The Case of the Missing Trade and other Mysteries: Comment

Data Appendix

A. Rescaling of the estimation equation: Importance to analysis

Rescaling the estimation equation is often used in estimation to ensure that the resulting errors of regression are homoskedastic. Trefler recognizes that there are two sources of heteroskedasticity in these panel data -- the differences in factors, and the differences in countries. He creates a weighting scheme for his data, with each observation x_{jc} divided by the product $ó_j^T s_c^{1/2}$. The variable $ó_j^T$ is created from the data, and is the factor-specific standard error under the null hypothesis. The variable s_c is the share of world expenditure undertaken by country c.

In general, and without prior information on the distribution of errors, the appropriate weighting of observations ($ó_j^*$, $ó_c^*$) can be calculated simultaneously (or iteratively) with the parameter estimates. In the HOV model, the natural starting point for weights is the distribution of errors under the null hypothesis.[1] The weights can be derived iteratively so that

$$e_{jc} = a_{jc} - (v_{jc} - s_c)$$

has a constant standard error across factors (j) and across countries (c). This will remove the systematic heteroskedasticity along these two dimensions under the null hypothesis. My calculations of such weights for factors (indf) and countries (indc) yielded the following:

indf	$ó_j^*$	indc	$ó_c^*$	indc	$ó_c^*$
1	1.37175	1	0.83748	18	0.04725
2	1.84318	2	0.60635	19	0.44950
3	1.09834	3	1.42268	20	0.79418
4	3.05412	4	0.08276	21	1.66876
5	1.97881	5	0.71924	22	0.10829
6	8.37419	6	0.27012	23	0.01162
7	2.28436	7	0.01669	24	0.22652
8	3.76270	8	0.16834	25	0.07907
9	8.60013	9	0.11545	26	0.11374
		10	0.10655	27	0.69962
		11	0.04132	28	0.64638
		12	0.03601	29	0.22940
		13	0.32195	30	0.10424
		14	0.06866	31	0.15735

15	0.09891	32	0.56417
16	0.12709	33	2.68240
17	0.09708		

Although the $ó_j$ in the first iteration was identical to the $ó_j^T$ of Trefler, the figures varied somewhat as the balance between the factor dimension and the country dimension was achieved.

Trefler calculated (with one iteration) a scaling for systematic differences across factors, but used the square root of the country's expenditure share to "correct" for country-specific heteroskedasticity. Unfortunately, this measure had less-than-complete correlation with the weights I derived.

The choice of scaling factor is particularly important in this instance because the data come in such different scales that the resulting errors under the null hypothesis fail a test of normality. I perform Shapiro-Wilk tests of normality on three sets of errors: those defined by e_{jc} in equation (8) of the text (i.e., the data have already been divided by the world factor endowment), those derived using Trefler's scaling scheme (superscript T), and those created using the scaling reported above (superscript *). The results were

	Shapiro-Wilk	prob value
e_{jc}	0.61	0.000
e_{jc}^T	0.72	0.000
e_{jc}^*	0.98	0.09

Only in the final case do we fail to reject the hypothesis of normality of errors.

Once the null hypothesis of the HOV model is rejected, both Trefler and I move on to explore alternative theories to explain the country-specific and factor-specific variation noted in the data. Introduction of the anti-trade bias coefficients necessitate another iterative adjustment to the scaling factors -- in its absence the errors from these equations once again exhibit heteroskedasticity and throw into question the standard errors used in hypothesis testing. The hypothesis tests presented in Table 3 of this paper are conducted after an iterative calculation of weights to approximate normality of errors.

B. The factor-immobility hypothesis.

Consider the possibility that factor-price equalization has not occurred leaving factor-use ratios differing across countries. I first define (continuing the notation in the text) two benchmark factor-use matrices against which country-specific factor-use can be compared. The first benchmark (**A**) is the average technology implied by world full-employment conditions:

(A1) $$\mathbf{A}\,\mathbf{X}_w = \mathbf{V}_w$$

The second benchmark technology (**A***) describes the factor-use ratios observed in each comparative-advantage country for the given commodity price vector, and will be appropriate for goods entering international trade. Each column is drawn from the comparative-advantage country for that good.

Each country c has a factor-use matrix $\mathbf{A}_c$ that potentially differs from these. It has its own full-employment condition as well, which contributes to world full-employment, as in (1) and (2) in the text. In this sense, the benchmark matrix **A** is a weighted average of the country-specific $\mathbf{A}_c$, with weights corresponding to country c share of total world output of each good.

Given these definitions, it is evident that the factors embodied in the trade vector $\mathbf{T}_c$ should be measured using $\mathbf{A}^*$. Given the production technology $\mathbf{A}_c$, and the production and consumption vectors ($\mathbf{X}_c$ and $\mathbf{E}_c$), the identity (A2) defines the factor-equivalent consumption "technology" $\mathbf{A}_{Ec}$ implicitly.

(A2) $$\mathbf{A}^*\,\mathbf{T}_c \equiv \mathbf{A}_c\,\mathbf{X}_c - \mathbf{A}_{Ec}\,\mathbf{E}_c$$

With perfect mobility of factors within each economy and under conditions leading to factor-price equalization, these factor-use matrices (**A**, **A***, and $\mathbf{A}_c$, $\mathbf{A}_{Ec}$ for each country c) will converge element-by-element to the Heckscher-Ohlin factor-use matrix $\mathbf{A}_{HO}$. For a given change in the commodity-price vector

that provides an incentive to reallocate, as the degree of factor immobility increases the degree of

divergence of these matrices from $\mathbf{A_{HO}}$ increases.

Unfortunately, the factor-use matrices $\mathbf{A}^*$ and $\mathbf{A_{Ec}}$ are unobserved. An estimation strategy must

address this. Appeal to factor-price equalization and identical factor-use ratios across countries is one such

solution, with one country's factor-use matrix $(\mathbf{A_U})$ used to represent all. This was Trefler's strategy, with

the one country being the US. If the more general case of country-specific A_c is correct, then this

simplification will introduce estimation biases. Specifically, Trefler uses the US factor-use matrix $(\mathbf{A_U})$ to

construct an observable factor-equivalent trade vector and assumes that $\mathbf{A} = \mathbf{A_{Ec}} = \mathbf{A_U}$. Given the factor-

use matrices defined above, the full-employment condition must be rewritten as:

(A3) $\qquad\qquad\qquad \mathbf{A}^* \, \mathbf{T_c} = \mathbf{V_c} - \mathbf{A_{Ec}} \, S_c \, \mathbf{X_w}$

$\qquad\qquad\qquad \mathbf{A_U} \, \mathbf{T_c} + (\mathbf{A}^* - \mathbf{A_U}) \, \mathbf{T_c} = \mathbf{V_c} - S_c \, [\mathbf{V_w} - (\mathbf{A} - \mathbf{A_{Ec}})\mathbf{X_w}]$

(A4) $\qquad\qquad\qquad \mathbf{A_U} \, \mathbf{T_c} = [\mathbf{V_c} - S_c \, \mathbf{V_w}] + S_c \, (\mathbf{A} - \mathbf{A_{Ec}}) \, \mathbf{X_w} - (\mathbf{A}^* - \mathbf{A_U}) \, \mathbf{T_c}$

The Trefler formulation has the left-hand dependent variable, but includes only the first term on the

right-hand side. In this more general statement of trading equilibrium for country c there are two potential

biases to using the Trefler formulation. The first bias (represented by the second term on the right side of

(A4)) is non-zero when there are differences between the elements of A and A_{Ec}. The second bias

(represented by the last term in (A4)) is non-zero when the factor-use ratios for the US in each traded good

differ from those of the comparative-advantage countries.

Conway (1998) provides a detailed derivation and estimation of these biases. For this paper, it

suffices to indicate that the biases from non-zero $(\mathbf{A}-\mathbf{A_{Ec}})$ elements were statistically insignificant in the

Trefler data. However, the bias from non-zero elements of $(\mathbf{A}^* - \mathbf{A_U})$ was important. Define the factor-

embodied trade vector created by Trefler as $\mathbf{F_c} = \mathbf{A_U} \, \mathbf{T_c}$. Consider without loss of generality the first row of

vector expression (A4), where for simplicity the elements of the matrix $(\mathbf{A}-\mathbf{A_{Ec}})$ are set equal to zero.

(A5) $$\mathbf{F_{1c}} = [\mathbf{V}_{1c} - S_c\, \mathbf{V_{1w}}] - (\mathbf{A_1}^* - \mathbf{A_{1U}})\, \mathbf{T_c}$$

The second term of the right-hand side can be decomposed as:

(A6) $$(\mathbf{A_1}^* - \mathbf{A_{1U}})\, \mathbf{T_c} = [(A_{11}^* - A_{11U})/A_{11U}]\, A_{11U}\, T_{1c} + [(A_{12}^* - A_{12U})/A_{12U}]\, A_{12U}\, T_{2c} + ...$$
$$+ [(A_{1n}^* - A_{1nU})/A_{1nU}]\, A_{1nU}\, T_{nc} \qquad \text{for n commodities}$$

Define the coefficients $\tilde{a}_{1i} = [(A_{1i}^* - A_{1iU})/A_{1iU}]$. These represent the percent by which the factor-use ratio to produce good i in the comparative-advantage country deviates from the same ratio observed in production in the US. The theory behind the $\tilde{a}_{ji}$ is based on factor reallocation costs. If, for example, these costs are losses in productivity in the new industry (when compared to factors already in that industry), then the quantity of factors reallocated will be less because the costs of moving factors are positive. In that case, use of scarce factors in the contracting industries will be relatively more intensive, while use of the abundant factors in the expanding industry less intensive, than under perfect mobility. (A6) can then be simplified as:

(A7) $$(\mathbf{A_1}^* - \mathbf{A_{1U}})\, \mathbf{T_c} = \Sigma_i\, \tilde{a}_{1i}\, A_{1iU} T_{ic}$$

Note that the $\tilde{a}_{ji}$ will not differ by trading country. They may differ by factor, however, reflecting the degree of factor immobility in the US. When the US is an exporter of the good, then $\tilde{a}_{ji}$ is zero; when the US is an importer of the good, then $\tilde{a}_{ji}$ is positive. Combining (A5) and (A7), stating all variables as shares of world factor endowment as in the text, and adding a measurement error e_{jc}, yields (A8) for factor j.

(A8) $f_{jc} = v_{jc} - S_c - Ó_i \tilde{a}_{ji} A_{jiU}T_{ic}/V_{jw} + e_{jc}$

While the $\tilde{a}_{ji}$ are not identifiable without detailed microeconometric work, we can characterize an average $\tilde{a}_j$

that will be observed in the data when factor reallocation is costly. First, it will be positive on average.

Second, for non-US countries the positive elements of $\tilde{a}_{ji}$ will be multiplied by positive elements of the

embodied-factors trade vector $f_{jc} = A_{jU}T_{ic}/V_{jw}$, since the non-US countries will on average be exporters to

the US. The zero elements of $\tilde{a}_{ji}$ will symmetrically be multiplied by negative elements of f_{jc} on average.

There can thus be a magnification of the factor-immobility effect in the observed data. (Third, at this level

of aggregation the $\tilde{a}_j$ could have a country-specific component – but one unrelated to productivity

differences across countries. I ignore that for simplicity in what follows.)

　　　If I introduce the average $\tilde{a}_j$ into (A8), then the estimation equation becomes:

$$f_{jc} = v_{jc} - S_c - \tilde{a}_j Ó_i A_{jiU}T_{ic}/V_{jw} + e_{jc}$$

$$= v_{jc} - S_c - \tilde{a}_j f_{jc} + e_{jc}$$

(A9) $f_{jc} = (1/(1+\tilde{a}_j))[v_{jc} - S_c + e_{jc}]$

This is the element-by-element form implied by equation (13b) in the manuscript. Each diagonal element of

$\hat{e}$ takes the value $(1/(1+\tilde{a}_j))$.

1. An alternative approach would be to use the White (1980) correction for heteroskedasticity.

As the source of heteroskedasticity is transparent in this case, I implement the more efficient

generalized least-squares correction.