International Relative Price Levels: An Empirical Exploration[1]

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1 Introduction and Summary

This paper offers an initial exploration into the structure of international relative price levels using product-level data from the 2005 benchmark purchasing power parities of the International Comparison Program (ICP). Measurement of purchasing power parities (PPPs) has a long history, dating from the work associated with the Penn World Table in the late 1970s.[2] From their inception, the PPPs have been used extensively to compare incomes across countries. More recently, the PPPs have been used to construct new measures of real effective exchange rates (REERs). These exchange rate applications exploit the unique ability of the PPPs to provide information on relative price levels across countries. As such, using PPPs to construct REERs allows one to capture a dimension of competitiveness not visible when one is limited to using indexes that measure price changes alone.[3]

The work reported here was prompted by questions that arose from the exchange rate applications. These applications have used the familiar PPPs, which are full economy-wide measures aggregating prices with GDP product weights. We wanted to know how these REERs might be affected if one used PPP measures that gave less weight to, or excluded, non-tradable goods and services. In addition, since it is acknowledged that some goods and services are particularly difficult to accurately compare across countries, we wanted to learn the extent to which the full GDP measures were being influenced by the readings for "comparison resistant" goods and services.

Along with these new questions, the product-level data from the benchmark also allowed us to take a fresh look at a few old chestnuts. For example, To what extent is the cross-country dispersion in prices related to whether a product is internationally tradable?; and, To what extent does the well-known

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[2] See Kravis, Heston, and Summers (1978); Summers and Heston (1991); and Heston, Summers, and Aten (2006).
[3] See Thomas et al. (2008, 2011) for details and examples.

relationship between income and relative prices hold up at the product level and to what extent does tradability influence this relationship?

With respect to the product-level dispersion in prices, our findings are not surprising: The dispersion in tradables prices is a good deal smaller than that in non-tradables. Relative income "explains" a significant portion of the variation in prices in almost all products—tradable and non-tradable, but its impact is greatest on non-tradables. With respect to the construction of REERs from PPPs, we find that excluding comparison resistant goods from the U.S. REER cuts in half the measured difference between U.S. prices and the prices of its trading partners, in 2005. Excluding non-tradable goods from the measure eliminates the difference entirely.

The rest of the paper is organized as follows: The next section describes the nature of the data that the ICP provided and lays out the basic constructs and notation used later. Section 3 reports on the within-product distribution of deviations from PPP and relates them to a rough notion of tradability. It also reports on regressions relating the within-product deviations to relative incomes. Section 4 looks at the questions related to our PPP-based REER and Section 5 offers a few concluding thoughts.

2 Data Description

The ICP provided the 2005 benchmark purchasing power parities for 146 countries and 129 basic headings; a "basic heading" is the lowest level of disaggregation for which PPPs are computed (World Bank 2008, p. 14).[4] It also provided expenditures on each basic heading, population, market exchange rates, the 2005 values for GDP, and purchasing power parities for GDP.

The 2005 ICP benchmarks have two advantages over previous benchmarks. First, they are the first to include actual price observations for China, and the first since 1985 to include actual price observations for India (the 1993 results for both countries were imputed). Indeed, as Deaton and Heston (2008) note, previous price data for these countries have been based on partial information and indirect methods. Second, the price collection in the 2005 benchmark relied on the ICP's "Structured Product Descriptions," which is a list of standardized attributes used to identify a product as narrowly as possible (World Bank, 2008, p. 142); this identification enhances the comparability of prices across countries.[5]

With this information, we measure the 2005 bilateral relative price level of the United States with respect to country *j* in basic heading *i* as

$$q^{i}_{j,us} = \frac{E_{j/\$}}{PPP^{i}_{j}}, \qquad i = 1,\ldots,129;\ j = 1,\ldots,144, \tag{1}$$

where $E_{j/\$}$ is the 2005 market exchange rate for country *j* with respect to the U.S. dollar and PPP^{i}_{j} is the PPP exchange rate of the *i*th basic heading in the *j*th country. A value of 2 for $q^{i}_{j,us}$ means that the price level in the United States for the *i*th basic heading is twice the price level of the same basic heading in country *j*.

3 Cross-country Distributions of Relative Prices

Figure 1 shows the percentiles of the distribution of $\ln q^{i}_{j,us}$ across countries for 92 basic headings. [6] To ease the presentation, we first split these distributions into two groups, tradable and non-tradable, and then ordered the headings within each group by their median. The tradable and non-tradable split is, admittedly, ad-hoc and based on the authors' a-priori views. Nonetheless, it seems to hold up pretty well as a rough first sorting. Two features of the data jump out from the chart: First, the medians of the distributions for tradable

[4] Chapters 6 and 7 of the World Bank (2008) describe the methodology used in the computation of PPPs at the basic heading level.

[5] See Chen and Ravallion (2008), appendix G of World Bank (2008), and Deaton and Heston (2008).

[6] Following suggestions from ICP staff, we excluded basic headings associated with government activities such as government production of health services, collective services, and social protection, as the cross-country comparability of these comparison-resistant headings is not sufficient for the purposes of this paper. Also, the data file we received had incomplete data for Zambia and Zimbabwe, which are excluded from our analysis.

products are generally lower than those for non-tradable products.[7] Second, the dispersion of relative prices for tradables is considerably smaller than that for non-tradables. This, of course, conforms with our priors that international trade tends to equate prices across countries and this tendency is greatest for the most readily tradable products.

We next examine the extent to which the cross-country dispersion of relative prices within each of the 92 basic headings is related to the cross-country dispersion of income levels. [8] To that end, we estimate the following:

$$\ln q^i = \alpha_i + \beta_i \cdot \ln y + u_i, \qquad i = 1, \ldots, 92;\ u_i \sim N(0, \sigma_i^2) \tag{2}$$

where $q^i = (q^i_{1,us}, \ldots, q^i_{j,us}, \cdots, q^i_{144,us})$; y is a 144x1 vector of relative per-capita GDPs, measured as the international dollar value of the jth country's per-capita GDP relative to that of the United States, and u_i is a 144x1 vector of disturbances assumed to be white noise.

Figure 2 shows the estimates of β_i and their 95 percent confidence bands; we arrange these estimates using the ordering of the medians in Figure 1. For 76 of the 92 basic headings, the estimated β is negative and significantly different from zero. In other words, for most all basic headings, an increase in the per-capita income of the jth country relative to U.S. per-capita income tends to lower the q^i for that country, which corresponds to an increase in the price of the ith good in the jth country relative to the corresponding U.S. price. That is, for most all types of goods and services, higher prices are associated with higher incomes. At the aggregate level, this association has been termed the "Penn Effect." Our results show that in the vast majority of cases it also holds at the product level. However, for three of these products (motorcars, motorcycles, and passenger transport by air), the estimated β is significantly positive, meaning that higher prices are associated with lower incomes, a deviation from the Penn Effect. This seemingly contradictory result might be the result of countries with lower incomes (i.e., small markets) not being able to exploit the economies of scale involved in industries with large fixed costs. We also note that the estimates of β_i tend to be larger (in absolute value) for non-tradables than for tradables. This pattern for the betas is not a necessary consequence of the pattern seen in Figure 1, as the estimated intercept could have absorbed the variation in the medians.

4 Structure of U.S Bilateral Relative Prices

In this section we explore the importance of non-tradable basic headings for measuring U.S. international relative price levels. Specifically, the goal is to see how sensitive PPP-based REERs are to the inclusion of non-tradable and comparison resistant products in the country-level parities. The PPP-based REER we look at is the "weighted average relative price" (WARP) measure described in Thomas et al. (2008, 2011). The WARP starts with the published country-level GDP-based PPPs and constructs a relative price, q, for each country. These country-level relative prices are then aggregated by taking their weighted geometric average with moving U.S. bilateral trade shares as weights. This average is then a measure of the level of U.S. prices relative to its trading partners. In this exercise we focus on just its 2005 value.

The green circles in figure 3 depict U.S. bilateral relative price levels based on the ICP's published parities for the largest U.S. trading partners. By this measure (in 2005), U.S. GDP prices were twice has high as the GDP prices in India and 30 percent below those in Switzerland. To what extent is this structure of bilateral relative prices influenced by prices of non-tradable products and to what extent is it influenced by the existence of comparison-resistant basic headings?

To address these questions, for each trading partner, we construct a geometric average of relative prices using alternative "lists" of basic headings that differ by whether they include non-tradable or comparison resistant headings. The aggregates we construct are $q_{j,L} = \prod_{i \in L} q^i_{j,us}{}^{w_{ij}}$, where L is a list of basic headings

[7] Tobacco and Gas are, however, important exceptions because they are tradable products but have the largest relative prices in this group, higher than many of the relative prices for non-tradable. One possible explanation for this seemingly odd result is that Tobacco and Gas have lower taxes in the United States than in other countries.

[8] See Obstfeld and Rogoff (1996) for a review.

and w_{ij} is the jth country's expenditure share for the ith basic heading; the weights for each list are normalized to add-up to one. We use three lists:

L1 : Domestic expenditures on all basic headings (Dom.Exp.All)

L2 : Domestic expenditures on author-defined tradable products (Dom.Exp.Tradable)

L3 : Domestic expenditures on all headings excluding those flagged by the World bank as being "comparison resistant." (Dom.Exp.All.Ex.Non.Comparable)

As a check on our procedures, we compare the all heading measure q_{jL_1} to the published ICP's GDP relative prices, denoted here as $q_{j,GDP}$. In general, the gap between $q_{j,GDP}$ and q_{jL_1} is small but it is noticeable for Thailand and Malaysia. This gap is due to q_{jL_1} measuring prices on domestic expenditures whereas $q_{j,GDP}$ is measuring prices of expenditures on domestic products – that is, excluding imports and including exports.

Taking q_{jL_1} as our benchmark of economy-wide relative prices, we find that excluding non-tradable headings (q_{jL_2}) shifts down the structure of U.S. bilateral relative price levels with the shift being particularly pronounced vis-à-vis emerging economies. For example, with the full product list, U.S prices are measured to be 105 percent above those in India; whereas, if we exclude non-tradables the gap shrinks to 60 percent. In contrast, vis-à-vis Switzerland, the measured differential shrinks by only one percent with the exclusion of non-tradables. Excluding comparison-resistant headings, regardless of whether they are tradable or not, (q_{jL_3}) also shifts down the structure of relative prices, but to a lesser extent than when prices in non-tradable headings are excluded.

Although these differences are concentrated in the measures for developing countries, they nonetheless map into significant differences for the WARP trade-weighted U.S. aggregate. This is shown in the shaded, rightmost column of Figure 3, which plots the WARPs corresponding to our different lists using bilateral trade shares for 2005. If one includes the prices of all headings, then U.S prices appear to be 25 percent above the average of its trading partners. If we exclude prices of products that are difficult to compare across countries, the measured wedge shrinks to about 10 percent. Finally, if we limit ourselves to prices for tradable goods, there appears to be little difference between U.S. prices and those of its trading partners.

5 Summary and Concluding Remarks

The 2005 ICP offers PPP benchmarks across 144 countries for 129 basic headings, a level fine enough for us to define tradable products in alternative ways. Using an ad-hoc but plausible classification of tradables, we find that the cross-country dispersion of relative price levels depends importantly on whether the basic heading is tradable or not: distributions of tradable basic headings have a lower median and narrower dispersion than the distributions of non-tradable basic headings. As one might expect, the negative relationship between relative income and relative price (the Penn Effect) is weaker for tradables than non-tradables. Nonetheless, it is significant across most all categories of goods and services.

From the ICP's basic-heading-level data we get a good sense of the extent to which the WARP REER is affected by the inclusion of non-tradable prices. For 2005, with the full product list the WARP shows U.S. prices to be more than 20 percent above those of its trading partners, while for tradable products alone, there is little difference between U.S. prices and those of its trading partners.

We think this is useful to our understanding of what is behind WARP-type measures, but we do not, as some might, take it as evidence against the appropriateness of using the full product list to construct measures of competitiveness. As Keynes noted in 1925, it is the price of non-tradables ("sheltered goods" in his terms) that determines the competiveness of a country because it is those prices that determine the cost of producing tradable goods. The price of "unsheltered goods" will be equalized by trade. (Keynes, 1925, p. 301). Corden makes a similar point by equating a country's international competiveness with its profitability in some or all tradable industries. (Corden, 1994, p. 267).

Of course, productivity differentials also figure importantly into the mapping from the prices of non-

tradables to the cost of producing tradables. Unfortunately, broad, cross-country data that compare the levels of productivity are not available. Even if they were, we would still need something like the ICP to provide the starting points for such a mapping. So, for now, we will continue to exploit the good works of the ICP as much as possible and note our appreciation for the access to this very rich and useful data set.

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Figure 1: Distribution of Relative Prices – 2005, Selected Basic Headings

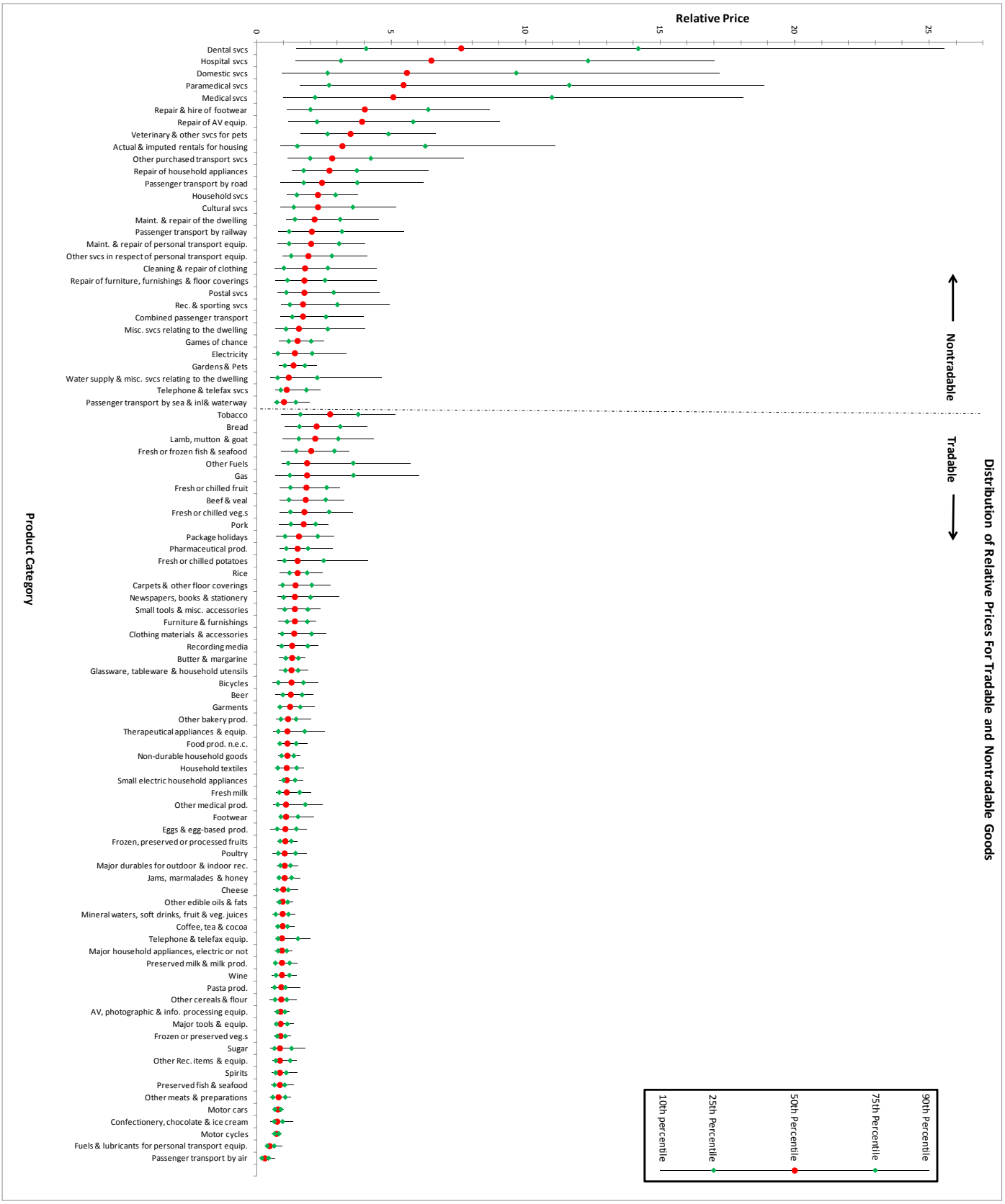

Figure 2: 95 Percent Confidence Intervals for Estimate of β_i in Equation (2)

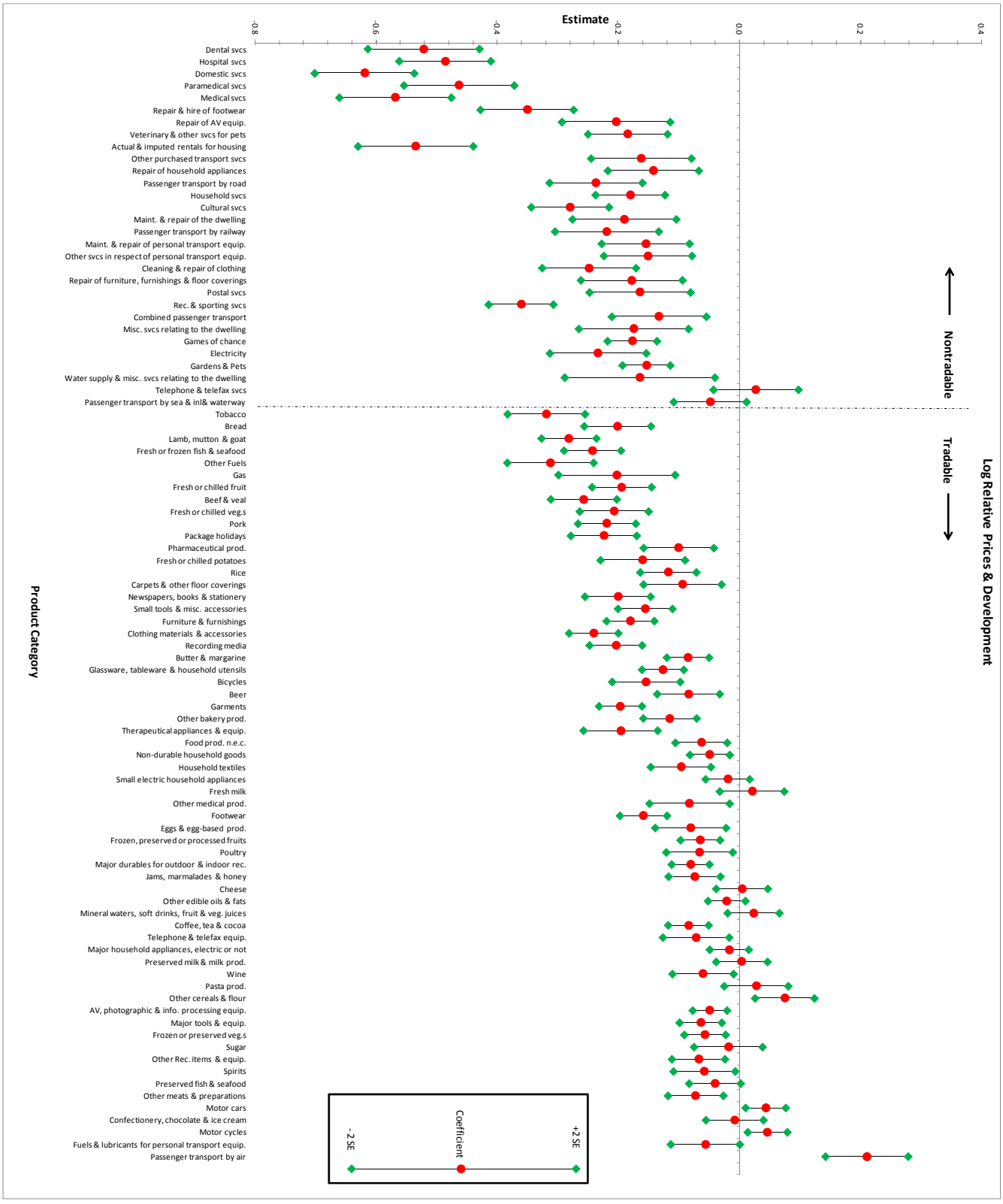

Figure 3: U.S. Bilateral Prices in 2005: Selected Trading Partners and Measures of Tradability