36
New Zealand	14	42	28	24	28	50	46	48	37
Ireland	43	45	25	33	43	52	47	49	43
Other									
Cyprus	3	3	4	4	26	9	17	13	46
Fiji	1	1	1	1	34	11	13	15	41
Iceland	2	2	2	2	45	43	27	37	48

Notes: R = resources; A = agriculture; M = manufacturing; O = overall; TIR = rank of trade intensity ratio.

ranks. The last column of table 6.9 reports the ranks of the unadjusted trade intensity ratios.

Controlling for the resources listed, and for distance and the trade balance, the regression analysis makes some dramatic changes in the measures of openness. For example, Panama, which has a very high overall trade intensity ratio, has the lowest adjusted ratio, using the scaled model. Thus, although Panama is very trade dependent, her resources suggest that she should be even more so. Peru and Cameroon are essentially the same.

According to the adjusted trade intensities in table 6.9 the countries with the highest barriers to trade are Panama, Peru, Cameroon, and Argentina. The most open countries are Singapore, Hong Kong, and Malaysia.

For many of the less-developed countries, the adjustment to the trade intensity ratio makes them appear less open. The measures for the industrial market economies tend to adjust in the opposite way, with relatively low trade intensity ratios but relatively high openness measures. For example, the United States has the lowest trade intensity, equal to 7 percent of GNP (table 6.1). If the scaled model is used, the United States ranks eighteenth in terms of overall openness, though it is only third among the industrial market economies. If the unscaled model is used, which emphasizes these bigger countries, the United States moves up to number thirty-four. A fairly big change among these countries is that Australia and Canada are estimated as not very open, even though they rank ahead of several other of these countries in terms of trade intensity. Note also that the anomaly of low Japanese trade in agricultural products remains unexplained; similarly for West Germany. Two other anomalies are the relatively low resource trade of Switzerland and New Zealand.

The choice between the ordering in table 6.2 and the adjusted ordering in table 6.9 depends completely on the quality of the model that underlies the adjustment. Now we must begin the criticism phase of the analysis to decide if the model seems to be doing the job as well as it can be done. We are attributing the residuals in the model completely to the trade barriers, which is obviously incorrect if there are omitted variables that could account for a significant portion of the unexplained variability of trade.

The first criticism of the model is that it does not explain the trade of many countries very well. Table 6.10 contains country R^2's indicating the proportion of the variability of trade that is explained by the model. These R^2's are much lower than the factor-analytic R^2's reported in table 6.5. Table 6.10 indicates that in terms of R^2's, the model does a relatively poor job of explaining the trade composition of about a third of the countries. Remember that the model is estimated separately for each commodity. Although the R^2's for each commodity must be positive, the R^2's for each country need not be. In fact, there are quite a few negative country R^2's. Unlike the factor-analysis results, there appears in table 6.10 to be no tendency for the model to work relatively well on one or more of the subsets of commodities.

Table 6.10 Country R^2, Regression Model

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Low-income economies								
Pakistan	.67	.22	.27	.54	.15	−.90	.43	.12
Bangladesh	−17	−2.9	−15	−11	.85	.70	.91	.82
Sri Lanka	.62	−.34	−2.2	.01	.97	.65	.88	.87
Ethiopia	−4.2	−2.7	−100	−13	.74	.98	.79	.90
Lower-middle-income economies								
Peru	−27	−19	−7.7	−16	−3.2	−4.2	.59	−1.5
Colombia	−31	.41	−2.2	−.92	−38	.52	.79	−.44
Costa Rica	−12	−.51	−16	−2.3	−1.6	.64	.45	.43
Dominican RP	−3.1	−1.3	−25	−3	.95	.02	.10	.51
Philippines	.66	−.17	−1.9	.24	.70	−.92	.57	.52
El Salvador	−3.5	−4.7	−41	−6.2	.77	.09	−.18	.53
Thailand	.52	.07	−1.7	.21	.78	.14	.33	.56

Table 6.10 (continued)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Cameroon	−1.5	−2.1	−15	−2.7	.66	.23	.50	.60
Morocco	−.69	−2.5	−3.2	−1.1	.79	−1	.36	.61
Ivory Coast	−.51	.07	−4.7	−.13	.08	.74	−.11	.62
Egypt	−.16	−.38	−4.8	−1.2	.70	.24	.62	.62
Nicaragua	−11	−2.6	−31	−8.2	.96	.60	.64	.76
Turkey	.63	−.47	.08	.56	.96	−.44	.53	.87
Ecuador	.96	−.26	−.69	.85	.92	.55	.69	.90
Indonesia	.97	.30	.81	.96	.90	−.37	.81	.90
Upper-middle-income economies								
Argentina	−7.3	.62	−2.7	−.82	−3	−1.3	−.93	−1.2
Portugal	.65	.12	−.31	.41	−.46	−.03	.40	−.19
Hong Kong	−2.9	−.75	.18	−.18	−1.8	−.39	.14	−.08
Panama	−1	−7.8	−10	−2.6	.08	.12	.28	.14
Brazil	1.00	.99	.97	1.00	.83	−6.6	−1.1	.19
Trinidad and Tobago	.13	−13	−.10	.11	.39	−1.1	.60	.43
Greece	.97	−.25	−.33	.75	.63	−.40	.25	.54
Yugoslavia	.88	−1.1	−.75	.45	.70	−1.1	.38	.58
Malaysia	.89	.41	.26	.69	.92	.29	.60	.69
Israel	.85	−.48	.24	.66	.99	.34	.25	.79
Singapore	.74	−2.4	−.43	.65	.84	−.49	.80	.83
High-income oil exporters								
Saudi Arabia	1.00	.91	.99	1.00	.99	−3.9	.94	.99
Industrial market economies								
U.S.A.	1.00	1.00	1.00	1.00	−5.1	−1.8	−1.5	−3.9
Australia	.72	.95	.88	.84	−4.4	.38	.06	−1.5
Austria	−.59	−.26	.28	−.20	−.94	−.97	−.36	−.63
U.K.	.30	.09	.67	.39	−.47	−.09	−1.1	−.54
Switzerland	−1.6	−.58	−.18	−.51	−.89	−5.5	−.09	−.36
Ireland	−.70	.26	−.95	−.45	−.85	.13	.10	−.32
Netherlands	.54	.30	−1	.42	−.04	.18	.14	−.01
Germany FR	.98	.89	.98	.98	.06	−9	.11	.06
New Zealand	−9.5	.18	−2.3	−1.4	−.25	.30	.13	.26
Denmark	.24	−.03	−.06	.18	.59	−.12	.05	.33
Finland	.70	.15	−.85	.27	.69	.25	.18	.43
Japan	1.00	.98	1.00	1.00	.66	−9.3	.14	.44
Sweden	.77	.14	−.05	.44	.87	.01	.09	.48
Canada	.99	1.00	.99	1.00	.89	.26	.78	.60
France	.92	.49	.35	.89	.88	−2.9	−1.7	.67
Belgium	.92	−.09	.02	.71	.92	−.61	−.08	.68
Norway	.66	.11	.24	.66	.70	.24	.66	.72
Italy	.89	.47	.25	.80	.88	−1.3	.12	.73
Spain	.96	.09	−.99	.87	.98	−.22	−1.5	.85
Other								
Cyprus	−16	−18	−15	−15	.46	−2.1	.66	.15
Iceland	−43	−.71	−54	−6.3	.81	.69	.63	.71
Fiji	−235	−15	−1E3	−102	.87	.96	.82	.93

Notes: R = resources; A = agriculture; M = manufacturing; O = overall.

The lack of fit is meant to suggest inadequacies in the model: nonlinearities, unmeasured resources, or trade barriers. Why does the scaled model do so poorly in explaining the trade of Peru, Argentina, the United States, and Australia? Note also the dramatic differences in the R^2's for the scaled and unscaled model. Many of these differences are due to the relatively heavy weight put on the larger countries in the unscaled version. An example is the United States, which is such an extreme country in the unscaled model that the fit is essentially perfect, but it is very poor in the scaled model in which the U.S. data are the very small numbers implied by very low trade intensity ratios. Because of the quality of the fits, it is best to think of the unscaled model as describing the larger countries, primarily the industrial market economies, and to think of the scaled model as describing the smaller countries.

Tables 6.11 and 6.12 contain "intervention" rates, which, like the R^2's, measure the size of the estimated residuals. The principal difference is that the intervention rates use the absolute residuals, not the squares thereof, which reduces the influence of the largest residuals. The residuals are compared with GNP in table 6.11 and with predicted net trade in table 6.12.

Countries are sorted in table 6.11 from largest to smallest values of the intervention rates to produce an ordering comparable with the adjusted trade intensity ratio (a country that intervenes little is an open country). Discrepancies between these intervention rates and the ad-

Table 6.11 **Intervention Rates, Regression Model ($\Sigma_j \mid E_{ij} \mid / GNP_i$)**

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Low-income economies								
Bangladesh	.16	.26	.47	.89	.02	.05	.04	.11
Ethiopia	.24	.55	1.25	2.04	.03	.04	.05	.13
Pakistan	.04	.07	.11	.22	.05	.10	.08	.23
Sri Lanka	.14	.34	.48	.95	.04	.15	.09	.29
Lower-middle-income economies								
Turkey	.06	.08	.10	.24	.03	.08	.07	.17
Dominican RP	.19	.26	.32	.77	.02	.11	.06	.19
Ecuador	.05	.12	.17	.33	.05	.07	.07	.19
Indonesia	.05	.05	.06	.17	.09	.06	.06	.21
Philippines	.07	.10	.19	.36	.05	.09	.06	.21
Nicaragua	.36	.52	.79	1.68	.02	.12	.10	.24
Colombia	.08	.10	.19	.37	.09	.11	.06	.25
Egypt	.11	.15	.31	.57	.05	.11	.10	.25
Cameroon	.24	.29	.50	1.03	.07	.10	.10	.27

Table 6.11 (continued)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Thailand	.09	.18	.22	.49	.04	.14	.09	.27
El Salvador	.27	.42	.65	1.35	.04	.13	.11	.28
Peru	.31	.26	.38	.95	.13	.10	.08	.31
Morocco	.22	.23	.34	.79	.09	.15	.11	.34
Ivory Coast	.15	.46	.38	.99	.09	.20	.14	.43
Costa Rica	.39	.81	.94	2.13	.14	.26	.15	.55
Upper-middle-income economies								
Brazil	.00	.00	.01	.01	.04	.10	.05	.19
Yugoslavia	.04	.06	.15	.25	.05	.06	.09	.21
Israel	.05	.10	.17	.32	.02	.07	.15	.25
Greece	.03	.08	.13	.24	.07	.08	.11	.26
Argentina	.05	.07	.11	.23	.05	.14	.08	.27
Panama	.28	.35	.59	1.21	.12	.10	.16	.39
Malaysia	.10	.23	.18	.52	.09	.22	.14	.45
Portugal	.11	.13	.23	.47	.16	.13	.18	.47
Trinidad and Tobago	.35	.26	.34	.95	.24	.10	.15	.49
Hong Kong	.17	.13	.42	.72	.14	.12	.41	.67
Singapore	.50	.28	.85	1.63	.35	.15	.30	.80
High-income oil exporters								
Saudi Arabia	.01	.01	.02	.05	.06	.07	.06	.20
Industrial market economies								
Canada	.00	.01	.01	.01	.02	.06	.04	.11
France	.02	.02	.04	.08	.02	.06	.07	.15
Spain	.02	.04	.07	.13	.02	.05	.09	.16
U.K.	.02	.03	.04	.09	.04	.04	.08	.16
U.S.A.	.00	.00	.00	.00	.07	.03	.06	.16
Italy	.03	.04	.09	.15	.03	.07	.11	.21
Norway	.11	.06	.11	.28	.10	.05	.07	.22
Austria	.05	.05	.08	.19	.06	.07	.11	.23
Japan	.00	.00	.01	.01	.05	.08	.11	.23
Sweden	.04	.09	.14	.27	.03	.10	.11	.23
Australia	.02	.02	.03	.07	.10	.06	.08	.24
Germany FR	.01	.01	.02	.04	.05	.07	.12	.24
Denmark	.05	.11	.11	.27	.05	.13	.10	.28
Finland	.05	.13	.15	.34	.05	.13	.12	.30
Switzerland	.06	.04	.19	.29	.05	.07	.19	.31
Belgium	.05	.07	.19	.31	.05	.08	.19	.32
Netherlands	.11	.08	.13	.33	.14	.10	.11	.34
New Zealand	.17	.24	.23	.63	.06	.16	.14	.37
Ireland	.15	.18	.29	.62	.15	.18	.18	.51
Other								
Fiji	1.90	2.33	3.99	8.22	.05	.07	.05	.16
Iceland	.89	1.07	1.44	3.40	.06	.24	.12	.42
Cyprus	.58	.77	1.21	2.55	.09	.19	.18	.46

Notes: See table 6.10.

Table 6.12 Intervention Rates, Regression Model ($\Sigma_j \mid E_{ij} \mid / \Sigma_j \mid N^*_{ij} \mid$)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Low-income economies								
Bangladesh	.90	.99	.89	.92	.57	.43	.27	.36
Ethiopia	.85	.91	.98	.95	.50	.31	.53	.43
Sri Lanka	.54	1.13	.81	.83	.35	.88	.45	.57
Pakistan	.47	1.05	1.12	.87	.74	1.10	.97	.95
Lower-middle-income economies								
Cameroon	1.03	.98	.85	.92	.71	.56	.43	.53
Indonesia	.30	.82	.55	.47	.46	.97	.42	.53
Ecuador	.31	1.30	.89	.76	.32	1.04	.67	.57
Nicaragua	.89	.99	.94	.95	.33	.70	.53	.57
Egypt	.72	1.11	.88	.89	.77	.85	.47	.64
Peru	.95	1.11	.92	.98	.79	.79	.50	.69
Philippines	.82	.96	.94	.92	.53	1.01	.64	.72
Colombia	.99	1.29	.98	1.05	.99	.84	.59	.80
El Salvador	1.03	1.04	1.02	1.03	.89	1.03	.67	.83
Morocco	2.20	1.24	.87	1.17	.64	1.33	.67	.83
Dominican RP	1.42	1.24	.96	1.14	.41	1.54	.58	.84
Thailand	1.09	1.31	.86	1.02	.51	1.36	.71	.86
Turkey	1.31	1.47	.95	1.17	.40	1.70	.96	.94
Costa Rica	.99	1.18	1.06	1.09	1.09	1.07	.85	1.01
Ivory Coast	.68	1.70	1.00	1.14	1.35	.95	1.64	1.19
Upper-middle-income economies								
Panama	.74	1.01	.85	.86	.53	.81	.59	.61
Singapore	1.16	1.15	1.08	1.11	.72	.90	.66	.72
Greece	.29	1.85	.84	.78	.50	1.99	.80	.82
Brazil	.06	.12	.20	.11	.55	.95	1.07	.85
Argentina	.87	.59	.85	.75	1.41	.83	.74	.86
Portugal	.61	1.42	.73	.81	.66	1.92	.79	.87
Israel	.80	1.68	1.22	1.22	.24	1.38	1.88	1.08
Yugoslavia	.58	1.23	1.38	1.12	.74	1.24	1.54	1.16
Malaysia	.51	1.62	.72	.87	.60	2.28	1.26	1.27
Trinidad and Tobago	1.68	1.10	.90	1.16	2.23	1.20	1.02	1.44
Hong Kong	1.44	2.25	2.65	2.15	1.58	2.81	5.30	3.20
High-income oil exporters								
Saudi Arabia	.02	.27	.11	.06	.12	.76	.29	.23
Industrial market economies								
Canada	.05	.08	.08	.07	.29	.50	.41	.42
Australia	.27	.35	.35	.33	.91	.75	.59	.73
Norway	1.42	1.28	1.25	1.32	.79	1.54	.84	.91
Spain	.34	1.58	1.34	.96	.30	1.69	1.39	.96
France	.23	1.20	.94	.60	.33	1.37	1.54	.97
Sweden	.79	1.34	.95	1.01	.36	1.31	1.55	1.05
Japan	.04	.15	.06	.06	.68	1.04	1.60	1.11
Austria	.76	1.71	1.61	1.24	.74	1.37	1.81	1.25
U.S.A.	.03	.06	.02	.03	1.46	1.22	1.16	1.28
U.K.	2.36	2.33	1.06	1.59	.79	1.64	1.73	1.31

Table 6.12 (continued)

	Unscaled Model				Scaled Model			
	R	A	M	O	R	A	M	O
Finland	1.23	2.38	1.62	1.75	.67	1.94	1.83	1.43
Italy	.47	1.57	1.58	1.09	.57	1.61	2.97	1.52
Germany FR	.17	.34	.17	.19	1.87	1.18	2.15	1.70
Belgium	.62	2.33	3.46	1.89	.67	1.78	3.27	1.77
Denmark	1.26	2.70	1.94	1.98	.74	2.65	2.57	1.84
Switzerland	1.20	1.39	3.94	2.25	.80	1.32	4.42	1.92
New Zealand	1.12	1.51	1.24	1.29	1.06	2.30	3.19	2.09
Netherlands	1.88	2.23	1.07	1.49	2.53	1.80	2.02	2.12
Ireland	2.08	1.17	1.11	1.27	1.86	3.27	1.89	2.20
Other								
Fiji	1.04	1.03	.99	1.01	.57	.31	.28	.34
Cyprus	1.21	1.03	.96	1.03	.80	1.00	.55	.73
Iceland	1.04	1.08	.93	1.00	.87	1.07	.50	.79

Notes: See table 6.10.

justed trade intensity ratios occur when the large positive and large negative residuals offset each other in the computation of the adjusted trade intensity ratio, making a country appear to be only average on the openness scale, but nonetheless to intervene a great deal. For example, among the industrialized countries, Canada is the second least open economy, but also appears not to intervene very much. This suggests that many of the other industrialized countries have large positive residuals, which make them appear more open and more interventionist. Among low-income economies, Sri Lanka is estimated to intervene a lot, but is also estimated to be very "open." Generally speaking, there are major differences in the measures of intervention and the measures of openness.

The intervention rates in table 6.12 are comparable with R^2's and are ordered from smallest to largest. When these intervention rates exceed one, the model is not performing very well in the sense that the residuals are generally larger than predicted trade. There are a distressing number of large numbers in table 6.12. It seems highly unlikely that these large residuals should be attributed completely to trade barriers.

The commodities that contribute most to all of these measures are listed in tables 6.13 and 6.14. The biggest residuals are petroleum and petroleum products. In part, this is a consequence of the fact that these categories of trade are relatively large, but we hoped that the oil production variable together with capital and labor would offer a good

Table 6.13 Influential Commodities, Scaled Model ($\Sigma_i \mid E_{ij} \mid / \Sigma_{ij} \mid E_{ij} \mid$)

Resources		Agriculture		Manufacturing	
petroleum products	.093	fish, fresh	.035	clothing	.028
petroleum	.088	coffee	.028	road vehicles	.024
gas	.019	fruit, fresh	.027	special transactions	.021
fertilizers	.008	meat, fresh	.019	elect. machinery	.019
aluminium	.008	cocoa	.017	coal	.013
coal	.007	sugar	.014	ships	.011
tin	.007	paper	.013	telecom equipment	.010
base metal	.004	wood, rough	.013	organic chemicals	.009
copper	.004	tea	.012	steel plates	.009
iron ore	.004	veg oil, nonsoft	.011	woven textiles	.008

Table 6.14 Extreme Commodities, by Country ($E_{ij}/\Sigma_j|E_{ij}|$)

Resources		Agriculture		Manufacturing	
Argentina					
petroleum products	.08	fish, fresh	−.10	road vehicles	.03
petroleum	−.03	meat, fresh	−.05	mach., elec.	.02
gas	−.02	wool	−.04	special transactions	−.02
aluminium	−.02	coffee	.04	chemical n.e.s.	−.01
fertilizers	−.01	fruit, fresh	.04	clothing	−.01
iron ore	−.01	maize	.02	leather	−.01
Australia					
petroleum products	−.21	tea	.03	clothing	.04
gas	−.05	fruit, fresh	.03	ships	.03
coal	.04	wheat, unmilled	.03	machinery SITC 718	.02
iron ore	.02	wool	.02	mach., elec.	.02
petroleum	−.02	wood, shaped	.02	organic chemicals	.02
fertilizers	−.01	paper	.01	woven textiles	−.01
Austria					
petroleum	.14	coffee	−.03	clothing	−.05
petroleum products	−.03	fruit, fresh	−.03	road vehicles	−.05
gas	−.02	cocoa	−.02	steel SITC 674	.03
coal	−.01	paper	.02	mach., elec.	.02
electric energy	.01	wood, shaped	.02	special transaction	−.02
tin	−.01	fish, fresh	.01	iron SITC 673	.01
Bangladesh					
petroleum products	−.04	cocoa	−.10	mach., elec.	.04
gas	−.04	wood, rough	−.06	ships	.03
fertilizers	−.03	fruit, fresh	.03	road vehicles	.03
tin	−.01	rubber	−.03	steel SITC 674	.02
iron ore	.01	meat, fresh	.02	machinery SITC 718	.02
coal	.01	veg oil, hard	−.02	woven textiles	−.02

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Belgium					
gas	−.04	coffee	−.02	steel SITC 674	.06
coal	−.02	fruit, fresh	−.02	special transactions	.05
petroleum	−.02	cocoa	−.02	clothing	−.05
nonferrous metals	−.01	wood, shaped	−.01	plastic material	.04
petroleum products	.01	oil seeds	−.01	road vehicles	.03
iron ore	−.01	alcoholic beverages	−.01	iron SITC 673	.03
Brazil					
petroleum	.06	cocoa	−.10	road vehicles	.03
petroleum products	.04	coffee	−.10	footwear	.01
iron ore	.03	fish, fresh	.06	steel SITC 674	.01
gas	.02	wood, rough	−.04	medicinal products	.01
copper	−.01	fruit, fresh	−.03	chemical n.e.s.	.01
aluminium	.01	animal food	.02	organic chemicals	.01
Cameroon					
petroleum products	−.14	coffee	−.09	mach., elec.	.03
petroleum	.07	cocoa	−.05	special transactions	−.03
gas	−.02	cotton	−.01	coal	−.02
aluminium	.01	rice	.01	road vehicles	.02
coal	−.01	paper	.01	ships	.02
iron ore	−.01	animal food	−.01	organic chemicals	.02
Canada					
gas	−.04	paper	−.14	ships	−.04
petroleum products	−.02	fruit, fresh	.05	road vehicles	.02
petroleum	.01	coffee	.05	special transactions	−.02
coal	.01	wood, shaped	−.03	clothing	.02
aluminium	−.01	pulp	−.03	electrical machinery	.01
base metal	.01	fish, fresh	−.02	organic chemicals	.01
Colombia					
petroleum	.14	fish, fresh	.06	clothing	.02
petroleum products	−.14	coffee	.06	road vehicles	−.02
fertilizers	.01	cocoa	−.05	cement	.02
gas	−.01	tea	−.03	medicinal products	.01
tin	.01	cotton	−.03	organic chemicals	−.01
iron ore	−.01	fruit, fresh	−.02	chemical n.e.s.	.01
Costa Rica					
petroleum	−.14	fruit, fresh	.13	mach., elec.	−.03
petroleum products	.08	coffee	.09	coal	.03
coal	.01	fish, fresh	−.05	chemical n.e.s.	−.02
aluminium	−.01	paper	−.03	plastic material	−.01
tin	.01	meat, fresh	.02	organic chemicals	−.01
fertilizers	.01	sugar	−.02	medicinal products	.01
Cyprus					
petroleum products	−.09	fish, fresh	−.13	clothing	.04
petroleum	.05	veg., fresh	.05	mach., elec.	.03
aluminium	−.02	coffee	−.03	footwear	.03
other minerals	.01	tobacco manuf.	.02	cement	.02
fertilizers	−.01	alcoholic beverages	.02	ships	.02
gas	−.01	sugar	−.01	special transactions	−.02

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Denmark					
petroleum products	−.06	meat, fresh	.07	mach., elec.	.03
petroleum	.05	coffee	−.03	road vehicles	−.02
coal	−.02	fish, fresh	.03	clothing	−.02
gas	.01	meat	.03	furniture	.02
base metal	.00	meat, dried	.03	steel tubes	−.02
aluminium	−.00	fruit, fresh	−.03	steel SITC 674	−.02
Dominican Republic					
petroleum products	−.04	sugar	.19	clothing	−.04
petroleum	−.03	fish, fresh	−.07	mach., elec.	.02
tin	−.01	fruit, fresh	−.03	road vehicles	.02
coal	.01	cocoa	.03	medicinal products	−.02
fertilizers	−.01	veg oil soft	−.03	organic chemicals	.02
aluminium	−.00	rubber	−.02	woven textiles	.01
Ecuador					
petroleum	−.14	fish, fresh	.05	special transactions	.03
petroleum products	.07	fruit, fresh	.04	mach., elec.	−.02
gas	−.03	tea	−.02	structures	.01
fertilizers	.01	wheat, unmilled	.02	medicinal products	−.01
coal	.01	fish, tinned	.02	telecom equipment	.01
aluminium	−.01	rubber	−.02	power machinery	−.01
Egypt					
petroleum products	−.08	fish, fresh	.05	special transactions	−.04
petroleum	.07	wheat, unmilled	−.03	coal	−.03
aluminium	.02	sugar	.03	road vehicles	.03
coal	−.00	cocoa	.03	mach., elec.	.02
fertilizers	.00	fruit, fresh	−.03	woven textiles	.02
gas	−.00	coffee	−.03	cement	−.02
El Salvador					
petroleum	−.10	fruit, fresh	−.07	road vehicles	.05
petroleum products	.03	fish, fresh	−.07	woven textiles	.02
aluminium	−.00	coffee	.06	mach., elec.	.02
coal	.00	cotton	.04	medicinal products	−.02
fertilizers	.00	veg., fresh	−.03	textile yarn	.02
gas	−.00	tea	−.03	machinery SITC 718	.02
Ethiopia					
petroleum products	.15	cotton	−.02	road vehicles	−.04
gas	.03	coffee	.02	special transactions	.04
petroleum	−.02	meat, fresh	.02	mach., elec.	−.03
fertilizers	−.02	fish, fresh	.02	clothing	−.03
coal	−.01	sugar	−.02	coal	.02
tin	.01	rice	−.02	ships	−.01
Fiji					
petroleum products	−.13	fish, fresh	.11	clothing	−.02
petroleum	.11	coffee	−.05	coal	−.02
aluminium	.02	fruit, fresh	−.05	mach., elec.	.02
tin	−.01	sugar	.03	special transactions	−.02
coal	−.01	meat, fresh	−.03	woven textiles	.02
gas	−.00	wool	−.02	inorganic elements	−.01

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Finland					
petroleum products	.08	paper	.15	road vehicles	−.05
petroleum	−.04	coffee	−.04	ships	.04
coal	−.01	fruit, fresh	−.03	clothing	.01
electric energy	−.01	pulp	.03	special transactions	.01
zinc	.01	wood, shaped	.03	aircraft	−.01
aluminium	−.01	veneers	.02	mach., elec.	−.01
France					
petroleum	.08	coffee	−.03	clothing	−.05
gas	−.02	fruit, fresh	−.03	road vehicles	.04
tin	−.01	wheat, unmilled	.03	aircraft	.03
coal	.01	cocoa	−.02	mach., elec.	.02
iron and steel	.00	meat, fresh	−.02	toys	−.02
fertilizers	−.00	alcoholic beverages	.02	telecom equipment	−.02
Germany					
petroleum	−.11	coffee	−.04	road vehicles	.13
gas	−.03	fruit, fresh	−.04	mach., elec.	.05
coal	.02	meat, fresh	−.02	clothing	−.03
petroleum products	.01	cocoa	−.02	special transactions	.02
fertilizers	.00	fish, fresh	.02	coal	.02
copper	.00	wood, rough	−.01	machinery SITC 718	.01
Greece					
petroleum	.12	meat, fresh	−.05	special transactions	−.05
petroleum products	−.10	fruit, fresh	.03	ships	−.03
aluminium	.01	tobac., unman.	.02	coal	−.03
tin	−.01	coffee	.02	cement	.03
base metal	.01	veg., preserved	.02	textile yarn	.02
copper	.01	milk	−.01	mach., elec.	.02
Hong Kong					
petroleum	.10	animals	−.02	clothing	.18
petroleum products	−.09	paper	−.02	toys	.06
tin	−.00	fruit, fresh	−.01	woven textiles	−.03
base metal	.00	meat, fresh	−.01	watches	.02
copper	−.00	sugar	−.01	textile yarn	−.02
gas	.00	veg., fresh	−.01	telecom equipment	.02
Iceland					
petroleum products	−.05	fish, fresh	.23	special transactions	.02
aluminium	.04	fruit, fresh	−.06	clothing	−.02
petroleum	−.02	coffee	−.05	inorganic elements	−.02
fertilizers	−.01	meat, fresh	−.02	footwear	−.02
other minerals	−.01	veg., fresh	−.02	electrical machinery	−.02
coal	−.00	sugar	.02	cement	−.01
Indonesia					
petroleum products	−.20	tea	−.04	road vehicles	.03
petroleum	.09	sugar	−.02	plastic material	−.02
gas	.07	fish, fresh	.02	telecom equipment	.02
coal	−.01	veg., fresh	−.02	organic chemicals	−.01
base metal	.01	wood, shaped	.02	special transactions	.01
fertilizers	.01	veneers	.02	inorganic elements	−.01

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Ireland					
petroleum products	−.14	meat, fresh	.07	organic chemicals	.05
petroleum	.12	butter	.03	office machinery	.04
coal	−.01	food preparations	.03	clothing	−.04
base metal	.01	milk	.02	instruments	.02
aluminium	−.01	alcoholic beverages	.02	road vehicles	−.02
fertilizers	−.00	fruit, fresh	−.02	special transactions	.01
Israel					
gas	.02	fruit	.02	pearl	.09
petroleum	.01	coffee	−.02	metal manufactures	.08
coal	.01	meat, fresh	−.02	road vehicles	−.05
fertilizers	.01	fruit, fresh	.02	special transactions	−.04
copper	−.01	oil seeds	−.02	chemical n.e.s.	.03
tin	−.00	cotton	.02	office machinery	−.03
Italy					
petroleum	−.08	meat, fresh	−.05	mach., elec.	.06
petroleum products	.04	coffee	−.03	footwear	.04
gas	−.02	animals	−.02	jewelry	.03
iron and steel	−.01	wood, shaped	−.02	clothing	.03
tin	−.00	cocoa	−.01	woven textiles	.03
base metal	.00	fish, fresh	.01	furniture	.02
Ivory Coast					
petroleum products	.11	cocoa	.12	road vehicles	−.03
petroleum	−.06	wood, rough	.05	mach., elec.	−.03
gas	.01	coffee	.05	ships	−.02
coal	.01	meat, fresh	−.02	special transactions	.02
tin	.01	rice	−.02	aircraft	−.01
aluminium	−.00	fish, fresh	−.02	steel SITC 674	−.01
Japan					
petroleum	−.07	coffee	−.04	road vehicles	.10
petroleum products	.07	wood, rough	−.03	clothing	−.03
gas	−.02	cocoa	−.03	sound recorders	.03
iron ore	−.01	fruit, fresh	−.03	steel tubes	.02
copper	.01	meat, fresh	−.02	electrical machinery	.02
tin	−.00	wood, shaped	−.02	ships	.02
Malaysia					
petroleum	.04	wood, rough	.11	mach., elec.	−.03
tin	.04	veg oil, hard	.09	machinery SITC 718	−.03
petroleum products	−.03	rubber	.08	road vehicles	−.03
base metal	−.02	wood, shaped	.04	steel SITC 674	−.02
copper	−.01	sugar	−.02	ships	−.01
fertilizers	−.01	cocoa	.02	power machinery	−.01
Morocco					
fertilizers	.09	fruit, fresh	.06	special transactions	−.04
petroleum	.06	fish, fresh	−.04	inorganic elements	.04
sulphur	−.02	wheat	−.04	coal	−.02
tin	−.02	coffee	.03	road vehicles	.02
gas	.01	veg oil, hard	−.02	ships	−.02
petroleum products	.01	wood, rough	−.02	electrical machinery	.01

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Netherlands					
petroleum	−.24	meat, fresh	.02	plastic material	.03
gas	.07	veg material	.02	organic chemicals	.03
petroleum products	.05	veg,. fresh	.02	road vehicles	−.02
coal	−.01	coffee	−.02	ships	.02
fertilizers	.01	fruit, fresh	−.02	clothing	−.02
iron ore	−.00	fish, fresh	.01	special transactions	.02
New Zealand					
petroleum	.07	meat, fresh	.11	road vehicles	−.05
petroleum products	−.05	wool	.06	mach., elec.	−.02
aluminium	.02	butter	.05	steel SITC 674	−.02
fertilizers	−.01	milk	.04	plastic materials	−.02
gas	.00	sugar	−.02	machinery SITC 718	−.01
coal	.00	cheese	.01	woven textiles	−.01
Nicaragua					
petroleum products	−.04	cotton	.09	medicinal products	−.02
aluminium	−.01	cocoa	−.07	agricultural manufactures	−.02
coal	−.01	fruit, fresh	−.06	plastic materials	.02
base metal	−.01	fish, fresh	−.06	road vehicles	.02
iron ore	−.00	meat, fresh	.04	cement	−.02
tin	.00	paper	.02	mach., elec.	.02
Norway					
gas	.20	fish, fresh	.03	clothing	−.03
petroleum products	−.11	paper	.02	pig iron	.02
aluminium	.04	wheat	−.02	inorganic elements	−.02
petroleum	−.02	animal food	.02	road vehicles	−.02
base metal	−.01	meat, fresh	−.01	fertilizer manufactures	.01
nickel	.01	fish, tinned	.01	furniture	−.01
Pakistan					
petroleum products	−.15	rice	.06	clothing	.05
petroleum	.03	coffee	−.04	woven textiles	.03
tin	.01	fish, fresh	.03	agricultural manufactures	−.02
coal	−.01	sugar	.02	floor covering	.02
gas	−.01	cotton	.02	steel SITC 674	−.01
aluminium	−.01	fruit, fresh	−.02	fertilizer manufactures	−.01
Panama					
petroleum	.22	coffee	−.04	special transactions	−.05
petroleum products	−.09	cocoa	−.02	coal	−.04
tin	−.00	cotton	−.02	clothing	−.03
aluminium	−.00	fruit, fresh	.02	mach., elec.	.02
fertilizers	−.00	meat, fresh	.01	telecom equipment	−.02
base metal	−.00	wheat	.01	steel tubes	.02
Peru					
petroleum products	.16	wood, rough	−.05	special transactions	.02
petroleum	−.13	veg oil, hard	−.05	coal	.02
fertilizers	−.03	rubber	−.04	clothing	.01
copper	.02	fruit, fresh	−.03	inorganic elements	−.01
tin	−.02	wood, shaped	−.02	machinery SITC 718	.01
coal	−.01	fish, fresh	.02	telecom equipment	.01

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Philippines					
petroleum	.11	tea	−.06	clothing	−.04
base metal	.03	sugar	.06	special transactions	.03
petroleum products	.02	fish, fresh	.05	mach., elec.	−.02
silver	.02	rubber	−.04	steel forms	−.01
tin	−.02	cocoa	.02	pearl	−.01
gas	.01	veg oil, hard	.02	power machinery	−.01
Portugal					
petroleum	.19	maize	−.03	special transactions	−.05
petroleum products	−.12	fish, fresh	−.02	coal	−.03
tin	−.01	oil seeds	−.02	road vehicles	−.03
fertilizers	−.01	cotton	−.02	textile products	.02
aluminium	−.01	pulp	.02	clothing	.02
coal	.00	alcoholic beverages	.01	woven textiles	.02
Saudi Arabia					
petroleum products	.18	wood, rough	−.04	road vehicles	−.02
gas	−.03	fish, fresh	−.04	special transactions	.02
petroleum	−.03	veg oil, hard	−.04	inorganic elements	.02
tin	−.02	rubber	−.03	mach., elec.	−.02
aluminium	−.02	coffee	.03	coal	.02
base metal	.01	meat, fresh	.02	power machinery	−.01
Singapore					
petroleum	−.23	coffee	.03	special transactions	.06
petroleum products	.17	fruit, fresh	.01	coal	.04
gas	.01	fish, fresh	.01	mach., elec.	−.03
tin	.01	rubber	.01	telecom equipment	.02
fertilizers	−.00	veg oil, hard	.01	clothing	−.02
coal	.00	sugar	−.01	steel tubes	−.01
Spain					
petroleum products	−.04	fruit, fresh	.03	road vehicles	.07
gas	−.02	maize	−.02	special transactions	−.04
iron and steel	−.01	oil seeds	−.02	iron SITC 673	.03
fertilizers	−.01	meat, fresh	−.02	clothing	−.03
tin	−.01	rubber	−.01	mach., elec.	.03
copper	.01	veg oil, hard	−.01	telecom equipment	−.02
Sri Lanka					
petroleum products	.06	tea	.10	clothing	.03
petroleum	−.02	sugar	−.05	woven textiles	−.02
fertilizers	.02	coffee	−.05	organic chemicals	.02
tin	−.01	rice	−.04	woven textiles	−.01
aluminium	.01	cocoa	.04	steel SITC 674	.01
base metal	−.01	rubber	.03	textile yarn	−.01
Sweden					
petroleum products	.05	paper	.07	road vehicles	.06
gas	.02	coffee	−.05	clothing	−.05
iron ore	.01	fruit, fresh	−.05	telecom equipment	.03
coal	.01	pulp	.03	special transactions	.02
petroleum	.00	wood, shaped	.03	electrical machinery	−.02
electric energy	−.00	fish, fresh	.02	sound recorders	−.01

Table 6.14 (continued)

Resources		Agriculture		Manufacturing	
Switzerland					
petroleum	.09	fruit, fresh	−.03	road vehicles	−.07
petroleum products	−.03	coffee	−.02	clothing	−.05
coal	.01	cocoa	−.02	watches	.04
gas	.01	meat, fresh	−.01	medicinal products	.03
aluminium	.01	fish, fresh	.01	mach., elec.	.03
base metal	.00	alcoholic beverages	−.01	textile machinery	.03
Thailand					
petroleum products	−.09	rice	.08	special transactions	−.04
gas	−.03	veg., fresh	.06	clothing	−.03
tin	.01	tea	−.06	woven textiles	.02
base metal	−.00	sugar	.05	mach., elec.	.02
iron and steel	−.00	fish, fresh	.04	woven textiles	.01
copper	−.00	maize	.02	coal	−.01
Trinidad and Tobago					
petroleum products	.32	fish, fresh	−.03	mach., elec.	−.04
petroleum	.09	meat, fresh	−.01	ships	−.03
gas	−.03	veg., fresh	−.01	machinery SITC 718	−.02
aluminium	−.01	wheat	−.01	aircraft	−.02
coal	−.01	paper	.01	inorganic elements	.02
iron ore	−.01	cocoa	.01	road vehicles	−.02
Turkey					
petroleum	−.07	cotton	.04	textile yarn	.03
petroleum products	−.02	fruit, fresh	.04	organic chemicals	−.02
other minerals	.01	tobac., unman.	.04	cement	.02
gas	−.01	animals	.04	special transactions	−.02
iron and steel	−.01	tea	−.03	floor covering	.02
tin	−.01	sugar	.02	power machinery	−.02
United Kingdom					
petroleum products	−.11	meat, fresh	−.02	mach., elec.	.06
gas	−.06	fruit, fresh	−.02	aircraft	.03
petroleum	−.03	paper	−.01	machinery SITC 718	.03
silver SITC 681	.01	alcoholic beverages	.01	power machinery	.03
fertilizers	.01	fish, fresh	.01	power machinery	.02
aluminium	−.01	veg., fresh	−.01	steel tubes	.02
United States					
petroleum products	−.17	oil seeds	.02	mach., elec.	.05
petroleum	−.15	maize	.02	aircraft	.03
gas	−.06	animal food	.01	machinery SITC 718	.03
coal	.01	fish, fresh	.01	ships	.02
fertilizers	.01	meat, fresh	−.01	office machines	.02
aluminium	−.00	wood, shaped	.01	electrical machinery	.02
Yugoslavia					
gas	−.06	fruit, fresh	−.03	footwear	.05
petroleum products	−.06	rubber	−.02	organic chemicals	−.03
petroleum	.05	fish, fresh	.02	furniture	.02
aluminium	.01	tea	−.02	road vehicles	.02
coal	−.01	pulp	−.01	clothing	.02
base metal	−.01	cotton	−.01	power machinery	.02

explanation of trade in petroleum products. Part of the problem may be the difficulty of predicting the location of petroleum refineries, which may indeed be greatly influenced by policy interventions. After petroleum, fish is a problem commodity. This is suggestive of an omitted resource variable: coastline or access to fisheries. Coffee and fruit are also problem commodities. The land variables include land suited to tropical agricultural production, and in principle this should help explain trade in coffee and fruit. Is it possible that trade in these items is influenced by policy interventions? The one clear positive note is that clothing is the manufactured commodity for which the interventions seem most significant. That seems to square well with the facts.

Table 6.14 contains the same information for each country. A negative number in table 6.14 means that actual net exports are less than predicted by the model. Either exports are too small or imports too great, at least as judged by the behavior of the other countries in the sample. A positive number means that net exports are large compared with the other countries; either exports are too large or imports too small. A positive number thus suggests either an export subsidy or an import barrier, higher than other countries'. A negative number, on the other hand, suggests either an unusually low export subsidy or an unusually low import barrier. In a word, positive means relatively protected, negative relatively unprotected.

Take a good look at this table and try to form a judgment as to whether it gives a sense of the products that are significantly affected by trade barriers. Keep in mind, however, that products with small valuation at the three-digit SITC level cannot appear in these tables since their residuals would be correspondingly small.

Consider the first country, Argentina, which has one of the lowest overall R^2's. Ten percent of its sum of absolute residuals is due to overpredicting fish net exports, 8 percent from underpredicting petroleum products net exports, and so forth. The data suggest that Argentina's fish sector is relatively unprotected and that the petroleum products sector is protected or subsidized, compared with other countries.

Look at a couple of other countries, say, the United States and Japan. The United States has unpredictably low levels of net exports of petroleum products and petroleum, but appears to protect or subsidize machinery and aircraft. Japan protects or subsidizes road vehicles. Japan's unusually high net exports of petroleum products are offset by unusually low net exports of petroleum. Incidentally, this feature recurs for many countries and suggests that the model is incapable of explaining the location of petroleum refining. The measures that depend on these residuals therefore need to be viewed with suspicion.

As I examine these results, I am left with a feeling of skepticism regarding the usefulness of the adjusted trade intensity ratios as indicators of trade barriers. I see tastes (Japan's coffee), omitted resources (Iceland's fish), and historical accidents (Switzerland's watches). I am not sure that I see trade barriers. What seems clear is that, in the absence of direct measures of barriers, it will be impossible to determine the degree of openness for most countries with much subjective confidence.

Notes

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1. This model leaves unspecified certain details of the structure of world demand and supply that would determine international product prices. These prices may change in response to changes in technology, shifts in world trade barriers, or worldwide growth of factor supplies. Policy analysis and econometric estimation that take international product prices as exogenous will nonetheless be appropriate provided that countries are small enough that internal events such as the imposition of trade barriers have no noticeable effects on international prices.

2. Here I am assuming that the tariff proceeds are redistributed in a lump sum or that the government utility function conforms with the private sector.

3. In the Bayesian language, it would be better to say that the unobservables are treated as if they came from a distribution with an infinite variance.

4. These numbers have been truncated after two decimals, and the columns for R, A, and M therefore appear not to add to the column for O.

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Comment Drusilla K. Brown

Measures of the degree to which countries interfere with international commerce have typically been based on a bottom-up approach: measuring tariff and nontariff barriers, product by product and country by country. Alternatively, one could estimate a theoretical model that could predict the pattern and volume of trade under free trade conditions. The degree to which countries are "open" can be evaluated by comparing actual trade with the pattern of free trade predicted by the

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model. Countries that deviate most from the trade pattern predicted by the model would be deemed relatively more protectionist.

This second approach is adopted by Leamer in chapter 6, "Measures of Openness." In this chapter, factor endowments of land, labor, capital, oil production, and minerals, along with distance and the trade balance, are used to predict net trade within a product category for each country. Net trade within a product category is regressed on factor endowments for a cross section of countries. A separate equation is estimated for each product category.

While this model does not predict the pattern of trade under free trade conditions, it would predict trade if each country were to adopt the world's average level of protection. Thus, a country that trades less than the model predicts must have a higher than average level of protection, and those that trade more have a lower than average level of protection.

This is an extremely ambitious project and will yield information of great interest to both academic economists and policymakers. This approach is also a great improvement over measuring openness by calculating imports and exports as a fraction of GNP. As the chapter points out, such an approach merely indicates the degree to which countries differ in their factor endowments, not in the level of protection.

The question I address first is, What does this approach tell us? Suppose for a moment we really have found the true model that predicts trade, and we have found a country and product for which the regression equation fits the pattern of trade poorly. This procedure will tell us how a country's trade pattern is deviating from the average trade pattern for countries similarly endowed. If that is what we mean by "openness," this is an appropriate procedure.

However, will this approach tell us which countries are most protectionist? In a two-country model, if one country is protectionist the trade for both partners will deviate from the free trade pattern, and thus both countries will appear "closed" by this measure. Nonetheless, in a world of more than two countries the problem is not very damaging. If in a multicountry system some countries are open and trade mutually, we would expect that their actual trade pattern would be closely correlated with the free trade pattern, although countries close to protectionist countries may trade less than expected.

A second problem along these lines was noted in the chapter. The model will give misleading results if similarly endowed countries adopt similar structures of protection. Countries following the protection standard will appear normal, while countries with peculiar structures of protection will be singled out.

According to the measures used in the chapter, a country that is peculiar in its choice of intervention may be "open" as measured by the adjusted trade intensity ratio, but will also have a high index of intervention. This discrepancy occurs because the measure of openness compares the total amount of actual trade to the total amount of predicted trade. The intervention index, on the other hand, focuses on the absolute value of the residuals, thus checking to see if a country is trading in the "right" product categories. Therefore, a country that has a level of protection equal to the world average but applying to unusual product categories will have an appropriate level of trade but in the "wrong" product categories. As a result, the intervention index will be high.

A third problem with the interpretation of results will arise if some factors have a variable supply. Trade barriers that raise the return to capital will increase a protectionist country's "endowment" of capital over time. Consequently, if protection in a country has occurred over several years, such a country may cease to appear protectionist.

Problems with interpretation, however, do not pose insurmountable obstacles. If we accept the approach, then the next step is the choice of a theoretical model. The model chosen must satisfy very stringent conditions, for it is insufficient that it be a model with some statistical power to explain the pattern of trade. Rather, it must be *the* model of international trade, for all residuals are attributed to protection.

The framework chosen in the chapter is the n-factor n-good version of the Heckscher-Ohlin model. It is hard to imagine that the $n \times n$ version of the Heckscher-Ohlin theorem adequately explains the actual pattern of trade for the purposes of this study. Factor endowments undoubtedly play a role in determining the pattern of trade in goods, but there are many other factors, such as differences in taste and the presence of scale economies.

Scale economies, in particular, pose problems for the factor proportions theory. A small country may be heavily endowed with an input used intensively in the production of a particular good but may not be large enough to accommodate a firm that fully exploits the available economies of scale. Consequently, the small country may specialize in the production of goods produced with constant-returns-to-scale technology, while a large country specializes in the increasing-returns-to-scale industry. In this event, the model will be biased toward the result that small countries are more open than large countries in goods produced with increasing returns to scale but less open in goods produced with constant returns to scale. For example, scale economies and country size may explain the unusually large exports of aircraft by the United States or the absence of Austria's exports of road vehicles.

A second problem associated with scale economies is that in industries dominated by monopolistically competitive firms, trade may occur even between countries with identical tastes and factor endowments. In cases where a single monopolistically competitive industry straddles two or more product categories, trade in goods will be driven by product differentiation. Factor endowments may have little explanatory power.

A second difficulty with applying the Heckscher-Ohlin model to this problem is that higher dimensional trade theory does not predict the commodity composition of trade when the number of goods exceeds the number of factors. Rather, only the direction of factor trade is predictable. As a result, it would be more appropriate to use net factor trade as the dependent variable rather than net commodity trade.

For example, watches from Switzerland and beverages from France are offered as cases in which the model performed poorly because of omitted factors of production or as the result of an "accident of history." Similarly, the model had difficulty predicting the location of petroleum refining. Given the indeterminacy of the pattern of trade in goods when the number of goods exceeds the number of factors, it is likely that accidents of history will indeed affect the pattern of trade in goods.

Comparing actual trade against predictions of the $n \times n$ Heckscher-Ohlin theorem thus may be largely a measure of the inadequacies of this model, rather than a measure of trade barriers. This is similar to the criticism applied to the simple technique of calculating trade as a fraction of GNP, which is primarily a measure of the disparity of factor endowments among countries.

However, adopting net factor trade as the dependent variable will sidestep the indeterminacy problem when the number of goods exceeds the number of factors and should help to resolve some of the difficulties associated with trade in products produced with increasing returns to scale by monopolistically competitive firms. No matter what the pattern of trade in goods in these two instances, it should still be the case that factors of production embodied in the net trade bundle will unambiguously reflect relative factor abundance in the absence of protection. In these instances, the model predicting trade in goods may perform poorly, while a model predicting trade in factors could capture the essence of trade fairly well.

Despite these problems, some of the results presented in the chapter are highly effective in challenging conventional wisdom. For example, according to this study Japan is not dramatically more protectionist than the United States, and for most calculations Japan appears to have less intrusive barriers to trade. This is a result that many trade economists and Japan specialists suspect to be the case, but is not widely accepted outside of the profession. However, some of the results are impossible to believe. For example, according to this study one of the least protected industries in the United States is meat. Similarly, the results suggest that meat is an unprotected sector in Japan, which is clearly not the case.

This method of detecting protectionism is nevertheless very promising. The fundamental problems can be addressed simply by adding a few more factors of production, such as coastline for fishing and tropical weather conditions, and adopting a more general model that can accommodate accidents of history, scale economies, and trade pattern indeterminacies of the Heckscher-Ohlin model.