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The Differential-Productivity Hypothesis and Purchasing-Power Parties: Some New Evidence*

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Abstract

The structure of prices of goods entering into international trade relative to those that do not plays a key role in the Balassa-Samuelson explanation of why countries' exchange rates differ systematically from their currencies' purchasing power. The B-S analysis leads to the proposition that the tradable–nontradable price difference is lower for rich countries than for poor. This paper examines the gap, using prices collected by the International Comparison Programme. A variety of regressions were run to see if indeed the difference between tradable and nontradable price parities moved with income in the way B-S expected. They did.

1. Introduction

This paper examines the Balassa (1964) -Samuelson (1964) (B-S) differential-productivity model as an explanation of a principal finding of the United Nations International Comparison Programme (ICP), that a country's price level, the ratio of the purchasing-power parity (PPP) of its currency to its foreign-exchange rate, will be greater the higher its per capita income. Since this empirical finding can be explained in other ways as well, we look here in detail at one of the important links in the Balassa-Samuelson argument to verify that an intermediate part of their model also holds. Specifically, we are concerned with how prices of nontradable goods relative to those of tradables vary with country income. In the B-S model, the price-level proposition follows from a decreasing ratio of tradable to nontradable prices as income increases, since the real share of nontradables is relatively flat with respect to income. A more direct approach to the verification of B-S, an examination of actual productivity in the tradable and nontradable sectors of rich and poor countries, would be better, of course, but the data demands for this are prohibitive. Nonetheless, some relevant remarks along these lines are presented below.

The Organization of European Economic Co-operation studies of Gilbert and Kravis (1954) and Gilbert & Associates (1958) provided some early empirical evidence on the systematic PPP/exchange rate relationship for a small number of relatively homogeneous countries of western Europe. The first of the ICP benchmark studies (reported initially in Kravis, Kenessey, Heston, and Summers [1975] and more

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completely in Kravis, Heston, and Summers [1978]), covering the year 1970, provided additional empirical support for a larger number of countries covering a much wider range of national incomes. Incidentally, this 1970 study also allowed a view of the relative prices of tradables and nontradables. A preview of what is to come here is given in figure 1a, where a graph depicts the view from the initial ICP window on the tradables-nontradables relationship modelled in the B-S papers. (Two regression curves appear in the graph as part of a mild effort to judge the robustness of the empirical finding by considering two different definitions of tradables and nontradables. The distinction in definitions is described below.)

Alternative formulations that appear consistent with the ICP price-level finding have been put forward by, for example, Bhagwati (1984), Clague (1985), Kravis and Lipsey (1987, 1988), Panagariya (1988), and Quibria (1990). Bergstrand (1991) has attempted to sort out the differential-productivity and factor-endowments explanations from a demand-based explanation, and has found that all three have some explanatory value. These alternative explanations are generally complementary to the B-S formulation, and Bergstrand's effort notwithstanding, it is difficult to set out appropriate empirical tests, given the available data sets, to discriminate between these alternative explanations.

How well does the B-S formulation about the tradable vs. nontradable price relationship stand up, across countries and time? With the exception of Kravis and Lipsey (1988), most of the empirical work done so far has concentrated on the data of only the first two ICP benchmark studies. These covered 1970 and 1975, the years that bridged the major exchange-rate changes of 1973, and involved only 34 countries.[1] Here we draw on the data of the 1980 and 1985 benchmark studies also to see the experience of a total of 85 countries in what might be regarded as a less unusual time period.

Section 2 sets out a very simple version of the differential-productivity hypothesis that is consistent with the B-S model and also provides some background material on the closely related subject of service vs. commodity production. In section 3 evidence bearing on the hypothesis is examined which is based on aggregate data from the successive ICP benchmarks. Some of the difficulties of defining tradables and nontradables are taken up, and an alternative definition of tradables is considered. Section 4 examines the differential-productivity hypothesis from a slightly different standpoint by dealing with data at a disaggregated level well below the simple two-category breakdown of tradables vs. nontradables. Section 5 provides a conclusion.

2. A Simple Differential-Productivity Formulation

The Balassa-Samuelson Model

In our presentation we follow Balassa, who assumed competitive labor markets between sectors producing tradable and nontradable goods, and that prices are equal to marginal costs. The critical premise is that productivity differentials between rich countries and poor are greater in the production of commodities than services, and that, generally speaking, commodities are likely to be tradable and services nontradable. These assumptions allow one to derive the proposition that the prices of tradables relative to nontradables will be lower in rich countries than in poor countries. (A somewhat more formal statement is provided in Kravis, Heston, and Summers [1983, pp. 211–15].) As remarked above, the 1970 empirical facts shown in the graph of figure 1a bear this out.

A heuristic explanation of what is going on is provided in figure 2 (but note that figure 2 is also consistent with the Bhagwati factor-proportions explanation that the production of nontradables is more labor intensive than the production of tradables in both poor and rich countries). In figure 2 the capital-labor ratio in tradable and nontradable production is on the horizontal axis, and the marginal physical products (MPPs) of labor for tradables and nontradables are on the vertical axis. The left vertical axis is the scale for tradables and the right is the scale for nontradables, each expressed in physical units. (In this section, to facilitate the exposition, rich-country

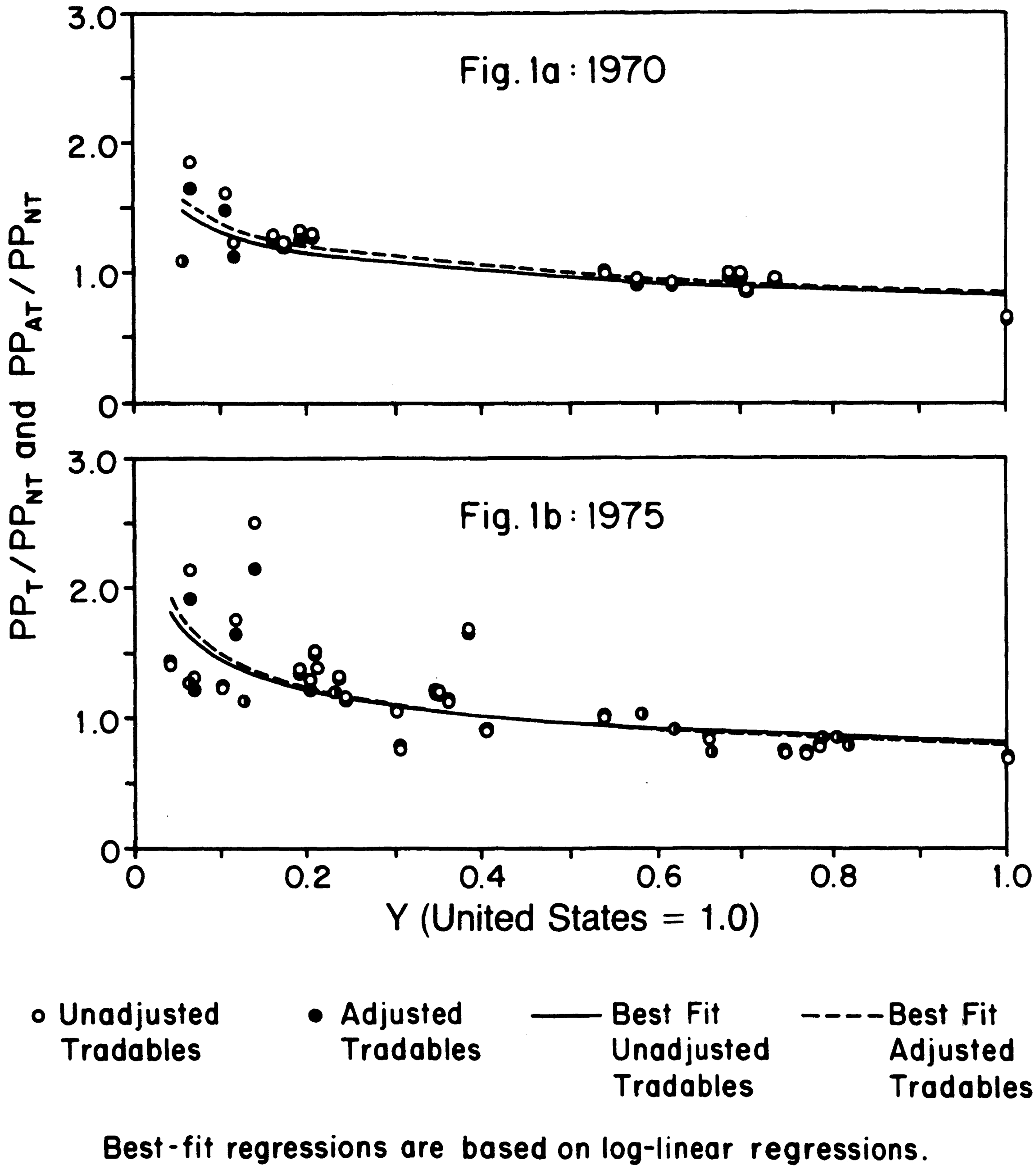

Figure 1. The Ratio of Tradable Price Parity to Nontradable Price Parity versus G.D.P. per capita: 1970, 1975, 1980, 1985

$$\left(\frac{PP_T}{PP_{NT}}\right) = \alpha_0 \cdot \left(\frac{GDP}{Pop.}\right)^{\alpha_1}$$

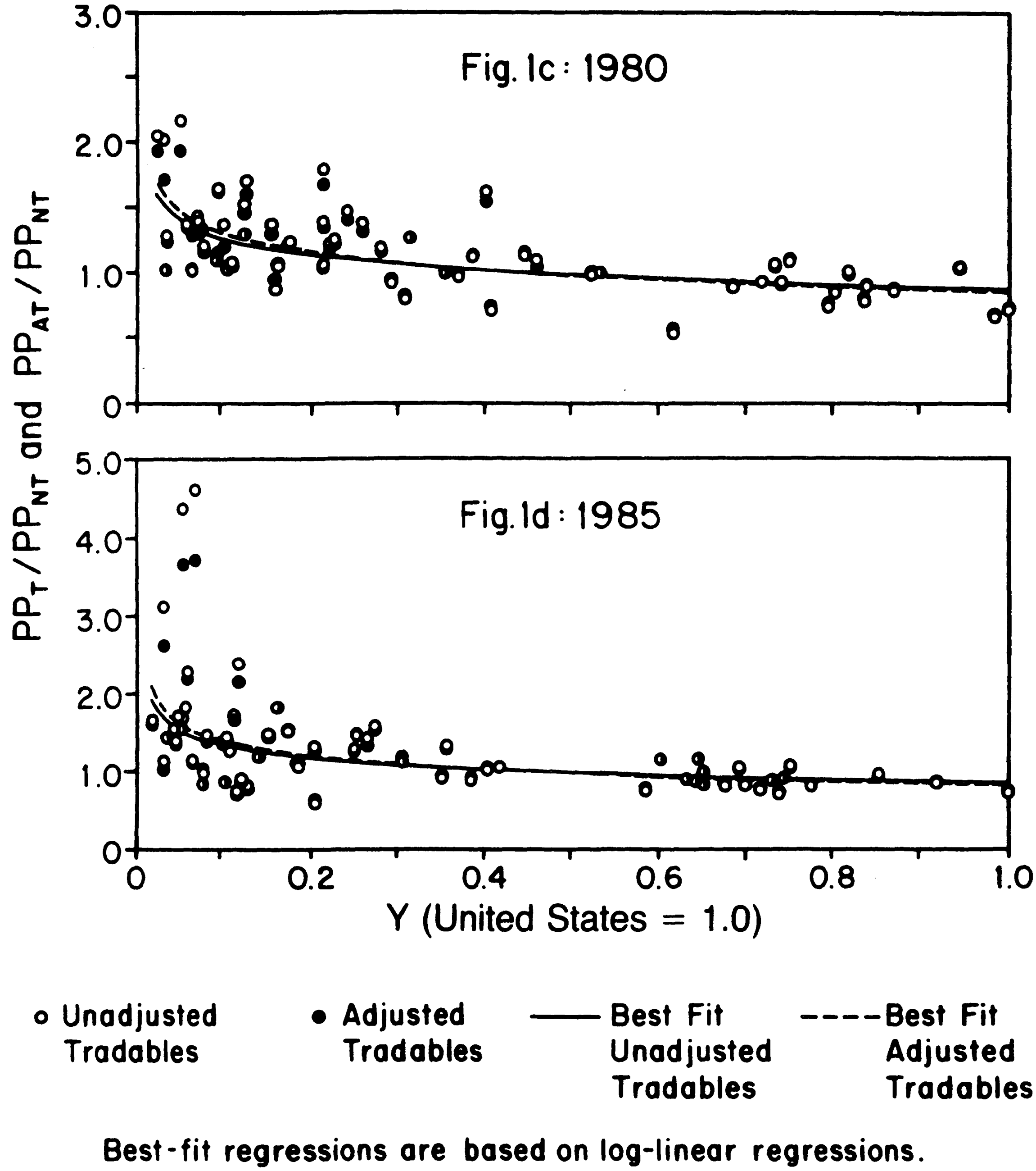

Figure 3. Continued

and poor-country variables will be denoted by upper- and lower-case symbols, respectively.) The poor country is operating with capital-labor ratios $(k/l)_{NT}$ for nontradables and $(k/l)_T$ for tradables, with MPPs of $\boldsymbol{a}$ and $\boldsymbol{b}$; and the rich country is operating at $(K/L)_{NT}$ and $(K/L)_T$ with MPPs of $\boldsymbol{A}$ and $\boldsymbol{B}$. Assume without loss of generality that the exchange rate between the poor and rich countries is 1.0 and the price of tradables in the rich country, P_T, is also 1.0. If there are no transport costs and the law of one price holds for tradables, then the price of tradables in the poor country, p_T, will also be 1.0. If labor is paid its marginal revenue product, then the wage rate in the tradable sector in the rich country, W_T, will be $\boldsymbol{A}$, and the wage rate in the poor country, w_T, will be $\boldsymbol{a}$. Competitive labor markets would equalize wages

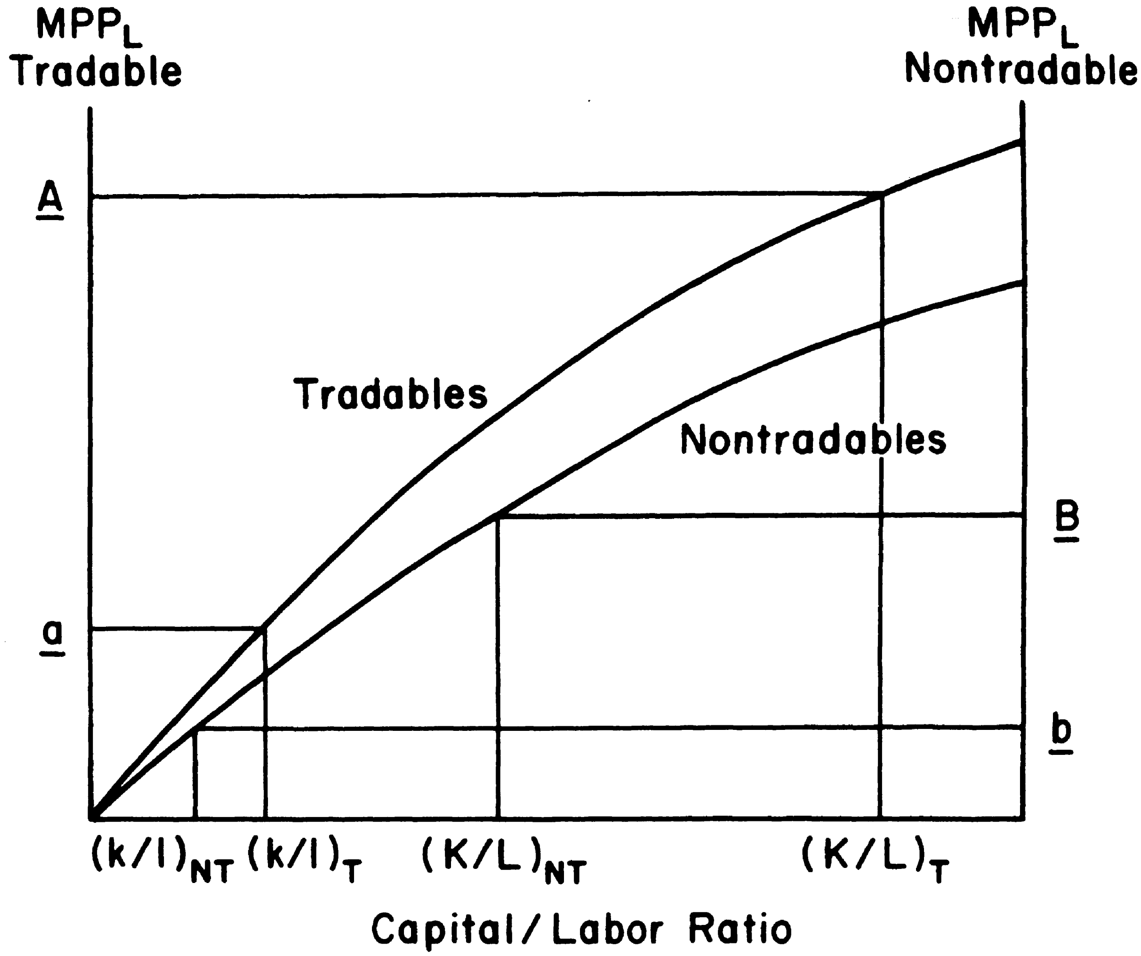

Figure 2. A Schematic Illustration of the Differential Productivity Hypothesis for a Rich and Poor Country

in the nontraded and traded sectors in both countries. The marginal cost in nontradables will be the wage divided by the MPP of labor, so in the rich country

$$P_{NT} = MC_{NT} = \mathbf{A/B},$$

and in the poor country

$$P_{NT} = mc_T = \mathbf{a/b}.$$

By the assumption above, figure 2 is drawn so that $\mathbf{b/a} > \mathbf{B/A}$. Therefore, the productivity differential between rich and poor countries is greater in tradables than nontradables. It follows that $P_{NT} > p_{NT}$. Since the PPP is an average of the prices of tradables and nontradables, the PPP of the poor country will be below the exchange rate. Its price of tradables is the same as the rich country's, but its price of nontradables is lower. This implies a tendency for the ratio of the tradable price to the nontradable price to decline with the level of per capita income, and this is just what is displayed in figure 1a.

A Brief Survey of Received Views on the Production of Services vs. Commodities

The historic generalization about services rising with the affluence of countries is associated with Colin Clark as set forth in *Conditions of Economic Progress* (1941).

Clark (1979) continued to assemble evidence on service-productivity levels and growth. His conclusion was that though the growth in service-sector productivity was greater than typically thought, it still was below that in commodity production.

In drawing this conclusion, Clark was influenced by the historical evidence on relative price movements of services and commodities. The historical pattern in Belgium, France, Japan, and the US was that service prices rose relative to commodity prices during most of this century, leading Clark to conclude that productivity growth was faster in the commodity-producing sectors. From this, one would conclude that if the poor countries today are like the rich countries 50 years ago, one would expect to find a greater difference in productivity between tradables and nontradables. The work of Clark is akin to the *cost-disease* formulation of Baumol as elaborated in Baumol, Blackman, and Wolff (1989).

Clark noted one important exception to the general proposition that productivity in services grows more slowly than in commodities. Fuchs (1968) studied growth in physical productivity in a number of service occupations in the United States for two periods, 1939–48 and 1948–63. The average annual growth in the first period was 3.2%, about the same as in commodity production, and in the latter period 1.2%. His conclusion was that much of the improvement in productivity in the first period was the reduction of a large number of redundant workers in the service industries that had built up since the depression.

An attempt was made to further examine evidence on labor intensity for the aggregates of tradables and nontradables. In Kravis, Heston, and Summers (1983), some stylized input-output relationships were examined that lent support to the differential-productivity formulation. The scaling of figure 2 in fact reflects these stylized relationships, where the poor country is a composite of the two lowest-income groups of countries in the 1975 benchmark study, and the rich country is the highest of the groups, namely the US. Figure 2 is drawn to reflect the greater nontradable-sector labor intensity in both rich and poor countries.

For this paper we also tried to infer labor intensity across countries from the share of labor compensation in value added in various industries. This effort was not well rewarded for two reasons. First, few countries report these data in their national accounts; and second, many countries with large sectors of individual proprietors lump their total earnings into compensation.

3. Evidence from Aggregate ICP Data

The ICP Data

Figure 1a's ordinates are the ratios of the price parity of tradables to the price parity of nontradables for 16 ICP benchmark countries in 1970. What exactly is meant by these tradable- and nontradable-price parities? The ICP works from the expenditure side in which GDP is broken down into about 150 basic headings of final-goods spending on consumption, investment, and government—from eggs to electrical machinery to government services. It compares prices of identical or very similar goods and services across countries, a difficult thing to do indeed. Before turning to some of the problems of determining which of the basic headings should be regarded as tradable and which nontradable, let us anticipate what some might regard to be a prior question.

Shouldn't the Tradables and Nontradables Be Defined in Terms of Production-Side Sectors Rather Than Expenditure-Side Categories?

Why not estimate the prices of tradables and nontradables based on output by production sector? Clearly, this would be desirable, since the items in the two groupings would then include intermediate- as well as final-expenditure goods and services. Unfortunately, the data requirements for estimating PPPs from the production side are *much* more demanding because, ideally, prices of both outputs and inputs are needed. Further, building up a comparison of GDPs from net value added by output sector requires the use of input-output tables comparable across countries for full implementation.

Happily, some studies from the production side have been carried out at the University of Groningen under the leadership of Angus Maddison (van Ark, 1993). These studies have used unit values rather than prices, except for the agricultural sector, and typically they have not incorporated double deflation. Of course, this may be the only feasible way to go. As a check on the expenditure-side findings reported in this paper, the ratio of tradable to nontradable prices has been examined for 17 countries in 1980 as developed in the available Groningen production-side studies. For what the finding is worth, we report that the income elasticity of the production-side price ratio is greater (in absolute value) than the expenditure-side elasticities: the relationship is much steeper (with an elasticity of −1.1) than in any of the ICP benchmarks.

Nature of the ICP Benchmark Results

Definitions of Tradables and Nontradables. In the ICP benchmark studies a country's GDP is the sum of its expenditures on about 110 detailed categories of consumption, as many as 35 detailed categories of investment, and the rest in government. In the present work, each of these 150-odd detailed categories has been classified as either a tradable or nontradable category. Needless to say, the assignment of some of the categories has been fairly subjective. In the absence of hard, specific information on what goods might potentially enter into international trade versus those that inevitably would be absorbed domestically, the categories placed in the nontradable classification are all service and construction categories. Following Peter Hill (1977, 1987), a service is taken to be a nonstorable good. All other categories are placed in the tradable classification. It should be emphasized that tradables in this definition are items that *could* be traded, but of course they are not necessarily in fact traded.

Nervousness about the adequacy of the classifications of the categories and concern about robustness with respect to variations in the classification procedures together inspired a small effort to see whether an alternative treatment of some of the nontradable services inherent in traded commodities would make a difference in the results. Embedded in the prices of some tradables are nontradable components such as retailers' services. We wanted to know if excluding these nontradable components from the tradable totals would alter the regression results. An "adjusted-tradables" concept in which the total tradable expenditure entering into the price-parity calculations, described below, was defined on a different basis. In the straight-tradables case, the tradable expenditure was the total spending over all the catagories classified as tradables; in the "adjusted-tradables" case, before summing to get total tradable expenditure, the expenditure of each individual tradable category was reduced by a factor between 0.7 and 0.9—the factor being chosen by us sensibly, but certainly highly subjectively—to take account of *our* perception (guess!) of the true differences in tradability of the goods labeled tradables.[2] Our criterion was the durability and personal-service character of the headings. Examples: clothing is durable but is assumed to have more nontradable elements than household textiles; fruits and vegetables are assumed to have a larger nontradable component than cereals.

The price of tradables (the price parity of tradables is a more apt term and will be used here) is calculated as the value of all tradable expenditures denominated in national prices divided by the value denominated in international prices. A similar price parity is calculated for nontradables. A comparison of the relationship between each of the price parities and GDP per capita is the empirical concern of what follows in this section. The ratio of the two price parities is the dependent variable of a log-linear regression in which the explanatory variable is GDP per capita. All of this was done for both tradables and "adjusted tradables." Figure 1a, with the price-parity ratio as ordinate and GDP per capita as abscissa, depicts this regression, and table 1 gives the relevant regression-parameter estimates.

The negative slope predicted by the B-S model is clearly there. The statistical significance of the negativity of the slope estimate leaves no doubt. Furthermore, the

Table 1. Regression Results: Ratio of Tradable-Price Parity to Nontradable-Price Parity versus GDP per capita (US = 1.0): 1970, 1975, 1980, 1085

$$(1)\ \ln\frac{PP_T}{PP_{NT}} = \alpha_1 \ln Y + \alpha_0$$

	1970	*1975*	*1980*	*1985*
$\hat{\alpha}_1$	−0.212	−0.278	−0.178	−0.228
	(0.040)	(0.042)	(0.026)	(0.037)
$\hat{\alpha}_0$	−0.158	−0.237	−0.143	−0.180
	(0.062)	(0.064)	(0.048)	(0.072)
$\bar{R}^2$	0.648	0.561	0.433	0.365
$\hat{\sigma}_n$	0.148	0.212	0.209	0.322
N	16	34	61	64

$$(2)\ \ln\frac{PP_{AT}}{PP_{NT}} = \beta_1 \ln Y + \beta_0$$

	1970	*1975*	*1980*	*1985*
β_1	−0.199	−0.256	−0.156	−0.200
	(0.036)	(0.038)	(0.023)	(0.034)
β_0	−0.186	−0.217	−0.124	−0.158
	(0.056)	(0.056)	(0.042)	(0.066)
$\bar{R}^2$	0.668	0.576	0.432	0.347
$\hat{\sigma}_n$	0.133	0.188	0.183	0.294
N	16	34	61	64

Note: T: Tradables, AT: adjusted tradables, NT: nontradables, Y: GDP per capita (US = 1.0). Standard errors of regression coefficients appear within parentheses below the estimates.

great similarity between the tradables and "adjusted-tradables" regression curves in figure 1a shows that the precise definition of tradables is quite unimportant. The slope coefficients for the two regressions differ by only about 0.02, about 10% of the coefficient itself.

Temporal Stability of the Relationship between the Tradable–Nontradable Price Ratio and GDP per Capita. Figures 1b, 1c, and 1d contain graphs of the same relationship for 1975, 1980, and 1985, but the country coverage grew from 16 in 1970 to over 60 in the later benchmarks.[3] Table 1 gives the regression results for all four benchmark studies. The price parity–GDP per capita relationship remains unmistakably negative (the slope standard errors are all very small) and it is quite stable over the 15 years covered by the four benchmark studies. The slope coefficients vary from −0.18 to −0.28 in the unadjusted tradable case, and from −0.16 to − 0.26 in the adjusted case. In every year the adjusted-tradables coefficients are about 90% of the unadjusted. The explained variance varies between 35% in 1985 and 69% in 1970.

Other Variables. A number of the studies mentioned have examined other variables that might help explain either the relationship in figures 1a–1d, or the relation of the comparative price level to per capita GDP; see, for example, Falvey and Gemmel (1991).[4] In order to focus sharply on the implications of the basic assumption that productivity differences between rich countries and poor are greater in tradables than in nontradables, this expanded approach has not been pursued here.

The Relationship between the Prices of Tradables and Income and the Prices of Nontradables and Income, Individually

The discussion thus far has examined the changes in the price of tradables *relative* to nontradables as income changes. A small amplification of this in which tradable and nontradable prices are looked at separately can be of some interest, particularly in connection with the disaggregation of the next section. The new dependent variables to be considered are:

$$P_T = \frac{\text{(Value of tradables at domestic prices)/(GDP at domestic prices)}}{\text{(Value of tradables at intl. prices)/(GDP at intl. prices)}}$$

and P_{NT}, defined in the same way except in terms of nontradables. The numerator of the P_T and P_{NT} expressions is a price parity and the denominator is the overall purchasing-power parity.

Can one judge the efficacy of international trade in equalizing tradable prices around the world by looking at how the relative cost of tradables, P_T, varies with national income? One might think that if the Law of One Price prevails, the P_T-GDP per capita relationship would be flat. The use of the overall PPP to standardize the tradable-price parity interferes with this notion, however. The way to learn about the effect of international trade on relative prices in different countries is to look at the regressions of price parity-exchange rate ratios on GDP per capita, but such an investigation is the subject of another paper. (It may be remarked here, though, that while the slopes of such tradable regressions would be zero if trade really equalized prices everywhere, in fact the empirically observed slopes are distinctly greater than zero for all four benchmark studies. Of course, the greater trade barriers of developing countries and the inclusion of nontradable components in the tradables expenditures would lead to such positive slopes. It is noteworthy,

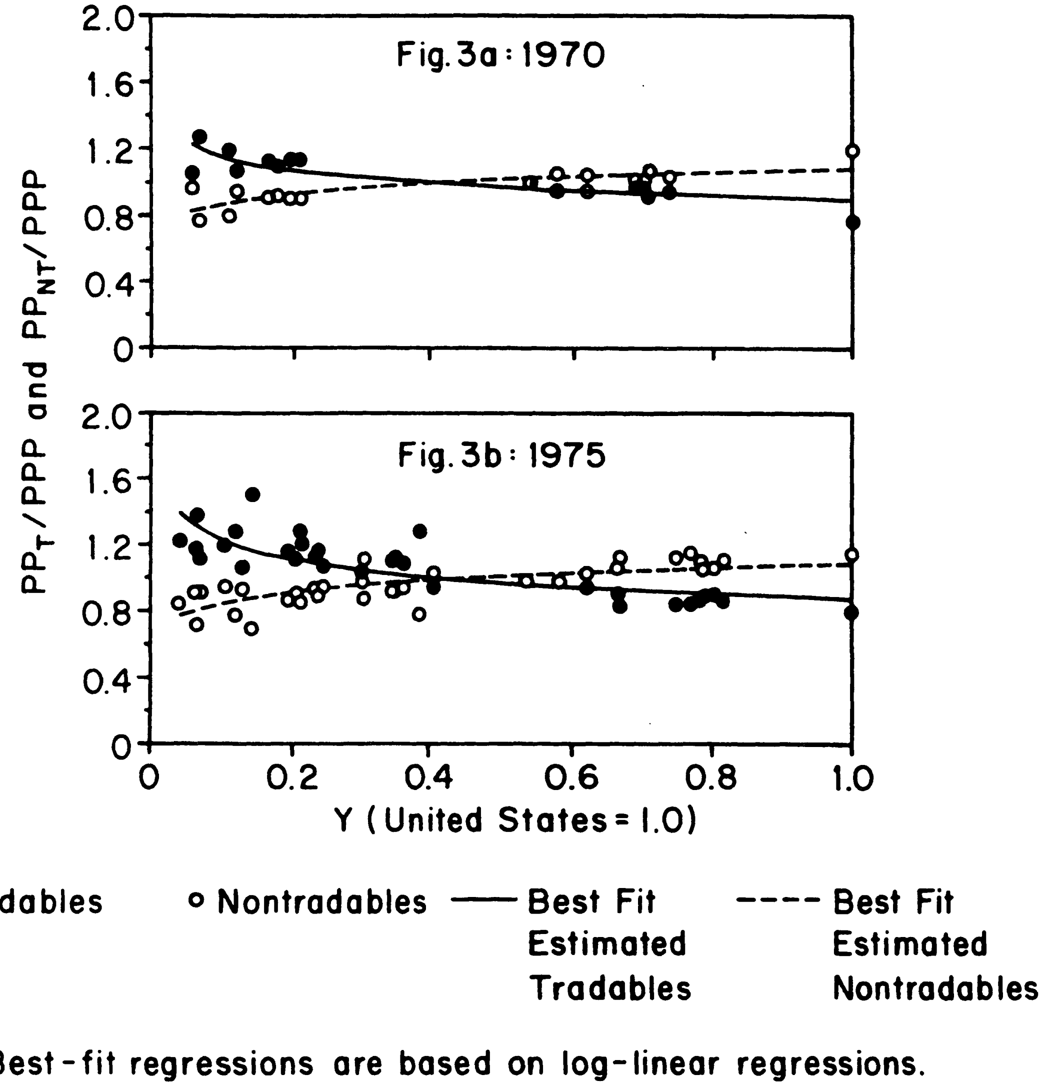

Figure 3. The Ratio of Tradable Price Parity to Overall PPP versus GDP per Capita and Ratio of Nontradable Price Parity to Overall PPP versus GDP per Capita

however, that the tradable slopes in all four benchmark studies are distinctly less than the nontradable slopes, evidence that trade does have an effect.)

The PPP is a weighted average of the tradable and nontradable parity, so if either the nontradable- or the tradable-price parity changes with income, they both must change and in opposite directions. Even before regressing P_T and P_{NT} separately against GDP per capita, it can be inferred from the negative slopes of figures 1a–1d that the P_T relationship will be downward sloping and the P_{NT} one will be upward sloping. This is because the dependent variable in figures 1a–1d, the ratio of the price parities, is equal to P_T/P_{NT}. A negative change in P_T/P_{NT} as income rises implies that P_T gets smaller and P_{NT} gets larger. Figures 3a–3d, displaying the results of regressing P_T/PPP and P_{NT}/PPP separately against GDP per capita for the four benchmark years, verifies that this is indeed empirically correct: the standardized price of tradables actually goes down with country income, and the standardized price of nontradables goes up. Table 2 gives the regression numbers.[5]

(We stubbornly resist the temptation to explore the possibility of reducing the scatter around these two regression curves by introducing other explanatory variables,

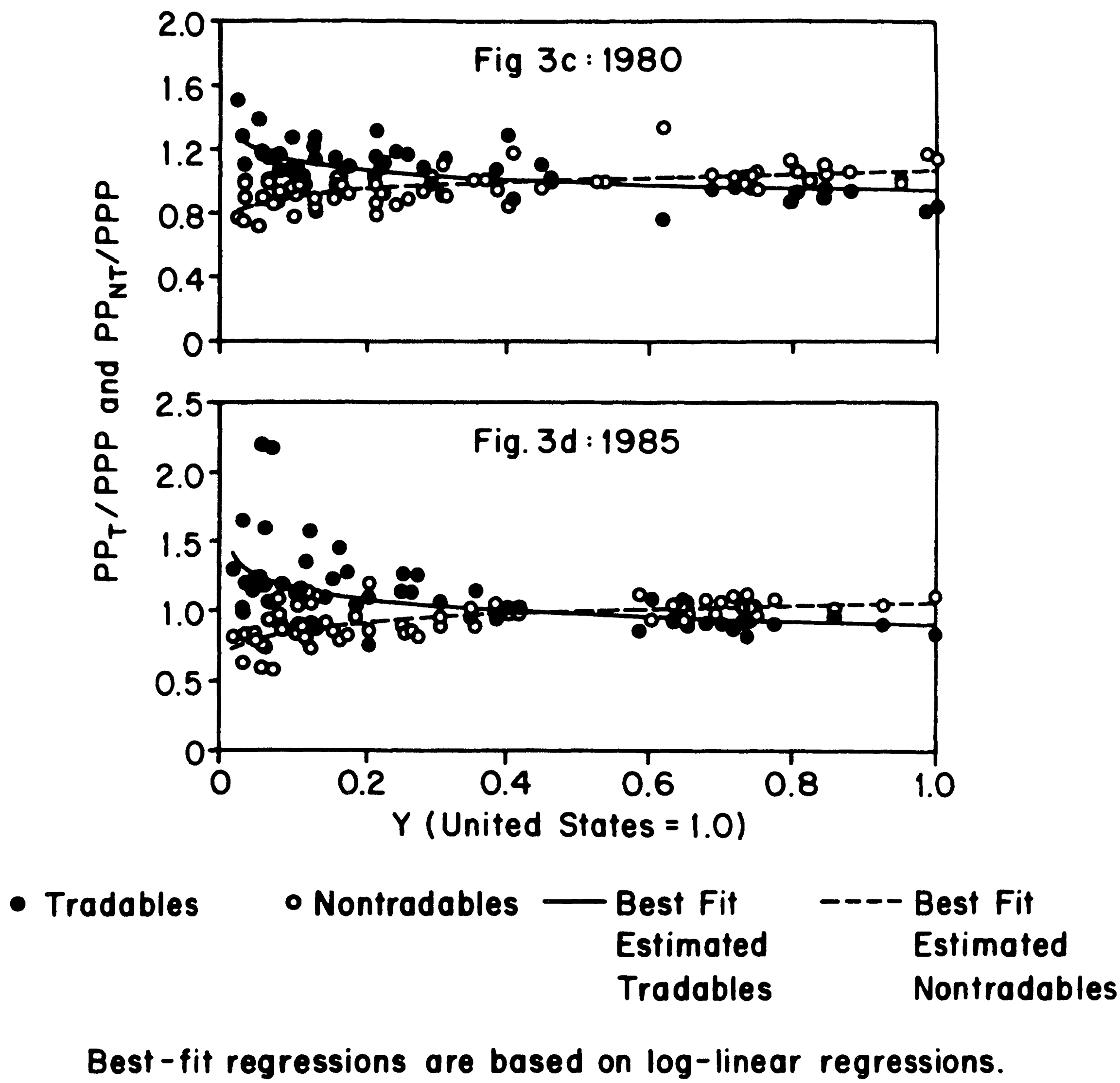

Figure 3. Continued

though we do recognize that doing so might eliminate possible bias in the income-slope estimate if the added variables are correlated with income. If we were to embark on that path, we would think first of the possibility that an extreme deviation of a country's point from the curve is best explained by an abnormal difference between its exchange rate and its PPP. But we do not wish to engage in the tail chasing implicit in following up on that lead.)[6]

4. Evidence from Disaggregate ICP Data

The aggregate of nontradables includes sectors with widely different technologies, from manicurists to money managers. In a demand study, Summers (1985) looked at a number of subgroupings of nontradables to see whether their income elasticities of demand were similar. Here we also disaggregate, this time to see if the regression slopes of the standardized price parity vs. income relationship of the individual detailed categories of tradables are predominately less than the regression slopes of

Table 2. Regression Results: PP_T/PPP *vs. GDP/Pop. and* PP_{NT}/PPP *vs. GDP/Pop.*

$$(1)\ \ln \frac{PP_T}{PPP} = \alpha_1 \ln Y + \alpha_0$$

	1970	*1975*	*1980*	*1985*
$\hat{\alpha}_1$	−0.104	−0.144	−0.083	−0.109
	(0.019)	(0.020)	(0.012)	(0.020)
$\hat{\alpha}_0$	−0.100	−0.125	−0.066	−0.088
	(0.030)	(0.030)	(0.022)	(0.039)
$\bar{R}^2$	0.658	0.598	0.436	0.308
$\hat{\sigma}_n$	0.071	0.101	0.097	0.174
N	16	34	61	64

$$(2)\ \ln \frac{PP_{NT}}{PPP} = \beta_1 \ln Y + \beta_0$$

	1970	*1975*	*1980*	*1985*
β_1	−0.096	−0.112	−0.073	−0.091
	(0.017)	(0.018)	(0.011)	(0.014)
β_0	−0.087	−0.092	−0.058	−0.069
	(0.027)	(0.027)	(0.020)	(0.027)
$\bar{R}^2$	0.662	0.534	0.417	0.392
$\hat{\sigma}_n$	0.065	0.089	0.088	0.122
N	16	34	61	64

Note: T: tradables, NT: nontradables, Y: GDP per capita (US = 1.0). Standard errors of regression coefficients appear within parentheses below the estimates.

the nontradable categories. The motivation for this is the analysis underlying figures 3a–3d. Here, however, the investigation is at a more disaggregated level.

Figures 4a–4d show pairs of histograms of the estimated slope coefficients, one for the tradable and the other for the nontradable classifications, along with associated statistics, for each of the four benchmark years. While there is overlap between the tradable and nontradable histograms, to the naked eye it appears that the nontradable area lies predominately to the right of the tradable area, just as the B-S model would lead one to expect. Certainly the means and medians of the two compare in the B-S way. The appropriate *efficient* statistical test for making a definitive econometric judgment about whether or not the data support the B-S model is not obvious. The null hypothesis to be judged asserts that the tradable and nontradable regression slopes come from a single population while the B-S alternative is that they come from two distinct populations, with the tradables one lying to the left of the nontradables. The fact that the slope coefficients are not merely random drawings from either one or two populations is a complication. Each slope coefficient has its own standard error, and an efficient test must take account of this.

A nonparametric test using the Kendall tau statistic (Kendall, 1975) can be used to judge whether the tradable slopes lie to the left of the nontradables in the following

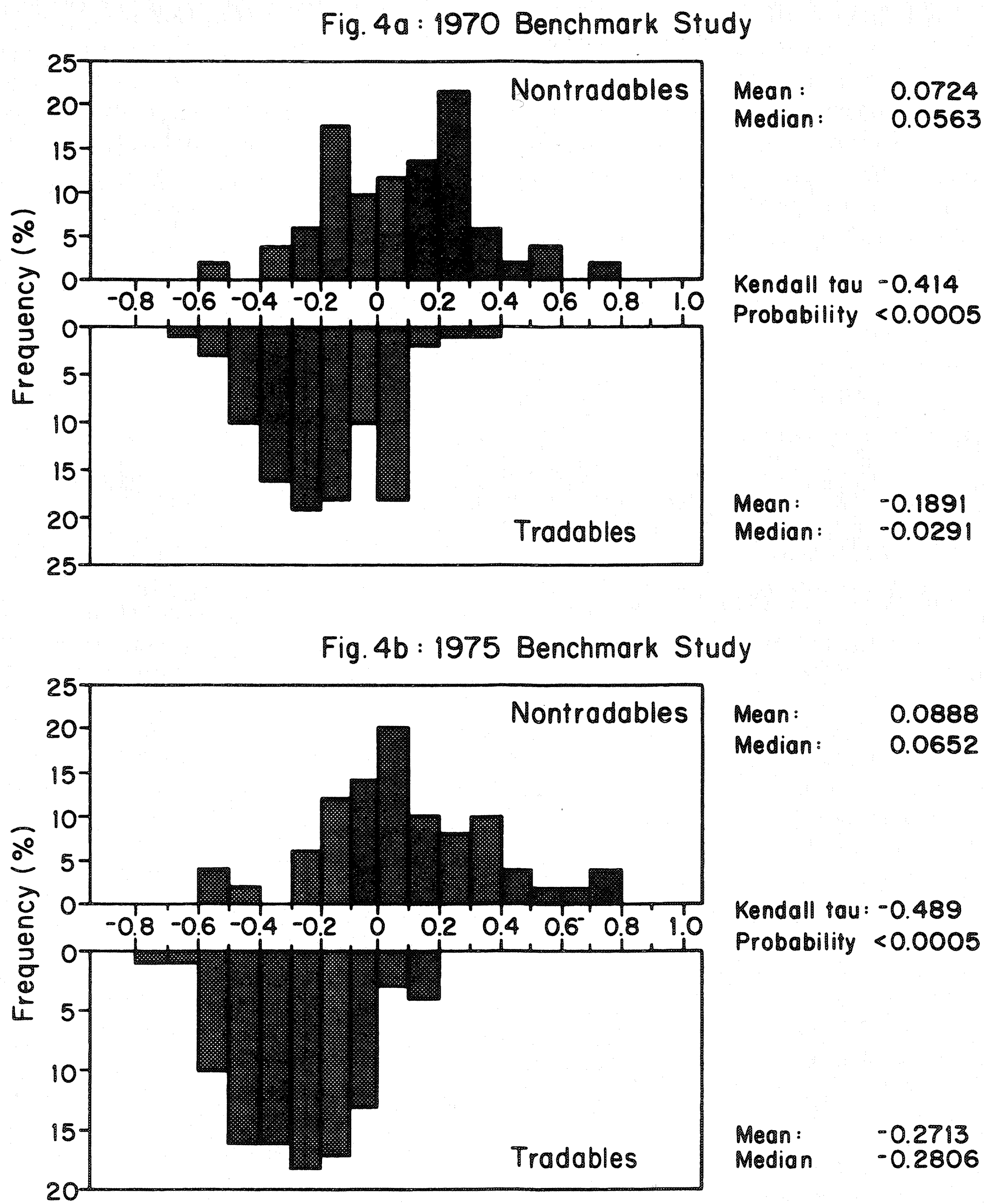

Figure 4. Histograms of Regression Slopes: Tradables and Nontradables 1970, 1975

$$\ln\left(\frac{PP_{ij}}{PPP_j}\right) = \alpha_1 + \alpha_2 \ln\left(\frac{GDP}{Pop}\right)_j$$

sense: The test provides a basis for judging whether the probability is less than one-half that the slope coefficient of a randomly selected tradable category is smaller than the slope coefficient of a randomly selected nontradable category.[7] Of course, being nonparametric, the test is likely to be lacking in power, but that is no disadvantage if the test leads to a *rejection* of the null hypothesis that the tradable slopes are not really smaller than the nontradable ones. As the test statistics reported

Fig. 4c: 1980 Benchmark Study

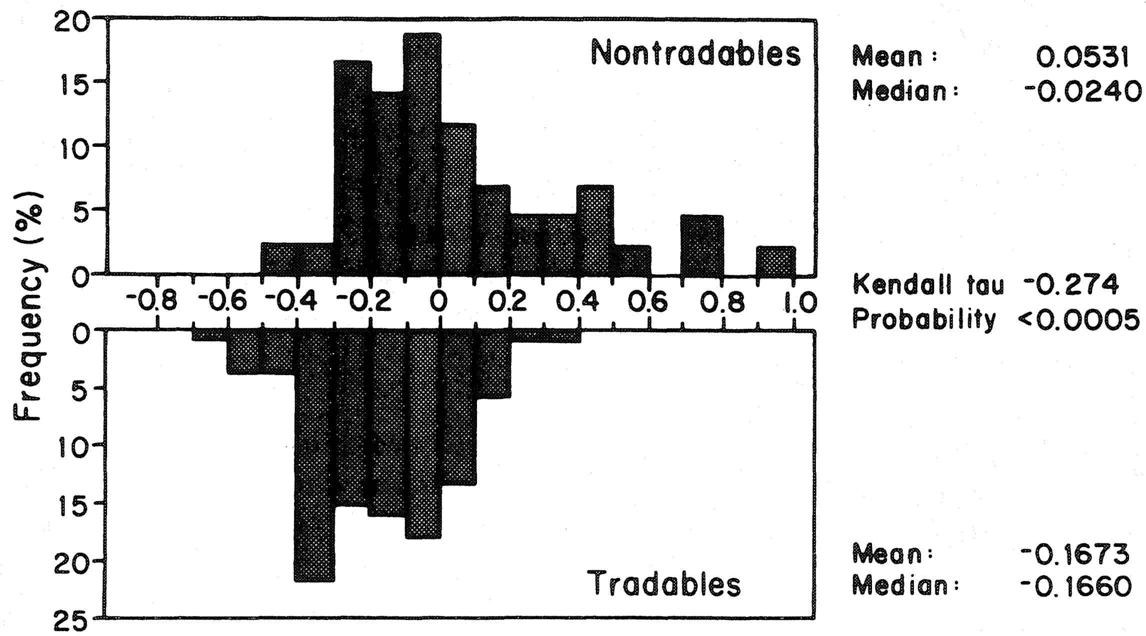

Fig. 4d: 1985 Benchmark Study

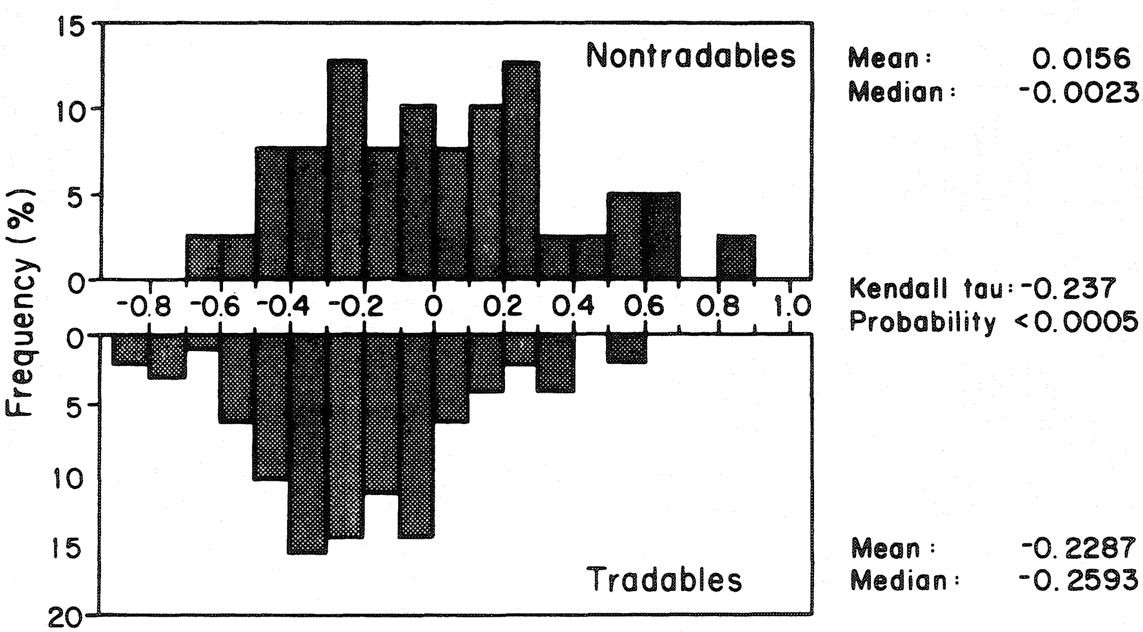

Figure 4. Continued

in figures 4a–4d show, the null hypothesis is *strongly* rejected.[8] Thus, the judgment in section 3 on the B-S price structure pronouncements based on aggregate data are confirmed by this testing based on disaggregate data.[9]

5. Conclusion

The structure of prices of goods entering into international trade relative to the prices of those that do not plays a key role in the Balassa-Samuelson explanation of why countries' exchange rates differ systematically from the purchasing-power parity of their currencies. Specifically, the B-S model's differential-productivity hypothesis leads to the expectation that the gap between the price of nontradables and the price of tradables would go up as one moved from poorer to richer countries. The contribution of this paper to an evaluation of the B-S explanation lies in its detailed examination of the tradable–nontradable price relationship for about 80 countries at four different time points, as best it can be inferred from the prices collected and processed by the International Comparison Programme. Specifically, price parities were estimated in each country for collections of goods that enter into international trade and for collections of goods that do not. A number of different kinds of regressions were run on aggregate and disaggregate data based on more than one set of definitions, covering four different points in time, to see if indeed the difference between tradable- and nontradable-price parities moved with income in the way B-S expected. They did.

Notes

1. The benchmark study covering 1975 is described in detail in Kravis, Heston and Summers (1982).
2. The "adjusted tradables" work was patterned after earlier work we did on the relationship between a country's real share of GDP devoted to services and its GDP per capita (Heston and Summers, 1992), where we calculated a measure of "augmented services." The idea there was to transfer from the commodity share to the service share the portion of commodity expenditures directed at trade and transport services used in producing the commodities. (The notion was that the production of these time-utility and place-utility components of commodities should be regarded as services—a slippery slope!) Unfortunately, the available input-output tables were inadequate in detail and country coverage for this purpose. The "adjusted tradables" enterprise was carried out in the same general spirit as that for "augmented services."
3. The 1985 benchmark study does not include the 18 countries of Central and South America that were in the 1980 benchmark study. However, additional countries in Africa, Asia, the Caribbean, and Europe brought the number of countries in 1985 to slightly more than in 1980.
4. Falvey and Gemmel (1991) looked at country size, size of labor force, mineral and land endowment, and trade imbalance as additional variables explaining the relative prices of traded to nontraded goods.
5. It is tempting to think one can make something of the fact that the absolute values of the tradable slopes are a trifle larger than the absolute values of the nontradable slopes. However, these magnitudes are determined simply by the relative proportions of total output that take the form of tradables and nontradables. If, say, 98% of all outputs were tradables so the overall PPP comes out close to the tradables-price parity, nearly all of the PP_T:PPP ratios would be close to one, making the slope coefficient close to zero. On the other hand, if the tradables proportion were 2%, the nontradables coefficient would be close to zero. In fact, tradables as defined in this paper constitute close to half of total output, and this of course lead to the approximately equal slope absolute values seen in table 2.
6. An overvalued exchange rate will tend to lower the price of tradables relative to nontradables in a country if imports are relatively free to affect domestic markets. In the case of Argentina, the predicted ratio in 1980 is greater than the actual ratio, suggesting that this effect was operative.
7. The Kendall tau test is a rank correlation test, and at first glance the present problem does not appear at all to involve correlation phenomena. However, as one of Kendall's examples illustrates (section 3.12 in the various editions of *Rank Correlation Methods*), the test can be applied, with appropriate dummy variable assignments, when the rankings of interest are associated with two distinct groups of observations.

8. The Studentized statistics for the 1970, 1975, 1980, and 1985, respectively −6.148, −6.947, −4.041, and −3.348, are all deep in the appropriate normal curve tail. A standard one-tail test leads to rejection of the null hypothesis at probabilities below 0.0005!
9. The usual statistical caveat—not made explicit frequently enough to be a cliche, unfortunately—stands in the background. The statistician's concern for statistical significance is not more important than the economist's concern for substantive significance. The statistician says "Yes, almost without doubt there is a systematic change in the difference between nontradable and tradable prices as income rises." That is an appropriate first step in supporting B-S, but it is not the last step. Left unsaid is whether the observed difference is enough substantively to justify saying B-S has identified the *cause* of the observed PPP–exchange rate relationship or just an interesting structural pattern in price structures around the world.

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