The Price of Capital: Evidence from Trade Data

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Abstract

We use highly disaggregated data on trade in capital goods to study differences in the price of capital across countries. This strategy is motivated by the fact that most countries import the bulk of machinery equipment from a small number of industrialized countries. We find the price of imported capital goods to be negatively and significantly correlated with the income of the importing country. We cross check our results in number of ways. Our results, which differ from findings using Penn World Tables data, caution against discounting a role for the higher price of capital goods in explaining the higher relative price of capital to consumption goods observed in poor countries.

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1 Introduction

In this paper, we revisit the evidence that evaluates whether the price of tradable capital goods constitutes a barrier to development. Equipment goods are a key component of physical capital. Because most countries import the bulk of their machinery and equipment from a small group of R&D intensive countries, capital goods abet the economic development of importing countries by transmitting technological advances across borders.[1] The relative price of capital goods is thus a crucial determinant of a country's access to these two channels of economic growth. A large empirical literature has linked differences in the relative price of capital goods in poor countries to lower levels of investment, income, and growth.[2] But there is disagreement as to the causes.

Data from the Penn World Tables (PWT) compiled by the World Bank (WB) for the United Nations International Comparison Program (ICP), the main source of capital goods prices (indices) across countries, suggest that for 1980, 1985, and 1996 the absolute price of capital goods was no higher in poor than in rich countries. Hsieh and Klenow (2007) take this result to indicate that the high price of investment relative to consumption goods in poor countries is entirely driven by the denominator.[3] This finding contradicts the hypothesis that investment goods are taxed more heavily, or subject to import barriers, broadly defined, that make capital goods more expensive, in poorer countries.[4]

Eaton and Kortum (2001), using similar data for 1985, also find no systematic differences in the price of capital goods between rich and poor countries. The authors, however, disregard this result, arguing instead that ICP reported prices might not properly reflect the price of capital in poor countries due to a lower quality of equipment and additional costs, not properly measured in the ICP data, that are higher in developing nations.

The finding that the price of capital goods is no higher in poor than in rich countries, and disagreement over the implications of this result, might be attributable to, and in fact hinge, on the quality of the underlying data. ICP (and PWT) documentation acknowledges the accuracy and quality of the data for most developing countries included in its benchmark surveys for 1970-1996 to be low.

Although the typical country receives a passing grade of C (average, across all countries), there is

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[1] Eaton and Kortum (2001) document these facts; see also Alfaro and Hammel (2007). We use the terms capital goods, investment goods, and machinery and equipment interchangeably.

[2] See Díaz-Alejandro (1970), De Long and Summers (1991, 1993), Jones (1994), Lee (1995), Taylor (1994), and Restuccia and Urrutia (2001). Work by Coe and Helpman (1995), Coe, Helpman, and Hoffmaister (1997), and Eaton and Kortum (2001) relate international trade to technology diffusion.

[3] Hsieh and Klenow (2007) run the log of the dollar price of investment goods (fixed investment, producer durables and structures) on the log of purchasing power parity GDP per worker for the benchmark years of 1980, 1985, and 1996. Our analysis focuses on the cost of producer durables (machinery and equipment).

[4] Hence, the difference in the relative price in poor countries is driven by differences arising from cheap non-tradables and the low productivity of poor countries in the investment and tradable goods sectors.

considerable variation by region (see Table A1). The average grade (on an A-D scale, A being best) for surveyed countries in Africa and the Middle East is D, for Western Europe B+. Many countries have not been part of benchmark surveys for as many as 30 years, and substantial methodological differences across regions (many associated with the "regionalization" method used to collect data) further limit comparisons. Across countries, collecting prices for similar capital goods, as discussed later in the paper, present additional challenges beyond the coverage and quality of the data. The methodologies used to collect prices in surveyed countries are a particular source of concern. Deaton and Heston (2008), discussing the ICP data, warn against comparing countries with quite different economies, particularly when using national accounts data provided by countries with weak statistical capability.

In this paper, we revisit the evidence using alternative sources of data.[5] We construct unit prices of capital goods using disaggregated information from trade data, a strategy motivated by the fact that most countries tend to import the bulk of capital goods (from a small number of industrialized countries).[6] Using highly disaggregated U.S. export data on capital goods for the period 1978-2001 to derive unit prices, we find the price of equipment goods to exhibit a negative and significant relationship with the income of the importer country. These results are robust to different specifications and sample restrictions (e.g., trimmed samples to reduce potential noise in the data and regressions by income group).

Because not all countries import the bulk of machinery from the United States, we complement our analysis with world import data compiled by Feenstra et al. (2005) for the period 1984-2000. Using this alternative data set to calculate unit prices for goods at the 4-digit Standard Industrial Trade Class (SITC) level, we find a negative and significant correlation between equipment prices and average income of the importer country. This negative relationship should be interpreted with caution, however, as units might vary by products within industries (even at the 4-digit SITC classification). Our results are nevertheless consistent with previous findings that the price of imported capital is higher in poor countries.[7]

Our explanation for why our results differ from those that employ ICP data are subject to important constraints, notably, that the detailed benchmark data from which the capital goods indices were derived are not readily available (data are confidential, and in many cases detailed records were not kept). Having obtained access to the 2005 data (ICP documentation explicitly notes that its newer and

[5] As explained in the text, the trade data (U.S. and world import data) are not without problems.
[6] Constituting nearly 100 percent of Malawi's machinery and equipment at one extreme, and more than 75 percent of the domestic supply in Bangladesh, Denmark, Mauritius, Portugal, Sri Lanka, and Sweden, capital goods imports are a good proxy for equipment investment for many developing and developed countries. There is nevertheless a strong bias towards domestic producers in some countries. See De Long and Summers (1993), Eaton and Kortum (2001), and Caselli and Wilson (2004).
[7] See Diaz-Alejandro (1970), Taylor (1998), and Eaton and Kortum (2001), among others. These papers argue that different policies broadly defined (e.g., taxes, import barriers) might drive up the price of capital in poorer relative to richer countries.

older data are not comparable due to substantial differences in methodology), Alfaro, Peri, and Taylor (2009) find the lack of correlation between price of equipment and income per capita across countries to hide substantial variation in price levels and deviations from the law of one price across regions. The data also suggests persistent measurement issues. Overall, their results do not contradict our findings.

In terms of the present study, we acknowledge that unit values might not fully capture the final user price of the imported capital good. The world import data, for example, do not include tariffs, and our U.S. export data do not include transportation costs. Including these costs, however, would likely strengthen our results.[8] Our analysis could be more complete if we considered the price of locally produced capital goods. But this information (as other scholars have noted) is difficult to assemble, especially for poorer countries (Eaton and Kortum, 2001; Caselli and Wilson, 2004). Overall, our results suggest that a role for the higher price of capital goods in explaining the higher relative price of capital to consumption goods should not be discounted.

The rest of the paper is organized as follows. In section 2, we describe existing sources of data for prices of capital goods. Our empirical results using trade data are presented in section 3. Results are discussed in section 4. Section 5 concludes.

2 The Price of Capital Goods: Sources and Limitations

2.1 Penn World Tables and the International Comparison Program

The Penn World Tables (PWT) present national accounts time series data for many countries. This comprehensive and relatively continuous data set has been used extensively in numerous cross-country studies, for example, in various empirical analyses of economic growth (e.g., Mankiw et al., 1992; Levine and Renelt, 1992) and as a source for prices of capital goods across countries (Jones, 1994; Restuccia and Urrutia, 2001; Hsieh and Klenow, 2007).

The PWT uses capital price data collected by the ICP as the basis for its investment price series. ICP benchmark studies are pricing exercises.[9] The ICP collects prices for between 500 and 1,500 individual goods and services in each participating country. For a given year, countries for which the ICP has price data are "benchmark" countries in the PWT tables. The number of benchmark countries has

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[8] As Obstfeld and Taylor (2004) note, developing countries' access to imported physical capital has been "affected by tariffs, quotas, commercial policies, exchange rate controls and the like." In a recent survey, Anderson and van Wincoop (2004) conclude that trade costs vary widely across countries by factors of as much as 10 or more.

[9] Purchasing power parities (PPPs) are the expenditure weighted average of price ratios. Their calculation requires two sets of data (1) *GDP expenditure* broken down into detailed components called "basic headings," and (2) *national annual average prices* of a sample of comparable items representing each of the basic headings. The prices are collected in the ICP surveys. For countries not surveyed in the ICP rounds, PWT prices are inferred from fitted values of price regressions run over the benchmark data. The results are interpolated to fill in the years between benchmark surveys and the price series aggregated using the Geary multilateral method.

increased from 16 in 1970 to 115 in 1996 to 146 countries in the most recent, 2005, round. As the ICP data underlie the PWT investment price series, an overview of how the data are collected and assembled seems warranted.[10] Appendix A details the construction of the series.

The price data are generated by an elaborate system of surveys. ICP surveys conducted for base years 1970, 1973, and 1975 were global exercises that included, in one set of simultaneous comparisons, a wide range of countries in all regions. This arrangement, however, became difficult to administer as the number of countries increased over time. "Comparison of countries far apart geographically and at different stages of development proved difficult because of the complexities of finding sets of items that were both reasonably nationally representative and globally comparable at the same time" (Ahmad, 2006).

Since 1980, the ICP has been regionalized (i.e., the participating countries are first grouped by region) with comparisons carried out independently within regions. Although it has simplified administration, regionalization has increased the complexity of the exercise, regions differing in the number of basic headings, selection of items, frequency and timing of surveys, methods of aggregation, and denominating currency. As Ahmad (2006) notes: "[T]here is a lot of diversity among the regions and among countries within regions in terms of coverage of items and the quality of observations, leading to differences in consistency and quality of estimates."

The approach taken involves a coordinated but relatively decentralized process whereby the World Bank's Global Office coordinates ICP data collection among the regions and countries, with individual country offices responsible for collecting the prices using any combination of methods they find most "convenient" (World Bank, 2006, p. 10). Regional coordinators can "edit" prices deemed incorrect. According to World Bank documentation, there seemed to be no "centralized" oversight either of the editing at the regional level or of the data collection process in general.[11]

There are also issues related to coverage of the surveyed countries. As noted earlier, although the number of benchmark countries in successive ICP rounds has increased, this trend masks the fact that the countries that participate in ICP surveys tend to be wealthy and under representative of non-industrialized regions. Prior to 1985, Kenya was the sole African country and Colombia the sole Latin American country surveyed. Moreover, by the PWT's own account, the quality of the series for most developing countries is low. For example, the 1993 round included reduced information surveys designed to accommodate the inclusion of countries with limited resources or statistical capability. The method involved dividing GDP into fewer basic headings and developing a price list for a limited set of items.

[10] The description of the methodology is taken from Summers and Heston (1991), "Part II: Programs and Data" in Penn World Tables (2002), Ahmad (2006), and World Bank (2006).

[11] We were unable to obtain through correspondence with individuals at the World Bank (due to confidentiality and lack of detailed records) details of the methods countries used the 1970-1996 ICP survey rounds.

The reduced information method was instrumental in increasing the number of participants, but the results were relatively unreliable as many of these countries lacked the experience and resources to conduct a thorough survey. As reported in Appendix A, Table A1, Africa, the Middle East, Eastern Europe, and Asia, for example, receive grades ranging from D to D+.

Acknowledging the many issues that attended the collection of individual prices, the methodology used for the 2005 ICP round differed considerably from that used in previous rounds (and the 2011 round targets further improvements). Although many issues and concerns persist in the 2005 round, the new data available to date exhibit significant discrepancies with the data obtained in previous rounds. In the case of sub-Saharan Africa, for example, 13 countries' (including previously benchmarked countries') PPP-based GDPs were revised up and 33 revised down. The revisions range from a 139 percent increase in GDP for the Republic of Congo to a 77 percent decrease in GDP for Zimbabwe. We mention the case of African countries as they tend to be poorer, but important differences were found as well for other developing (including previously benchmarked) countries.

Also noteworthy is that expenditure data, which come directly from countries' national income accounts, were neither collected nor edited by the ICP, PWT or WDI. (The quality of the national income accounts of many low-income countries is low; national baskets are not those priced by ICP, and there are also methodological differences across countries.)

Capital Goods

Recent revisions of price data all suggest significant limitations to using the PWT to measure prices, especially for developing countries. Further analysis of the capital goods methodology leads to the conclusion that the data might be particularly flawed, there being serious issues with regard to cross-country comparability, quality adjustment, and treatment of missing data for the price of equipment.

One important issue is the need to price items many of which are not common to all countries. This raises issues for consumption goods (services, for example), but the ICP acknowledges particular problems associated with the pricing of capital goods (ICP Handbook Chapter 9).

> Capital goods can be much more complex and variable than consumer goods. For this reason, it may be more difficult to obtain perfect matches between the capital goods purchased in different countries than for consumer goods. . . . The complexity of many capital goods is so great that the expertise required to draw up appropriate specifications for the products to be priced and to obtain average prices for them are not to be found within most statistical offices. (World Bank, 2006, Ch. 9, p. 2)

The list of predetermined equipment goods has been acknowledged to possibly not be representative (i.e., appropriate) across all countries (Ahmad, 2006; World Bank, 2006). Missing goods are therefore more common, and allowed to be filled using foreign (typically, rich-country exporter) prices following a procedure of marking them up using "average" transaction-cost based PPPs for other goods. But the data used in these adjustments are not publicly available, nor do we know how many imputed prices there are.

Moreover, although ICP surveys aim to price final goods, other sources have been accepted.

> The prices of equipment goods can be obtained directly from producers, importers or distributors or from their catalogues. They may even be obtained from actual purchasers, which is preferable in principle, but difficult in practice. The prices can be collected by whichever method, or combination of methods, countries find the most convenient — personal visit, telephone, letter, internet, etc. The prices must, however, be adjusted to conform to the valuation principles outlined above with regard to discounts, transport and delivery charges, installation costs and product taxes. (World Bank, 2006, Ch. 9, p. 10)

Because countries are free to collect prices using the methods they find most convenient, it is entirely plausible that country and regional offices are not using final purchase prices.[12] Estimating additional costs appears to be particularly complicated in the case of capital goods. The pricing of old machinery is also likely (only the 2005 round explicitly requested the pricing of new machinery and equipment, although, as mentioned, there is no centralized oversight). The 2005 round devoted considerably more effort to improving the specifications for items crucial to assuring equivalent pricing of similar items (such specifications did not exist in previous rounds).

To gauge the pervasiveness of these issues, Alfaro, Peri, and Taylor (2009) obtained access to the still confidential 2005 individual price level data (ICP documentation, as noted earlier, explicitly acknowledges that newer and older data are not comparable due to substantial differences in methodology). The authors document for many countries numerous missing values for items within the "equipment" heading (in some cases, more than 50% of items are missing). Many priced items seem to have had only one quote, and there is no indication which data were imputed and which collected. Also not indicated is whether the price of an item (say, laptop computers) is from a single quote or averaged across many quotes. Moreover, different regions priced different items. The linking via a handful of "ring" countries is not replicable, and does not match simple country-product-dummy analysis, so inter-regional price level comparisons are hard to verify. The African data are extremely variable, some countries reporting among the lowest and others among the highest prices for equipment in the world. This suggests potential quality adjustment and measurement issues.

[12] Such a scenario, in fact, seems likely given that the ICP permits the use of telephone interviews, catalogues, and other sources.

The absence of clear documentation tracking the original micro-data raises doubts about the veracity and consistency of the methods applied by the IPC for pricing capital goods. Deaton and Heston (2008) note serious issues in cross-country comparability, quality adjustment, and treatment of missing data for the price of equipment.

In light of the foregoing discussion, the raw data that underlie the PWT price series for many (in particular, developing) countries should be interpreted with caution, and other sources considered. In this paper, we use alternative sources of data for rich and poor countries (which themselves are not without problems) to capture differences in prices of capital goods as a way to identify potential biases.

2.2 Trade Data

Highly disaggregated trade data for machinery and equipment are one alternate source of capital goods prices. Research by Eaton and Kortum (2001) reveals that most of the world's capital goods are provided by a small number of R&D intensive countries, and most (in particular, developing) countries tend to import a large fraction of their capital goods. According to the authors, the average African and South Asian country purchases nearly 70 percent of its equipment from abroad. Malawi, for example, imported 99.7 percent of its equipment goods in 1985. Not only African and Asian countries, but also many advanced countries (including Australia, Austria, Finland, and Norway) import a large percentage of equipment goods. Purchases from the "Big Seven" countries (France, Germany, Italy, Japan, Sweden, the United Kingdom, and the United States) account for 70 percent of these foreign purchases. Imports of capital goods are thus for many countries a good proxy for equipment investment. This stylized fact motivates our empirical approach throughout the paper, although the data are not without issues, as we explain below.

2.2.1 U.S. Export Data

We use product-level export data from the U.S. Census Bureau compiled by Feenstra (2005) that report the value and quantity of U.S. trade identified by the 10-digit harmonized system (HS) numbers and destination country (designated by UN country name and number).[13] Reported data are: F.O.B. (free on board, which excludes transportation expenses such as freight costs and customs duties); measured in current (nominal) U.S. dollars; encompass the period 1972-2001; and include exports to approximately 150 countries per year. As HS numbers change frequently, Feenstra (2005) uses the full alphabetic product descriptions to create a concordance of SITC classifications that is consistent over time (SITC Revision 1 for 1972-1977 and SITC Revision 2 for 1978-2001). We utilize the SITC Revision 2

[13] Before 1988, U.S. exports at a disaggregate level were measured according to the Schedule B classification. Feenstra (1997) develops a concordance to link to the earlier data.

concordance to match U.S. export data to the appropriate 2-digit BEA industry classification. Following De Long and Summers (1991), Eaton and Kortum (2001), and Alfaro and Hammel (2007), we associate capital goods with the non-electrical equipment, electrical equipment, and instruments industries. We thus define capital goods as the output of BEA industry codes 20-27 and 33 (Farm and Garden Machinery; Construction, Mining, etc.; Computer and Office Equipment; Other Non-Electric Machinery; Appliances; Audio and Video etc.; Electronic Components; Other Electrical Machinery; and Instruments and Apparatus).

An extremely useful feature of these data is that their inclusion of both quantity and value information for a large number of products supports the calculation of unit prices. Following Schott (2004), we compute the unit value of capital good p exported to country c, u_{pc}, by dividing the export value (V_{pc}) by export quantity (Q_{pc}) measured in "number" of units, $u_{pc} = V_{pc} / Q_{pc}$.[14]

From the U.S. export data, we are able to derive unit values for more than 1.2 million equipment goods for 154 countries between 1978 and 2001. As the United States is not the sole exporter of capital goods, to capture as much as possible of capital goods trade originating in other industrialized countries, we complement our analysis with bilateral world trade data. Appendix Table A2 lists the sample of countries in our analysis.

2.2.2 World Import Data

We obtain world import data for capital goods from the World Trade Flows 1962-2000 database, which reports UN trade data classified by SITC Revision 1 for the period 1962-1983, and Revision 2 for the period 1984-2000. The data set includes bilateral trade flows reported at the four-digit level, in U.S. dollars, for a wide range of countries from 1962 to 2000.

This bilateral trade data set gives primacy to data reported by the importer country, when available.[15] When importer data are unavailable for a country-pair, the corresponding exporter report is used.[16] Data are reported in thousands of current U.S. dollars. Importer data are reported C.I.F. (cost, insurance, freight, which includes transportation costs), exporter data F.O.B. (which excludes transportation costs). Neither series includes tariffs. Moreover, due to budget constraints, for each bilateral flow (for each 4-digit SITC commodity), Feenstra et al. (2005) report only values in excess of $100,000. For example, if the total value of two units of an imported commodity is less than $100,000,

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[14] We chose "number" of units as this corresponds to the appropriate form of measurement for the types of capital goods surveyed by the ICP (e.g., tractors, jet pumps, etc.). Moreover, measurement in this common unit ensures that we are comparing "apples to apples" (as opposed, for instance, to a bag of apples to kilograms of apples).
[15] Approximately 75 percent of prices are calculated from importer reports.
[16] Feenstra et al. (2005) assume that importer reports are more accurate than exporter reports.

the commodity is not included in the data set. Despite this lower bound, the final data account for 98 percent of world trade.

As for U.S. export data, SITC codes are matched to U.S. BEA codes for 34 manufacturing sectors for which we associate equipment goods with the non-electrical equipment, electrical equipment, and instruments industries (BEA industries 20-27 and 33). Similarly, we compute the unit value of capital good p imported to country c, u_{pc}, by dividing the import value (V_{pc}) by import quantity (Q_{pc}) measured in "number" of units, $u_{pc} = V_{pc} / Q_{pc}$. Because units vary by products within industries, unit values might not be accurately computed at the industry level. Results obtained using this data set should thus be interpreted with caution. Information on trade quantities before 1984 being unavailable, we are able to derive unit prices only from 1984-2000.

3 The Price of Capital Using Trade Data

3.1 Equipment Price and Importer Income

We examine whether the price of traded goods varies with the income of the importer country by employing a specification analogous to that used by Schott (2004). Specifically, we regress the unit price on importer characteristics while controlling for various combinations of product and year fixed effects. Our basic specification is:

$$\log(u_{pct}) = \alpha_{pt} + \beta \log(GDP\ per\ capita_{ct}) + \varepsilon_{pct} \quad (1)$$

where $\log(u_{pct})$ is the unit value of imports (in current U.S. dollars) of equipment good p in country c in period t. The unit price for U.S. export data is for goods at the 10-digit HS level, and for world trade data for goods at the 4-digit SITC level. GDP per capita is for the importing country (from the World Bank's World Development Indicators 2005) and measured, to be consistent with the measurement of trade data, in current U.S. dollars. In the robustness section, we consider as well the PPP per-capita GDP series from the Penn World Tables.[17] α_{pt} refers to product-year fixed effects to control for level differences in unit values across products and time, and ε_{pct} is an error term. The estimation procedure uses White's correction for heteroskedasticity in the error term, and errors are clustered at the country level.

Table 1 reports the coefficient on log per-capita GDP of the importer country. Panels A and B present the results using U.S. export and world import data, respectively. Column (1) reports the coefficient on the importer's log per-capita GDP for a fully saturated model controlling for product and year interaction terms (i.e., product*year dummies). The coefficients are negative and significant in both

[17] In PWT, data for non-benchmarked years are extrapolated using national income account data from each country. See the discussion in Deaton and Heston (2008).

panels, and the results are also economically significant. The coefficients on column (1) imply that a 10 percent increase in an importer country's GDP per capita is associated with a 0.82 and 1.03 percent reduction in the unit values of capital goods when using the U.S. export and world import data, respectively. (However, as we explain next, caution should be exercised in interpreting these magnitudes). Columns (2) and (3), which consider product and year effects independently, again show a negative and significant relationship. The regression in column (4) controls for both product and year effects. In both panels, the coefficient is negative and significant with magnitudes similar to those in column (1). The statistical significance is for U.S. export data. Panel A reports this negative relationship to be statistically significant at the one percent level for all four specifications.

Unit values from disaggregated trade data can be noisy.[18] To dampen this effect, we trimmed the data.[19] The results of eliminating potentially "unrealistic" values by dropping observations below the 10th and above the 90th percentile, and of a 20-80 trim, are reported in Table 1, columns (5) and (6), respectively. With U.S. export data (panel A), the coefficient on average income for both trims is negative and significant at the one percent level. With world import data (panel B)**,** the coefficient on average income for both trims is negative and remains significant at the five percent level. In terms of the magnitude of the effects, the coefficients associated with trimmed data are lower than those obtained using all the data. For the 20-80 trim, the estimates in Table 1, column (6) imply that a 10 percent increase in an importer country's GDP per capita is associated with a 0.51 and 0.60 percent reduction in the unit values of capital goods when using U.S. export and world import data, respectively. Nevertheless, these results suggest that the negative relation does not seem to be caused by noise in the dependent variable.

3.2 Within-Product Relationship

At the level of individual products, unit values are negatively associated with importer per-capita GDP. Figure 1 plots importer log unit value versus log importer per-capita GDP for four products at the 10-digit HS level for the year 2000. Quite different in function, size, and price, these products nevertheless all seem to display a negative relation between unit price and income of the importer country. To formally assess the within-product relationship between importer unit values and importer income across time, we compute separate OLS estimations of:

$$\log(u_{pct}) = \alpha_{pt} + \beta_{pt}\log(GDP\ \ per\ capita_{ct}) + \varepsilon_{pct} \quad (2)$$

[18] See General Accounting Office (1995) for an in-depth study of classification methods and issues.
[19] We follow a strategy similar to that used by Schott (2004).

for each equipment good in each year, where $\log(u_{pct})$ is importer country *c*'s unit value of product *p* in year *t* and GDP per capita is the importer's per capita GDP in year *t*. We use White's correction for heteroskedasticity in the error term. For each year, we calculate the percentage of these coefficients by sign (positive or negative) and significance (at the 10 percent level). These results are reported in Table 2. Column (1) reports the percentage of coefficients that are positive and significant, column (2) the percentage of coefficients that are negative and significant. Non-significant results are reported in the last columns. We find with both world import and U.S. export data a consistent negative relationship between the unit value of capital goods and importer income.

Panel A tabulates the relationship between unit values and importer income using 10-digit HS U.S. export data. In total, we estimated more than 16,000 product-year regressions. With U.S. export data, the statistical significance of this relationship remains relatively constant over time. In 1978, 17 percent of U.S. exported capital goods exhibited a statistically significant negative relationship with the importer's per-capita GDP. By the late 1990s, about 21 percent of exported capital goods exhibited this relationship. Over the entire sample period, 60 percent of unit values exhibit a negative relationship with the importer's per-capita GDP. In any given year, the percentage of U.S. capital goods exports that exhibits a positive and robust relationship with importer average income never exceeds 10 percent.

Panel B reports the relationship using world import data. From 1984 until the mid-1990s, more than 50 percent of imported capital goods prices exhibited a negative relationship with importer average income, with approximately 30-50 percent of all products exhibiting a statistically significant negative relationship in any given year, and with relatively stable percentages in all four columns until 1993. After 1998, the percentage of products exhibiting a statistically significant negative relationship with importer average income falls to less than 30 percent.

To account for the potential for temporal effects and noise in our dependent variable, we tabulate the relationship between unit values and importer income *over all years* (rather than by year) for full and 90-10 trimmed samples of prices. These shares are reported in the bottom two rows of Table 2. These regressions are analogous to specification (2), but include year fixed effects. In Panel A, 37 percent of U.S. capital goods export prices exhibit a negative and statistically significant relationship with importer average income. The percentage drops slightly, to 35 percent, when we exclude the bottom and top deciles of export prices. A similar pattern holds for the world import data in panel B. In the full and trimmed samples, approximately 27 percent of prices demonstrate a negative and statistically significant relationship with importer average income. Within-product regressions (by year and across all years) demonstrate that a large share of traded capital goods prices exhibit a negative and statistically significant relationship with importer average income.

3.3 Robustness

a. Outliers, Constant Country and Products

Noise in the data being an important concern, we present additional robustness tests. In particular, to account for influential outliers, the first two columns of Table 3 present results from samples of 70-30 trimmed and 60-40 trimmed price data. The 70-30 and 60-40 trimmed samples keep the "middle" 40 and 20 percent of the price data, respectively. Remarkably, with the more finely disaggregated U.S. export data in panel A, a negative and highly statistically significant relationship between export price and average importer income holds. A negative and statistically significant relationship is observed with 70-30 trimmed world import data. This is a strong finding, given that Feenstra et al. (2005) initially dampened the noise in the world import data by excluding small shipments valued at less than $100,000.

To assess the importance of the different categories within total imports, we estimated regressions that take into account the value weights of each country's imported goods (by year). We first estimate regressions for prices below and above the mean and median value weights (columns 3-6). These regressions demonstrate that the price of goods that constitute a large share of a country's imports (i.e., above the mean or median value weight) *do not* exhibit a different relationship with average importer income than the prices of goods that constitute a small import share. As an additional check, we estimate regressions that exclude prices that are three, four, and five times the magnitude of the median value-weight for each country for both our 10-digit and 4-digit data. We also estimate regressions in which we exclude these right outlier prices as well as prices that are 1/3, 1/4, and 1/5 the median value-weighted product. Columns 7 and 8 report our most conservative estimates (i.e., exclude the largest number of potential outlier prices). The results in columns 7 and 8 are consistent with the previous findings. Overall, our regressions with various trimmed samples suggest that our results are not driven by noise in the data.

Variation in the sample of countries and products over time introduces an additional factor that could potentially influence the findings of our analysis. To account for this, we present in Table 4 results that limit our sample to the countries and products (separately and combined) that are constant throughout the period. Column 1 reports the coefficient on average importer income when the sample is reduced to countries that have observations over the entire sample period. With this reduced sample, the coefficient is negative with both U.S. export (panel A) and world import (panel B) data. For U.S. exports, the coefficient is significant at the one percent level. Similarly, when the sample is reduced to products traded in every year, column 2, the coefficient is negative and significant in both panels. Finally, when holding countries and products constant over the sample, column 3, the coefficient is negative for both U.S. exports and world imports, but significant only for U.S. exports. These findings are robust in a 90-10 trimmed sample that excludes the top and bottom 10 percent of prices (columns 4-6).

Our main result, that unit prices of capital goods exhibit a negative and significant relationship with the importing country's average income, is robust to various sample and specification checks. We report results for our regression controlling for the interaction of year and product (i.e., year*product dummies) only. Controlling separately for year, product, and year and product dummies yields similar results.

b. By Income Group

Our analysis thus far suggests that the price of imported equipment goods is higher in poorer countries. We test this explicitly by re-estimating our basic specification for low- and high-income countries separately. In any given year, a low-income country refers to "low" and "low middle" income countries, a high-income country to "high" income countries, as defined by the World Bank.[20] We report these results in Table 5. Dividing the sample into low- and high-income countries highlights the higher cost of imported capital goods in poor countries. With U.S. export data, the coefficient is negative in both the low- and high-income sub-samples, the size of the coefficient in the low-income sample being about double that of the coefficient in the high-income sample. These findings hold in 90-10 and 80-20 trimmed samples (not reported).[21] These results further suggest that poorer countries pay more for imported capital goods. With world import data, the coefficient in the low-income sample is negative and significant, the coefficient on average income positive but not significant for rich countries.

d. Sample Differences.

Many of the studies that use data from the Penn World Tables have limited their analysis to benchmark countries (as we use an alternative data source, our analysis embraces a broader sample that includes both benchmark and non-benchmark countries). Hsieh and Klenow (2007), for instance, examine benchmark countries in the 1980, 1985, and 1996 ICP surveys. The sample changes throughout these surveys. To allay any concerns that our results might be driven by sample differences, we estimate equation 1 for samples of benchmark countries in the 1985 and 1996 ICP surveys. The results, reported in Table 5, columns 3 and 4 demonstrate a negative relationship between the price of imported capital goods and importer average income. With U.S. export data, in panel A, the relationship is negative and highly statistically significant in samples limited to the benchmark countries in the 1985 and 1996 ICP survey.

[20] Because prior to 1987 the World Bank did not categorize countries by income group, we use for those years the per capita income values in 1987. The income group classification does not change for most countries over the sample period.

[21] We obtain similar results when we exclude the "Big Seven" exporting countries and also Korea, Brazil and India.

With world import data, there is a negative but weaker relationship. Trimmed samples display similar results.

e. PPP per Capita GDP (from the PWT)

Having questioned the quality and accuracy of PWT capital goods data, we have avoided incorporating any series from that data set in our analysis. We do, however, re-estimate our basic specification using as our independent variable the log of per-capita GDP measured in purchasing power parity (PPP) from the PWT (as opposed to average income from the World Development Indicators). Results are reported in Table 5, columns 5-7. Using both world import and U.S. export data, we find a negative and significant relationship between average income and unit price (column 5). This negative and statistically significant relationship is robust to 90-10 and 80-20 trimmed samples (columns 6 and 7). These results should not be surprising, as the per-capita GDP series from the PWT and WDI are highly correlated, PWT data relying, for methodological reasons, on growth rates from national income account data.

4 Discussion

Our findings of a negative and significant relation between income and the price of imported capital goods are consistent with a large literature that emphasizes the role of economic policy and institutions in shaping incentives to accumulate capital that frequently drive up its cost (Diaz-Alejandro, 1970; Taylor, 1998a, b). Trade economists also suggest that trade barriers are much larger, whether implied gravity barriers or direct measures of trade costs are used. Eaton and Kortum (2001) estimate barriers to trade in equipment to be quite high. In their vast survey of "trade costs," Anderson and van Wincoop (2004, p. 847) conclude that, on average, developing countries have significantly larger trade costs "by a factor of two or more in some important categories," and that these costs "also vary widely across product lines, by factors as much as 10 or more." But our conclusion differs from findings using PWT data that the absolute price of capital is no higher in poor countries. The current conventional wisdom among most macroeconomists is that the role of distortions in the price of capital goods is small, even negligible, in explaining income differences between rich and poor countries.

To fully explain the reasons behind these differences is beyond the scope of this paper. A more complete answer to this question would require, in addition to other data, detailed information on individual prices in the PWT, which, as noted, is confidential or non-existent.

Differences might, however, be due to "measurement" issues related to the data that underlie the analysis. As we and others have argued, the raw data for the PWT collected by the ICP might not be capturing the true costs of equipment goods or sampling the "same" goods.[22] Issues associated with the ICP methodology raise questions about the accuracy of the capital prices across countries. For example, mis-measured price indices (e.g., of investment series in the PWT) might not accurately capture the heterogeneity (and quality) of products. As mentioned, in theory the prices collected should be final prices. The use, in practice, of alternative sources is, in our view, troubling, there being no clear way to adjust these prices to obtain a final price, especially for complex/seldom sold/traded capital goods. If, during the ICP survey rounds, country and regional offices are assigning prices to goods from the same sources (i.e., catalogs, telephone calls), it should not be surprising that ICP prices are similar across countries.[23] Another possibility is that the ICP price measures might not properly account for the lower quality of capital goods and high share of used imported equipment in low-income countries. Additionally, the PWT uses expenditure shares from local sources, which might not reflect the real uses of capital goods.

Accounting for these forms of measurement error, however, does not readily explain why the cost of imported equipment goods along individual product lines would be higher in low-income countries. Furthermore, as U.S. export data do not include transportation and world import data do not include additional costs (tariffs, for example), differences in prices might reflect differences in information, higher costs being associated with searching for and negotiating (directly or indirectly) foreign purchases, the distribution and maintenance of goods, and conventional "gravity" variables (e.g., common currency, shared characteristics such as common language and border, etc.) as well as the volume of trade (Ayres and Siegelman, 1995; Anderson and van Wincoop, 2004).

Many of the main distributors of machinery and equipment do not have local offices in many developing countries (which are served via main headquarters, regional offices, or independent intermediaries).[24] Low-income countries might also be paying more for capital goods shipped in small quantities. Using our disaggregated 10-digit HS U.S. export data, we find that for U.S. exports of capital goods in shipments of one to two units, low-income countries are charged about six times more, and in

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[22] When comparing their results with those of ICP 1985 prices, Eaton and Kortum (2001) argue that ICP price measures do not adequately reflect the lower quality of equipment in poor countries. Another possibility is that the ICP ignores many components of the cost of equipment (e.g., learning about it and about how it works, adapting it to local conditions, maintenance, etc.) that are, in fact, higher in poorer countries. On the other hand, the authors note that ICP prices might consider wholesale and retail activities, which might cost less in developing countries (see Kravis and Lipsey, 1988).

[23] Barba-Navaretti et al. (2000) document that poorer countries tend to import higher shares of used capital goods. The 2005 ICP round required the pricing of new machinery. The policy for previous rounds is unclear on whether this was done (in this and previous rounds) given the high component of imported used goods and pricing of machinery not commonly used in the country.

[24] In conversation, ICP officials noted that for the ICP 2005 round the technical advisory group considered one price for equipment for small countries, though many were opposed, some, such as those working in Africa, strongly so on the grounds that the law of one price was not an acceptable assumption "because price discrimination operates against countries with small markets for equipment."

shipments of one to ten units, about four times more, than high-income countries.[25] Exploring these possibilities further is an important topic for future research.

Higher prices in poor countries might also reflect price discrimination. For example, price discrimination has long been present in the trade of automobiles (Mertens and Ginsburgh, 1985; Verboven, 1996). In an attempt to illuminate the role of discrimination in bargaining, Ayres and Siegelman (1995) documented how different individuals are often charged different prices for the same product (in their case, automobiles in Chicago). Observing that affluent white males (who have higher reservation prices) are often charged a lower price than blacks and females, the authors speculate that it might be profitable for firms to charge higher prices to groups of consumers that have a lower average reservation price if the variance of reservation prices within the group is sufficiently large. Within the context of traded capital goods, for example, suppose that a larger proportion of businesses in poor (than in rich) counties is willing to pay a high markup even though the mean (or median) firm in a developing country has a lower reservation price than its counterpart in a rich country. A vendor that knows this might rationally charge higher prices to all of its customers in poor countries.

Of course, higher unit prices could reflect higher product quality (Schott, 2004; Hummels and Klenow, 2005; Hallack, 2006). Addressing this issue directly is beyond the scope of this paper, as it is not easy to differentiate quality from other factors across products in our data (although the use of highly disaggregated U.S. data accommodates comparisons within more "similar" goods).[26] But if we assume this to be the case, the negative relationship between average income of the importing country and price of imported equipment implies that poorer countries are importing higher quality capital goods (or, equivalently, that richer countries are importing lower quality capital goods), which contradicts recent findings that suggest that developing countries import older, vintage capital goods. Barba-Navaretti and Soloaga (2001), for example, find that Eastern European countries import low quality computers (e.g., lower processing speed) relative to their benchmark country, the United States. Use of used machinery and equipment is widespread in Africa. But more generally, it seems unlikely that the United States would be exporting its highest quality and technologically advanced products to low-income countries rather than to richer export markets in Western Europe and North America. Testing these hypotheses further would be an important complement to our analysis.

Our results are compatible to those obtained by Alfaro, Peri, and Taylor (2009), who obtained access to the 2005 ICP confidential data and used the country-product-dummy (CPD) method outlined by the ICP (p. 156). The evidence indicates that the law of one price is rejected econometrically for

[25] For world import data, our analysis is limited by the fact that imports valued at less than $100,000 are not included, which likely excludes small shipments. Using this data set, we found that small shipments of capital goods cost about the same in low-income and high-income countries (a result likely due to the limitations of the data).

[26] See Hallack and Schott (2005) and Khandelwal (2007) for important work in this direction.

developing countries. There is, however, substantial variation. Significant markups for Latin America are not fully accounted for by tariffs, and prices in Latin America are higher than in Asia. The African data, moreover, are highly variable, suggesting remaining measurement issues. The authors explored some potential explanations for the mark-up differences across countries. They obtain significant results for remoteness, but the tariff variable was not significant. Thus, our preliminary evidence suggests an important role for transportation costs (consistent with the trade literature), and at the same time casts some doubt on the representativeness of the reported prices.[27]

Our results could also be related to some systematic biases in the collection of data in poor countries. Given that we use data collected by U.S. officials (in addition to the world trade data), this seems less likely. But an alternative explanation might be over-invoicing of machinery exports (contributing to higher prices) in corrupt (which tend to be lower income) countries. We test for this possibility by re-estimating our basic specification (1), controlling for corruption in the importing country (using the International Country Risk Guide corruption index).[28] After controlling for corruption, the coefficient on GDP per capita remains negative and statistically significant in full and trimmed price samples (results not reported).[29]

5 Conclusion

In this paper, we use highly disaggregated capital goods trade data to explore differences in the price of capital across countries, a strategy motivated by the fact that most countries import the bulk of machinery equipment (from a small number of industrialized countries). We find the price of imported capital goods to be negatively and significantly correlated with the average income of the importing country. Because most low-income countries import the bulk of capital goods, our results provide evidence that capital goods are more expensive in poor countries.

Our results should be viewed as suggestive. First, because most of the capital goods surveyed in the ICP rounds are measured in number of units, we use that measure, acknowledging that unit values might not fully capture the final user price of the imported capital good. The world import data, for

[27] Transportation costs can be incorporated in our analysis of U.S. exports by including importer fixed effects (which would account for the time invariant distance between the United States and the importer country). In a model with product*importer country dummies plus year dummies, the estimated coefficient on log GDP per capita is -0.11 and significant at 1%. In a model with product*year*country dummies (that account for more than 90 percent of the variation in import prices), the coefficient on log GDP per capita remains negative and highly statistically significant. These findings are consistent with our earlier results.

[28] The International Country Risk Guide (ICRG) corruption index is an assessment of corruption within the political system. The index is measured on a 0-6 scale, zero representing the highest, six the lowest, level of risk (with respect to corruption). Data are available beginning in 1985.

[29] The coefficient on the corruption variable is positive and statistically significant when using the world trade data, and positive, albeit not significant, when using the U.S. trade data.

example, do not include tariffs, and our U.S. export data exclude transportation costs. Including these costs, however, would likely strengthen our results.[30] Moreover, our analysis would be more complete if we considered the price of locally produced capital goods, but this information (as other scholars have noted) is difficult to assemble, especially for poorer countries (Eaton and Kortum, 2001; Caselli and Wilson, 2004). Finally, as is the case with many cross-country studies of traded goods, our results might be sensitive to the method by which we measure our units (e.g., whether we use number of units or weight). Because most of the capital goods surveyed in the ICP rounds are measured in number of units, we use that measure in our analysis.

These limitations notwithstanding, our results might have important implications, as they suggest that investment distortions and the higher price of capital might, indeed, be factors in observed differences in relative prices of capital. If the lack of correlation between price of capital and level of development found in the ICP data is due only to large error in and imperfect quality adjustment of the price data, removing barriers to capital goods prices and promoting market integration should have a relevant effect on development.

Appendix A: Penn World Tables (PWT) and the International Comparison Program (ICP)

a. Construction of the PWT

The Penn World Tables (PWT) present data on national accounts economic time series for many countries (Summers and Heston, 1991).[31] Regionalization of the United Nations International Comparison Program (ICP), beginning with the 1980 benchmark, facilitated estimation of the purchasing power parity (PPP) series for non-benchmark countries and extrapolation backward and forward in time. The PPP estimation typically entails regressing national price indices (developed for setting post-allowances for international employees working abroad) on per capita domestic currency converted to international dollars expressed relative to the United States.

The PWT uses the benchmark data to convert each country's expenditures at domestic prices to a common set of international prices. For benchmark countries, price levels for consumption, government expenditures, investment, and net foreign balances are obtained directly from the aggregation (using the Geary multilateral method) of the appropriate price headings from the ICP survey (there are 32 price

[30] In many developing countries, for example, tariffs were quite high during the sample period, which would likely drive up the price of imported goods. As Obstfeld and Taylor (2004) note, developing countries' access to imported physical capital has been "affected by tariffs, quotas, commercial policies, exchange rate controls and the like." More generally, Anderson and van Wincoop (2004) conclude from a recent survey that trade costs vary widely across countries, by factors of as much as 10 or more.

[31] See Penn World Tables (2002) for a detailed account of how the PWT is constructed.

heading parities for the various expenditure shares constructed by the World Bank from the various regional ICP regional comparisons).

For non-benchmark countries, prices are inferred from fitted values of price regressions run over the benchmark data. There are three potential sources for these international price series: the International Civil Service Commission (ICSC) index published in the Monthly Bulletin of Statistics of the United Nations Statistical Division (usually in September of each year), which covers 105 of the 115 countries in the PWT 1996 benchmark; the Employment Conditions Abroad index, which produces a number of binary price indices (compiled from data provided by firms, governments, and non-profit international agencies); and a State Department index that includes housing or a separate housing allowance.

Prices for non-benchmark countries are estimated, using these international price series, by means of a "shortcut" equation that regresses the log of the per-capita real expenditures of Domestic Absorption (DA) on the log of the nominal expenditures divided by the post-adjustment indices (both relative to the U.S. values), with dummy variables for the Sub-Saharan African and Central Asian countries. This serves to verify how close the benchmark price levels are to the indices, as the nominal per capita DA expenditures enter the equations on both sides. The coefficients are then applied to the non-benchmark data and the exponent of the result is the shortcut estimate of the real per capita DA.[32]

The price series (both the actual series from benchmark countries and predicted series from non-benchmark countries) are interpolated to fill in the years between benchmark surveys (1970, 1975, 1980, 1985, 1990, 1996) using national accounts data (originally from the World Development Indicators). If actual or predicted prices are unavailable for a country in a benchmark year, the price from the last available benchmark year is extrapolated. Thus, there are several possible price levels: actual prices from the ICP benchmark surveys; predicted price levels from the shortcut regression estimates discussed above; and extrapolated price levels. For both benchmark and non-benchmark countries, price series for investment are not adjusted for quality.

ICP documentation highlights some of the important difficulties of collecting similar prices for a wide range of countries.

> The ICP has to work with a single list of products that every country has to price. . . . The overall list may not be representative of any single country, and all countries will have to price some products that are representative of other countries even though they are not the kind of products they would include in their own CPI. . . . It is only possible to collect prices for a limited number of products within each basic heading, and it is crucial to the success of the entire ICP that the right products are identified and priced. . . . However, a country is usually not able to price every item, thus the results will depend upon the method used. . . . An important conclusion regarding the process to prepare PPPs is that insufficient or poor quality data for some countries can affect

[32] Real shares for consumption, investment, and government expenditures are also estimated for non-benchmark countries. These regressions are different from the shortcut estimate discussed in the text.

> the results for all countries and not just the PPPs for the country concerned. (World Bank, 2006, Introduction, p. 8)

Although in theory, ICP surveys price final goods, even the 2005 round allowed for other sources. In the particular case of capital goods, the ICP documentation notes that:

> In the case of equipment goods [in the system of national accounts], the purchaser price includes all the transportation or other costs incurred in delivering and installing the asset in the desired location. The purchaser price includes any (non-deductible) taxes payable on the assets and also includes the costs of any professional services incurred, such as the fees payable to surveyors, architects, lawyers, etc. As explained below, there are occasions when, for practical or cost reasons, it is necessary to depart from the strict SNA definition of purchaser prices in reporting prices of fixed assets for the ICP. (World Bank, 2006, Ch. 9, pp. 1-2)

b. The 2005 ICP Round: Capital Goods

In acknowledgment of the many issues associated with the collection of individual prices in previous ICP rounds, the methodology used for the 2005 ICP round differed considerably from that used previously. A coordinated but relatively decentralized process was employed whereby the World Bank's Global Office (which coordinates the ICP data collection process among regions and countries) creates a set of standard product descriptions (SPDs). Individual country offices are responsible for collecting the prices for these products using any combination of methods they find most "convenient" (World Bank, 2006, p. 10).

One important issue is the need to price items many of which are not commonly used in the different countries. This raises issues for consumption goods (services, for example), but there are particular problems associated with the pricing of capital goods, as noted in the ICP 2005 documentation.

> Some Special Problems: Capital goods can be much more complex and variable than consumer goods. For this reason, it may be more difficult to obtain perfect matches between the capital goods purchased in different countries than for consumer goods. Brands have an important role to play, but characteristics of a capital good with the same international brand and serial or model number are actually liable to differ from country to country because of variations in local tastes, conditions, climates, regulations or the marketing strategy adopted by the producer. . . . The complexity of many capital goods is so great that the expertise required to draw up appropriate specifications for the products to be priced and to obtain average prices for them are not to be found within most statistical offices. Building engineers, architects, quantity surveyors or other experts have to draw up the specifications and determine the appropriate prices. In some countries these specialists can be found in government departments such as public works departments, construction ministries or other government agencies responsible for building regulations or for purchasing equipment for government use. In other countries this work has to be contracted out to consultancy firms specializing in engineering and/or construction. These consultancies can be expensive and may use up a lot of the total resources available for PPP work. Contracting out the work to professional consultancy firms also means that there is no equivalent to the pre-survey

for consumer goods involving prolonged interaction between the regional coordinators and the national statistical offices. (World Bank, 2006, Ch. 9, p. 2)

One of the main objectives of the 2005 round was to improve the methodology in terms of the collection of data. To be consistent with the national accounts, countries are required to provide prices for machinery and equipment that are consistent with their valuation as fixed capital assets in the national accounts. This means that the prices must include trade, transport, and delivery and installation charges, include only import duties and other product taxes that are actually paid by the purchaser, and be reported after deducting any discounts that are generally available to most producers. The following rules should be observed in reporting prices for machinery and equipment.

- **Discounts.** The price should refer to the purchase of a single item so that it is not affected by discounts that may be available for large orders. However, the price of the single item should be reported after deducting any discount that is customarily available to most purchasers and that is available for most of the year.
- **Transport and delivery costs**. When prices of equipment goods do not include transport and delivery costs, these should be estimated by countries selecting their own average distance over which the items are transported and delivered.
- **Installation costs.** There are usually costs associated with the installation of fixed equipment and these are included as part of gross fixed capital formation in the national accounts. Installation charges include not only any charges that the purchaser pays for the item to be physically installed at the factory or other site, but also any costs for testing, running-in or calibrating the equipment. In the case of transport equipment there are usually no installation costs.
- **Product taxes.** Finally, the price should only include *non-deductible* product taxes. Countries that levy value added taxes normally allow purchasers to deduct the full amount of tax on capital goods. Sales and other product taxes and sometimes import duties may also be fully or partly deductible on capital goods.

  The transaction characteristics have to be respected since countries are required to report actual transaction prices and not list or catalogue prices. List or catalogue prices may be the initial source of price data, but these prices must be adjusted to meet the transaction characteristics noted above. (World Bank, 2006, Ch.9, pp. 8-10)

By way of example, the SDP form for a "Utility Tractor" issued by the Global Office for the 1993/96 ICP round gives a general description of the piece of equipment and its usual purpose and principal specifications. A particularly noteworthy feature of the form is the specification of three utility tractors. The Kubota M6800 is identified as the preferred model, but there are two alternates, a Massey-Fergusson and a Mahindra. A provision is also made for an unspecified alternate in the event that all three listed models are unavailable.[33]

In the first stage of the collection process, the Global Office decides on a core list of equipment goods to be priced by each country. For the 2005 ICP survey, the Global Office identified 108 core equipment goods including fabricated metal products (five), general-purpose machinery (15), special-

[33] Implicitly, the ICP method tries to adjust for quality differences, but as this example underscores, the methodology used (and lack of oversight) can generate significant biases in some poor countries.

purpose machinery (39), electrical and optical equipment (29), motor vehicles, trailers, and semi-trailers (11), and software (9), although in practice this number (and type) can be relaxed. Regional offices can draw up lists of equipment goods to be priced considered to be representative of their countries, but are expected to consult the core list of 108 goods first and provide prices for at least 80 of the specified items.

Countries are required to price machinery and equipment consistent with its valuation as fixed capital assets in the national accounts, meaning that prices must include trade, transport, and delivery and installation costs, all (including import duties) paid by the purchaser, and be reduced by any discounts generally made available to producers. Prices can be collected from any of a variety sources including directly from producers, importers, or distributors or their catalogs. Countries are free to collect prices using whatever method or combination of methods they find most convenient: personal visit, telephone, letter, Internet, and so forth. For the 2005 round, the Global Office even provided a list of Web sites that countries could visit.[34] Regional coordinators "edit" the prices to ensure that products that share the same technical characteristics can be compared.

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[34] Examples include Fabricated Metal Products: www.alcoa.com (aluminum extrusions); General Purpose Machinery: www.ingersol-rand.com (cranes and compressors), www.volvo.com (cranes), www.kawasaki.com (gas turbines), www.cat.com (engines and gas turbines), www.johndeere.com (diesel engines), and others; Special Purpose Machinery: www. agcocorp.com (agricultural machinery), www.cat.com (earthmoving, mining, quarrying, and material handling), www.cnh.com (agricultural machinery bra), (construction machinery including CASE, New Holland, and Kobelco), www.johndeere.com (agricultural, earthmoving, forestry and lawn care), www.ingersol-rand.com (earthmoving), www.volvo.com (earthmoving), www.komatsu.com (earthmoving), www.kawasaki.com (earthmoving), www.jcb.com (earthmoving, agriculture, and forklifts), www.makita.com (power woodworking tools), www.black&decker.com (power woodworking tools), and others; Electrical/Optical/Medical Equipment: www.leviton.com (switching devices), www.squared.com (control and switching devices), www.sylvania.com (controls, switching devices, and lights), etc.; Motor Vehicles/Trailers/Semi-trailers: www.mack.com (cab/chassis and tractor), www.paccar.com (truck/tractor brands including Kenworth, DAF, Leyland, Peterbilt, and Foden), www.navistar.com (cab/chassis and tractors), and others.

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Table 1: Unit Values of Capital Goods and Importer Characteristics

Panel A: U.S. Exports

	(1)	(2)	(3)	(4)	90-10 Trim (5)	80-20 Trim (6)
Log GDP per Capita (WDI)	-0.082	-0.058	-0.14	-0.080	-0.070	-0.051
	[0.015]***	[0.015]***	[0.017]***	[0.014]***	[0.010]***	[0.007]***
Product*Year Dummies	Y				Y	Y
Product Dummies		Y		Y		
Year Dummies			Y	Y		
R^2	0.76	0.73	0.01	0.74	0.62	0.48
# Observations	1273536	1273536	1273536	1273536	1026756	783929

Panel B: World Imports

	(1)	(2)	(3)	(4)	90-10 Trim (5)	80-20 Trim (6)
Log GDP per Capita (WDI)	-0.103	-0.102	-0.156	-0.099	-0.085	-0.060
	[0.044]**	[0.047]**	[0.072]**	[0.045]**	[0.039]**	[0.028]**
Product*Year Dummies	Y				Y	Y
Product Dummies		Y		Y		
Year Dummies			Y	Y		
R^2	0.69	0.68	0.01	0.68	0.57	0.46
Observations	217104	217104	217104	217104	177119	134378

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Panel A displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 10-digit product level) on log importer GDP per capita from 1978 to 2001. Panel B displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 4-digit SITC product level) on log importer GDP per capita from 1984 to 2000. Column 5: prices in the top 10% and bottom 10% dropped from the sample. Column 6: prices in the top 20% and bottom 20% dropped from the sample. Robust standard errors adjusted for importer clustering are listed below each coefficient.

Table 2: Relationship between Unit Values of Capital Goods and Importer Income, by Year

Panel A: Unit Value of Capital Goods and Importer Country GDP per Capita (by year and product), 10-digit HS U.S. Export Data

Year	% Positive & Significant	% Negative & Significant	% Positive & Non-Signif.	% Negative & Non-Signif.
1978	9%	17%	29%	45%
1979	9%	16%	31%	45%
1980	10%	17%	33%	40%
1981	8%	15%	33%	44%
1982	6%	17%	31%	45%
1983	6%	16%	35%	42%
1984	5%	17%	32%	46%
1985	5%	18%	33%	45%
1986	9%	14%	35%	41%
1987	8%	17%	37%	38%
1988	6%	17%	31%	46%
1989	6%	21%	30%	43%
1990	8%	19%	30%	43%
1991	8%	18%	32%	41%
1992	6%	20%	32%	42%
1993	6%	21%	29%	44%
1994	6%	22%	30%	42%
1995	7%	22%	32%	39%
1996	6%	23%	31%	40%
1997	6%	23%	32%	39%
1998	6%	22%	31%	41%
1999	6%	20%	32%	41%
2000	7%	22%	31%	40%
2001	9%	21%	29%	41%
All prices	11%	37%	23%	28%
90-10 trim	14%	35%	22%	30%

NOTES: This table reports the distribution of signs (and their significance) from product-level regressions by year for U.S. export data at the 10-digit HS level. The regression specification is of the form: log(price) = a + b* log(importer GDP per capita). The first column reports the percentage of capital goods that exhibits a positive and significant (at the 10 percent level) relationship with importer per-capita GDP. Column 2 reports the percentage of capital goods that exhibits a negative and significant relationship with importer per-capita GDP. Column 3 reports the percentage of capital goods that exhibits a positive and non-significant relationship with importer per-capita GDP. Column 4 reports the percentage of capital goods that exhibits a negative and non-significant relationship with importer per-capita GDP. For all four columns, significance is at the 10 percent level, based on robust standard errors (but not clustered by importer country's per-capita GDP). The rows for "All prices" and "90-10" report shares for product-level regressions for all years and include year fixed effects.

Table 2, continued

Panel B: Unit Value of Capital Goods and Importer Country GDP per Capita (by year and product), 4-digit SITC World Import Data

Year	% Positive & Significant	% Negative & Significant	% Positive & Non-Significant	% Negative & Non-Significant
1984	16%	30%	25%	30%
1985	13%	27%	23%	36%
1986	13%	39%	21%	27%
1987	19%	27%	28%	26%
1988	11%	45%	22%	23%
1989	11%	43%	19%	27%
1990	15%	41%	16%	28%
1991	16%	43%	14%	27%
1992	16%	49%	16%	19%
1993	15%	43%	16%	26%
1994	21%	34%	26%	19%
1995	22%	36%	18%	24%
1996	24%	43%	15%	19%
1997	25%	32%	23%	20%
1998	21%	27%	24%	28%
1999	24%	24%	29%	24%
2000	45%	23%	19%	13%
All prices	17%	27%	23%	33%
90-10 trim	16%	27%	28%	28%

NOTES: This table reports the distribution of signs (and their significance) from product-level regressions by year for world import data at the 4-digit SITC2 level. The regression specification is of the form: log(price) = a + b* log(importer GDP per capita). The first column reports the percentage capital goods that exhibits a positive and significant (at the 10 percent level) relationship with importer per-capita GDP. Column 2 reports the percentage of capital goods that exhibits a negative and significant relationship with importer per-capita GDP. Column 3 reports the percentage of capital goods that exhibits a positive and non-significant relationship with importer per-capita GDP. Column 4 reports the percentage of capital goods that exhibits a negative and non-significant relationship with importer per-capita GDP. For all four columns, significance is at the 10 percent level, based on robust standard errors (but not clustered by importer country's per-capita GDP). The rows for "All prices" and "90-10" report shares for product-level regressions for all years and include year fixed effects.

Table 3: Unit Values of Capital Goods and Importer Characteristics, Robustness--Outliers

Panel A: U.S. Exports

	70-30 Trim	60-40 Trim	Below Mean	Above Mean	Below Median	Above Median	Exclude 3xMedian	Exclude 3 & 1/3 Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log GDP per Capita (WDI)	-0.024	-0.005	-0.069	-0.068	-0.044	-0.0804	-0.06	-0.066
	[0.004]***	[0.001]***	[0.013]***	[0.017]***	[0.011]***	[0.015]***	[0.012]***	[0.012]***
Product*Year Dummies	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.36	0.24	0.73	0.88	0.69	0.83	0.72	0.78
# Observations	530259	265938	1042643	230893	636135	637401	916593	563028

Panel B: World Imports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log GDP per Capita (WDI)	-0.036	-0.011	-0.09	-0.16	-0.061	-0.137	-0.076	-0.085
	[.028]*	[0.008]	[0.05]*	[0.043]***	[0.05]	[0.042]***	[0.046]*	[0.04]**
Product*Year Dummies	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.35	0.22	0.68	0.78	0.65	0.74	0.66	0.68
Observations	94063	47419	177673	39431	107579	109525	156452	105793

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Panel A displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 10-digit product level) on log importer GDP per capita from 1978 to 2001. Panel B displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 4-digit SITC product level) on log importer GDP per capita from 1984 to 2000. Column 1: prices in the top 30% and bottom 30% dropped (i.e., 70-30 trim). Column 2: prices in the top 40% and bottom 40% dropped. Column 3: sample limited to prices below the mean value weight. Column 4: sample limited to prices above the mean value weight. Column 5: sample limited to prices below the median value weight. Column 6: sample limited to prices above the median value weight. Column 7: sample excludes prices that are three times greater than the median price. Column 8: sample excludes prices that are three times greater and less than 1/3 the median price.

Table 4: Unit Values of Capital Goods and Importer Characteristics, Robustness--Samples

Panel A: U.S. Exports	Countries Constant	Products Constant	Countries & Products	Countries constant, 90-10 Trim	Products constant, 90-10 Trim	Countries & Products, 90-10 Trim
	(1)	(2)	(3)	(4)	(5)	(6)
Log GDP per Capita	-0.077	-0.081	-0.047	-0.067	-0.065	-0.046
	[0.015]***	[.016]***	[0.020]**	[0.01]***	[0.012]***	[0.015]***
Product*Year Dummies	Y	Y	Y	Y	Y	Y
R^2	0.76	0.77	0.79	0.62	0.64	0.66
Observations	1240758	542780	405814	998433	445050	334520
Panel B: World Imports						
	(1)	(2)	(3)	(4)	(5)	(6)
Log GDP per Capita	-0.083	-0.102	-0.113	-0.027	-0.082	-0.071
	[0.056]	[0.044]**	[0.100]	[0.048]	[0.039]**	[0.081]
Product*Year Dummies	Y	Y	Y	Y	Y	Y
R^2	0.69	0.68	0.71	0.57	0.57	0.62
Observations	135319	201548	56330	109211	166262	46708

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Panel A displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 10-digit product level) on log importer GDP per capita from 1978 to 2001. Panel B displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 4-digit SITC product level) on log importer GDP per capita from 1984 to 2000. Robust standard errors adjusted for importer clustering are listed below each coefficient. Column 1: countries held constant throughout the sample. Column 2: products held constant throughout the sample. Column 3: countries and products held constant throughout the sample. Column 4: countries held constant throughout a 90-10 trimmed sample. Column 5: products held constant throughout a 90-10 trimmed sample. Column 6: countries and products held constant throughout a 90-10 trimmed sample. With U.S. export data in panel A, the coefficient on log GDP per capita remains highly statistically significant (p-value<0.01) in an 80-20 trimmed sample (results not reported).

Table 5: Unit Values of Capital Goods and Importer Characteristics, Robustness--Income Group, Sample and GDP Data

Panel A: U.S. Exports	Low Income	High Income	1985 Benchmark Countries	1996 Benchmark Countries	PWT per-Capita GDP	PWT per Capita GDP, 90-10 Trim	PWT per Capita GDP, 80-20 Trim
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log GDP per Capita	-0.21	-0.094	-0.115	-0.103	-0.121	-0.104	-0.077
	[0.037]***	[0.065]	[0.019]***	[0.018]***	[0.024]***	[0.017]***	[0.012]***
Product*Year Dummies	Y	Y	Y	Y	Y	Y	Y
R^2	0.73	0.8	0.78	0.76	0.77	0.64	0.5
Observations	464860	523710	610302	920921	994152	793320	602383
Panel B: World Imports							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log GDP per Capita	-0.253	0.025	0.01	-0.056	-0.148	-0.131	-0.098
	[0.127]**	[0.129]	[0.053]	[0.025]	[0.073]**	[0.067]**	[0.049]**
Product*Year Dummies	Y	Y	Y	Y	Y	Y	Y
R^2	0.68	0.75	0.71	0.7	0.69	0.57	0.46
Observations	90094	90052	104276	130786	175620	143851	109255

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Panel A displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 10-digit product level) on log importer GDP per capita from 1978 to 2001. Panel B displays OLS coefficients from a panel regression of importer-unit values of capital goods (at the 4-digit SITC product level) on log importer GDP per capita from 1984 to 2000. Robust standard errors adjusted for importer clustering are listed below each coefficient. Column 1: sample restricted to low and lower middle income countries. Column 2: countries restricted to high-income countries. Country income classifications follow the World Bank's definition. Column 3: sample restricted to countries in the 1985 PWT benchmark. Column 4: sample restricted to 1996 PWT benchmark countries. Columns 5-7: log GDP per capita is PPP GDP per capita from PWT. Columns 6-7: regressions estimated for 90-10 and 80-20 trimmed samples, respectively.

Table A1: Average “Grade” of PWT Data, by Region

Region	Average Grade	Letter Grade
Africa	1.56	D
N. Africa & Middle East	1.71	D
North America	2.44	C
South America	2.08	C-
Caribbean	1.81	D+
Asia	1.91	D+
Eastern Europe	1.60	D
Western Europe	2.77	B+
Oceania	2.50	C

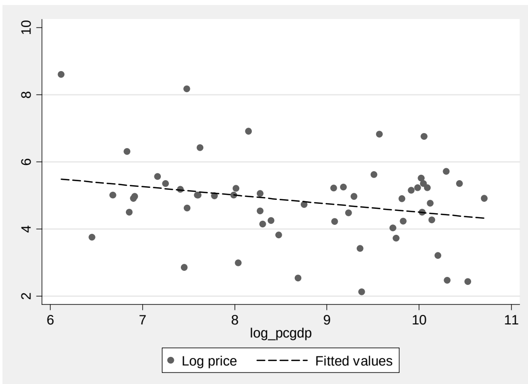
Source: Penn World Tables 6.1.
Notes: To compute regional grades, we averaged the Penn World Tables’ self-reported country grades. To calculate this average, we used the following numeric scoring: A=4, B=3, C=2, D=1.

Table A2: Sample of Countries

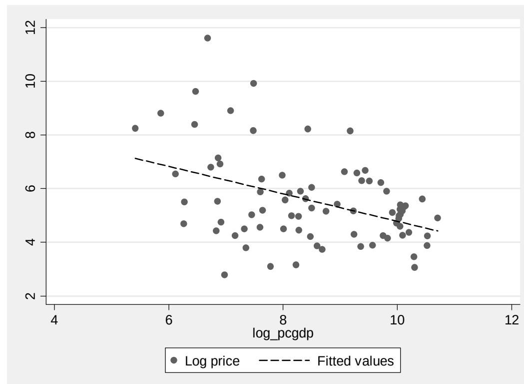
Albania	Dominican Rep.	Kiribati	Romania
Algeria	Ecuador	South Korea	Russia
Angola	Egypt	Kuwait	Rwanda
United Arab Emirates	El Salvador	Kyrgyzstan	Samoa
Argentina	Equatorial Guinea	Laos	Saudi Arabia
Armenia	Estonia	Latvia	Senegal
Australia	Ethiopia	Lebanon	Seychelles
Austria	Fiji	Macau	Sierra Leone
Azerbaijan	Finland	Macedonia	Singapore
Bahamas	France	Madagascar	Slovakia
Bahrain	French Guiana	Malawi	Slovenia
Barbados	French Indochina	Malaysia	Spain
Belarus	Gabon	Mali	Sri Lanka
Belize	Gambia	Malta	St. Kitts & Nevis
Belgium & Luxembourg	Georgia	Mauritania	Sudan
Benin	Germany	Mexico	Sweden
Bermuda	Ghana	Moldova	Switzerland
Bangladesh	Greece	Mongola	Syria
Bolivia	Guatemala	Morocco	S. Africa
Bosnia	Guinea	Mozambique	Tajikistan
Brazil	Guyana	Mauritius	Tanzania
Bulgaria	Guinea-Bissau	Nepal	Thailand
Burkina Faso	Haiti	Netherlands	Togo
Burundi	Honduras	New Caledonia	Trinidad
Cambodia	Hong Kong	New Guinea	Tunisia
Cameroon	Hungary	New Zealand	Turkey
Canada	Iceland	Nicaragua	Turkmenistan
Chad	India	Niger	Uganda
Chile	Indonesia	Nigeria	United Kingdom
China	Iran	Norway	Ukraine
Colombia	Ireland	Oman	Uruguay
Congo	Israel	Pakistan	Uzbekistan
Costa Rica	Italy	Panama	Venezuela
Croatia	Ivory Coast	Papua New Guinea	Vietnam
Cyprus	Jamaica	Paraguay	Yemen
Czech Republic	Japan	Peru	Zaire
Central African Rep.	Jordon	Philippines	Zambia
Denmark	Kazakhstan	Poland	Zimbabwe
Djibouti	Kenya	Portugal	

Figure 1: Log Unit Values versus Log Importer per Capita GDP for Four Types of Equipment Goods Exported from the United States (in 2000).

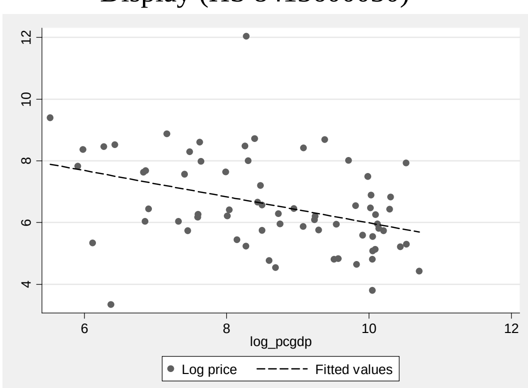
Electric Lamp (HS 9405203000)



Fuel Injection Pump for Compression- Ignition Engines (HS 8413301000)



Hydraulic Fluid Power Pumps, Rotary Positive Display (HS 8413600030)



Radio Transmitters for Frequencies Up to 30MHz (HS 8525106030)