

Additional Appendices (B-H): Pricing-to-Market and Absolute PPP
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Figure A.1: American Economic Association Memberships and Real GDP per capita

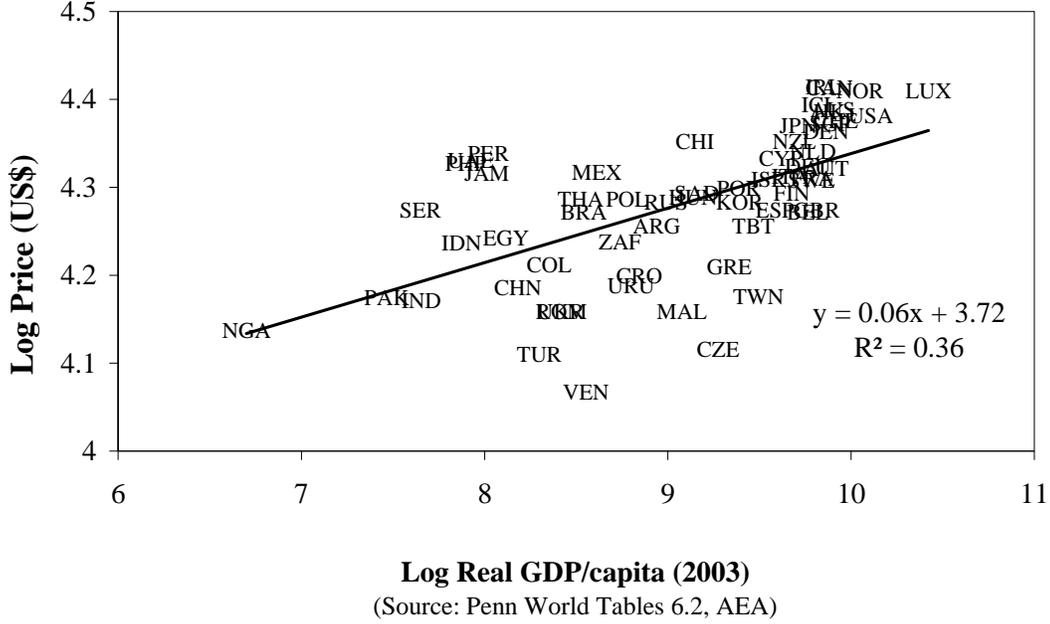


Figure A.1 plots American Economic Association (AEA) membership prices in 2008 by destination market income per capita. The relation between prices and income is positive and significant, although at 0.062 the elasticity is smaller than with tradables. The AEA has four membership prices tied to the income and professional status of subscribers. In 2009, students pay \$32; non-students with income below 50k pay \$64; non-students with income between 50k and 66k pay \$77; and those with income above pay 66k pay \$90. We calculate average unit values by destination country by weighting appropriately using membership data. The AEA also price discriminates by income on submissions for its different journals, including this journal. Submission fees vary from \$0 to \$100 (\$0 to \$200 for non-members) depending on the income of the country where the submitter works. The AEA journals differentiate submission fees by country income (low, medium, and high) and membership status. Since submissions from low income countries are free, we can not estimate the extent of pricing-to-market for all countries. However, restricting ourselves to countries with positive submission fees we find a pricing-to-market coefficient of 38 percent. All data are available in our submitted data file, Tables_Figures.xlsx.

Appendix C: Extended Sample of 20 Randomly Selected Goods in Alphabetical Order

Consumer/Automotive Goods

ALARM CLOCKS, NOT BATTERY OR AC POWERED

GLASSWARE, OF GLASS-CERAMICS, OF A KIND USED FOR TABLE, KITCHEN, TOILET, OFFICE, INDOOR DECORATION OR SIMILAR PURPOSES (OTHER THAN OF HEADING 7010/18)

MEN'S AND BOYS' SWEATERS OF COTTON, KNITTED OR CROCHETED CONTAINING GE 36% BY WEIGHT OF FLAX FIBER

MUSIC SYNTHESIZERS, OTHER THAN ACCORDIONS

POCKET LIGHTERS,GAS FUELED,REFILLABLE

RUTOSIDE (RUTIN) AND ITS DERIVATIVES)

TABLE OR KITCHEN GLASSWARE OTHER THAN DRINKING GLASSES, HAVING A LINEAR COEFFICIENT OF EXPNSN NOV 5X0-6/KELVIN IN TEMPERATURE RANGE OF O TO 300 DEG C

TARPAULINS, SAILS FOR BOATS, SAILBOARDS OR LANDCRAFT, AWNINGS, SUNBLINDS, TENTS AND CAMPING GOODS: SAILS OF SYNTHETIC FIBERS

TOILET/FACIAL TISSUES, TOWEL/NAPKINS STOCK & SIMILAR PAPER FOR HOUSEHOLD/SANITARY PURPOSES, CELLULOSE WADDING & WEBS CELLULOSE FIBERS IN ROLL/SHEETS

WASHING MACHINES, EXCEPT COIN OPERATED, FULLY AUTOMATIC, DRY LINEN CAPACITY NOT EXCEEDING 10 KG, HOUSEHOLD OR LAUNDRY TYPE

Non-Consumer/Automotive Goods (Agriculture, Industrial Supplies, and Non-Automotive Equipment)

4,4'-ISOPROPYLIDENEDICYCLOHEXANOL; & MIXTURES CONT NOT LESS THAN 90% BY WEIGHT OF STEREOISOMERS OF 2-ISOPROPYL-5-METHYLCYCLOHEXANOL,BUT CONT NO MORE T

BOVINE LEATHER WITHOUT HAIR ON, PRETANNED EXCEPT VEGETABLE PRETANNED, BUT NOT FURTHER PREPARED

CHICKEN CUTS AND EDIBLE OFFAL (EXCEPT LIVERS) FROZEN

COPPER POWDERS OF LAMELLAR STRUCTURE; FLAKES

GRINDERS, POLISHERS AND SANDERS, SUITABLE FOR METAL WORKING, ROTARY TYPE (INC COMBINED ROTARY-PERCUSSION) PNEUMATIC TOOLS FOR WORKING IN THE HAND

METHYLCHLOROFORM (1,1,1-TRICHLOROETHANE)

MONOLITHIC I/C'S, DIGITAL, SILICON, (MOS), VOLATILE MEMORY, STATIC READ-WRITE RANDOM ACCESS (SRAM) OVER 300,000 BITS

ORIGINAL ENGRAVINGS, PRINTS AND LITHOGRAPHS, FRAMED OR NOT FRAMED

PEANUTS, BLANCHED

SYNTHETIC FILAMENT YARN EXCEPT SEWING THREAD, NOT FOR RETAIL SALE, SINGLE, MULTIFILAMENT, WITH A TWIST OF GE 5 TURNS PER M OF POLYETHYLENE,PROPYLENE

Appendix D - Details of Quality Aggregation for Table 4

To formalize the quality argument, assume without loss of generality that goods can be classified individually using an $N + 1$ digit classification scheme, but only average prices at an N -digit level classification are observed. We model prices as depending on characteristics in a Lancasterian sense, where each level of aggregation (e.g. 1... N digit) involves a certain set of common characteristics.

Ideally, we would estimate β from a relationship based on completely disaggregated (i.e., $(N + 1)$ -level) individual good price data:

$$\ln P_{ijk}^{N+1} = \sum_{n=1}^{N+1} \alpha_{n,ij} + \beta \ln Y_k + \varepsilon_{ijk}$$

where i indicates a product group, j indicates the individual good within the product group, and k indexes the destination country.

Assume instead, however, that the unit values for group i (going to country k) we observe are actually geometric¹ trade-weighted averages of the prices of j heterogeneous goods:

$$(1) \quad P_{ik}^N = \prod_j \left(P_{ijk}^{N+1} \right)^{q_{ijk}}$$

where q signifies the trade share. The relationship between these average prices and log income can be expressed:

$$\ln P_{ik}^N = \sum_{n=1}^N \alpha_{n,i} + \sum_j q_{ijk} \alpha_{(N+1),ij} + \beta \ln Y_k + \sum_j \varepsilon_{ijk}$$

Given the i -specific fixed effects, we can rewrite this equation in deviation form using \hat{X}_{ik} notation to represent the deviations of X_{ik} from mean values \bar{X}_i for group i :

$$\ln \hat{P}_{ik}^N = \beta \ln \hat{Y}_{ik} + \sum_j q_{ijk} \hat{\alpha}_{(N+1),ij} + u_{ik}$$

The quality argument claims that $cov \left[\sum q_{ij} \hat{\alpha}_{(N+1),ij}, \ln \hat{Y}_{ik} \right] > 0$, since:

$$\hat{\beta} \rightarrow \beta + \frac{cov(\sum_j q_{ij} \hat{\alpha}_{(N+1),ij}, \ln \hat{Y})}{var(\ln \hat{Y})}$$

Interpreting the expression, $\hat{\alpha}_{(N+1),ij}$ is the quality of an individual good j relative to the average in the product category i . Since q_{ijk} is the fraction of product group i purchases in country k that are on good j , the weighted average $\sum_j q_{ijk} \hat{\alpha}_{(N+1),ij}$ is the average relative quality purchased by country k . Thus, if countries with relatively high incomes, $\ln \hat{Y}_{ik}$, tend to purchase relatively high-quality goods on average, then this covariance bias will make $\hat{\beta}$ positive even if $\beta = 0$. In practice, our estimates of $\hat{\beta}$ decrease with aggregation, as shown in Table 4 of the paper, indicating that the quality bias is negative. Low -income countries tend to purchase relatively high-quality goods. Appendix E below gives an example of the aggregation of categories in practice.

¹The analysis is much easier to express using geometric averages instead of arithmetic averages. Regressions analogous to those in Table 3 of the paper but using arithmetic averages have the nice interpretation of answering "What would the regressions look like if the data were truly less disaggregate?", however, and produce the same qualitative (and similar quantitative) conclusions.

Appendix E: Random Sample of Five Quality Groupings

HS Code	9-Digit Group*	7-Digit Group	5-Digit Group	Commodity Description
2601110030	A	A	A	IRON ORE NONAGGLOMERATED CONCENTRATES
2601110060	B	A	A	IRON ORE NONAGGLOMERATED COARSE
2601110090	C	A	A	IRON ORE NONAGGLOMERATED NOT COARSE
2601120030	D	B	A	IRON ORE AGGLOMERATED PELLETS
2601120060	E	B	A	IRON ORE AGGLOMERATED BRIQUETTES
2601120090	F	B	A	IRON ORE AGGLOMERATED NOT PELLETS OR BRIQUETTES
7204410020	G	C	B	NO 1 BUNDLES STEEL SCRAP
7204410040	H	C	B	NO 2 BUNDLES STEEL SCRAP
7204410060	I	C	B	BORINGS, SHOVELINGS AND TURNINGS STEEL SCRAP
7204410080	J	C	B	SHAVINGS, CHIPS, MILLING WASTE, SAWDUST, FILINGS, TRIMMINGS, STAMPINGS STEEL SCRAP
7204490020	K	D	B	NO 1 HEAVY MELTING STEEL SCRAP
7204490040	L	D	B	NO 2 HEAVY MELTING STEEL SCRAP
7204490060	M	D	B	CUT PLATE AND STRUCTURAL STEEL SCRAP
7204490070	N	D	B	SHREDDED STEEL SCRAP
9505104010	O	E	C	ARTIFICIAL CHRISTMAS TREES, OF PLASTIC
9505105010	P	F	C	ARTIFICIAL CHRISTMAS TREES, EXCEPT OF PLASTIC
0203210000	Q	G	D	CARCASSES AND HALF-CARCASSES OF SWINE, FROZEN
0203221000	R	H	D	HAMS, SHOULDERS AND CUTS THEREOF, OF SWINE, BONE IN, PROCESSED, FROZEN
0203229000	S	I	D	HAMS, SHOULDERS AND CUTS THEREOF, OF SWINE, BONE IN, EXCEPT PROCESSED, FROZEN
5209413000	T	J	E	WOVEN FABRIC OF COTTON CONTAINING 85% OR MORE BY WEIGHT OF COTTON WEIGHING MORE THAN 200G/M2 OF DIFFERENT COLORS PLAIN WV CERTIFIED HAND-LOOMED FABRIC
5209420030	U	K	E	WOVEN FABRIC OF COTTON CONTAINING 85% OR GT BY WEIGHT OF COTTON WEIGHING GT 200G/M2 OF YARNS OF DIFFERENT COLORS DENIM WEIGHING LE 360G/M2
5209420050	V	K	E	WOVEN FABRIC OF COTTON CONTAINING 85% OR MORE BY WEIGHT OF COTTON WEIGHING 360 G/M2 OF YARNS OF DIFFERENT COLORS DENIM
5209430000	W	L	E	WOVEN FABRICS OF COTTON, 85% OR MORE COTTON BY WEIGHT, WITH YARNS OF DIFFERENT COLORS, 3-THREAD OR 4- THREAD TWILL INCLUDING CROSS TWILL, OVER 200 G/M2

* A relatively small fraction (about 5 percent) of all goods are unique up to 10 digits. In the random sample of five 5-digit groups chosen, none of the goods were unique up to 10 digits in the Harmonized System Code.

Appendix F: Classifying Quality Variation among HS Codes

To explore the role of quality variation in the export pricing behavior of US exporters, we construct a classification where there is clear quality variation among goods. Goods are chosen from Feenstra's Harmonized System Concordance Dataset for 1989-2006. The dataset contains a complete list of the HS codes and descriptions used to identify U.S. exports between 1989 and 2006 and is available at <http://www.internationaldata.org/data/sasstata/usxss.html>.

Using the long description of the HS 10-digit classification code, goods are identified using keywords for each measure of quality (freshness, size, purity, identifiable, new or used, packaging, price, and stage).

Goods are chosen if they have at least two levels of quality differences and assigned a "grouping" number within the measure of quality.

The only difference within a grouping of goods should be of quality, but if there are slight differences within groupings besides quality, the word "close" is placed in the Notes column for every good in that grouping.

Measures of Quality (with keywords for searching):

- **Freshness** (frozen, fresh): Goods, mostly food products, that can be frozen, fresh, or live; Goods that can be fresh or dried.
- **Size** (exceed, less): Goods that have different sizes, in terms of quantity, power, weight, density, volume, or capacity.
- **Purity** (oil, modified, refined, virgin, leaded, medicinal, pure, purity, api): Goods with different levels of purity, mainly oils.
- **Identifiable** (fancy, color, grade, purebred, electric): Goods that vary by identifiable qualities, like fancy vs. non fancy, color vs. monochrome, purebred or not, electric or not.
- **New or Used** (new): Goods that can be new, used, or rebuilt.
- **Packaging** (retail, bulk, in container, package): Goods that are packed according to how they will be sold or used, so they come in different sizes or types of containers.
- **Price** (\$, valued): Goods that are valued at different prices.
- **Stage of Processing** (processed, shell, prepared, split, cooked): Goods that vary by their stage of processing when classified, including fresh food products vs. prepared or cooked food products.

In total, we construct 455 groups of 1122 goods. The file Quality.xls contains our classification scheme.

Appendix G: Reconsidering PTM for Goods Sold on Organized Exchanges

This appendix details our methodology for classifying HS-10 products as goods sold on an organized exchange. The goal of constructing a comprehensive subset of goods is to identify goods where producers have very little market power to test whether our empirical findings using the Rauch classification reflect pricing-to-market.

I. Interpretation and Narrow Test

We first note that there are inherent difficulties in interpreting this exercise because there is not necessarily agreement on what it means that a good is sold on an organized exchange. Some interpret goods classified as organized exchange as being goods for which sellers have no market power so that any price variation must be due to quality differences. Others interpret these to be goods where there is very little quality variation and hence any price variation must be due to price discrimination.

Both ideas have a great deal of merit, though neither is incontestable. Commodities that are actually traded on organized exchange typically have very strict quality requirements, and so we expect very little quality variation, and indeed ability to define and verify strict homogeneity requirements appears to be a determinant to the types of commodities that are actually traded. The recent issues with CDOs are of course a counterexample. Similarly, sellers of commodities actually traded on exchanges should have very little market power, so we should expect very little pricing to market. Still, using firm-level survey data, researchers have found evidence of price discrimination in export pricing of exchange traded commodities such as wheat, corn, and soybeans (Patterson and Abbott, *Journal of Industrial Economics*, 1994).

A further complication is that many “organized exchange” commodities are not actually traded commodities. There is naturally the need for a finer classification than Rauch’s 4-digit classification (1999), which motivates this new classification.¹ However, a larger issue is that many traded commodities are not traded; the futures contracts are purely financial with cash-settled payments based on price indexes for commodities. For example, the Chicago Merc’s milk futures are based on weekly average prices from USDA surveys.² Although these categories may reflect heterogeneous goods and goods with considerable deviation from the law of one price, they can nonetheless facilitate the hedging of risk. One interpretation of these results is that exporters have market power because the costs of exporting are high (both fixed and variable costs) and so few firms undertake it.

In any case, it seems unlikely that an examination of carefully classified organized exchange goods will be informative as to whether nonzero coefficients on the broader sample or even the Rauch sample are due to quality variation or pricing-to-market. Instead, a more informative test is whether the HS-10 classification is fine enough to identify goods with both little quality variation *and* little market power. That is, can a precise classification yield results with very little pricing-to-market. This would be

¹ For example, at the 4-digit level the catchall group “EDIBLE OFFAL OF BOVINE ANIMALS, SWINE, SHEEP, GOATS, HORSES, ASSES, MULES OR HINNIES, FRESH, CHILLED OR FROZEN” is classified as organized exchange traded.

² Feeder cattle futures are based on an even more heterogeneous sample: the sample consists of all reported auction, direct trade, video sale, and Internet sale transactions within the 12-state region of Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas and Wyoming of 650 to 849 pound Medium and Large Frame #1 feeder steers.

informative about the fineness of the HS-10 classification (although admittedly only for a particular set of goods, agricultural and industrial commodities).

We pursue this as our goal and so we focus on only commodities that are physically traded on organized exchanges. We also attempt to match the narrowest product group to the contract details of the futures contracts. These are our two guiding principles.

II. Classification Methodology

We consider all U.S. commodity exchanges and also the London Metal Exchange, and note the commodities that were contracted during the period of interest:³

Chicago Board of Trade (CBOT) – Ethanol, oats, rough rice, soybeans, soybean meal, soybean oil, wheat⁴

Chicago Mercantile Exchange (CME) – Butter, cattle, cheese, random lumber, pork bellies (milk, whey, pulpwood, hogs financial).

Intercontinental Exchange (ICE) -- Barley, canola, cocoa, cotton, frozen concentrated orange juice, sugar

London Metal Exchange (LME) – Aluminum alloy, cobalt, lead, molybdenum, nickel, tin, zinc

New York Mercantile Exchange (NYMEX) – Heating oil, crude oil, gasoline, propane (cocoa, coffee, cotton, electricity, sugar, jet fuel, uranium financial)

New York Commodity Exchange (COMEX) – Aluminum, copper, gold, palladium, platinum, silver

The file GoodsContractDetails.xls gives summary descriptions of each of the contracted goods, link the actual descriptions on the web, and a correspondence to the narrow (closest fitting) HS-10 codes in **bold**, as well as the broader classifications. Finally, the broader classifications also include those traded futures, for which the deliverable is purely financial. Below we detail the decisions used in constructing these correspondences.

Canola/rapeseed oil

The contract calls for Canola seeds, which is a rapeseed produced in Canada. Technically, we do not export any product satisfying this requirement. We use the closest match, which is crude rapeseed oil. We exclude refined rapeseed oil, since this is further removed from the contracted seeds.

Cocoa beans

³ Futures for steel and plastics such as polypropylene and polyethylene are first offered after 2001. There are other goods that are transacted on organized exchanges in Asia and Australia. A few of these are potentially relevant to the U.S. exports (i.e., rubber, wool, palm oil). Other goods are less relevant such as Azuki beans and dried cocoons. In addition, potato futures are traded in Europe, though these are based on an average of European price indexes and are financially settled. These goods are included in the Rauch classification, however, and do not change the results much.

⁴ The Minneapolis Grain Exchange and the Kansas City Board of Trade also trade wheat, but the contract details (hard red spring wheat and hard red winter wheat, respectively) differ only slightly from the CBOT wheat contract (soft red winter wheat), and in any case the distinction is too fine for the HS-10 classification.

We include cocoa beans, whole or broken, raw or roasted, but we exclude shells/husks/skins, cocoa butter, cocoa paste, cocoa powder, and other cocoa products. Again, these products contain substantially more processing and value-added, and so they may include branded items with market power.

Coffee beans

We include not roasted, not decaffeinated coffee, and we do not include skins and husks. We also exclude instant coffee and coffee packaged for retail sale for obvious reasons.

Dairy

For whey, we follow the contract specification and include only dried whey, and we do not include whey protein concentrates, other products from whey, or unspecified whey. For butter we include only butter but not other milk fats/oils or dairy spreads. For cheese, the contract is for grade A cheddar cheese. We include only the “Cheddar Cheese, NESOI”, which does not include grated, powdered or processed cheese. Grated, powdered and processed cheeses are catch all categories including all types of cheese.

Ethanol

The contract calls for denatured fuel ethanol, so we do not include drinking ethanol.

Fuels

We include both liquified and gaseous natural gas, since the contract does not distinguish, but we do not include condensates derived from natural gas. For propane, the contract calls specifically for liquefied propane, so we do not include gaseous.

For gasoline, the contract details call for reformulated unleaded blendstock gasoline and conventional 97 octane, M-grade gasoline. We therefore include only reformulated gasoline, but exclude oxygenated or leaded gasoline. The category is nonetheless blunt.

For light oil and heating oil, the detailed HS categories do not fit the contract details particularly well. The contract details for light oil call for 37-42 degrees API and sulfur content less than 0.42 percent, while the HS-10 categories distinguish between over and under 25 degrees API and over and under a much lower 0.05 percent sulfur content. We therefore include the over 25 degrees API but both categories for sulfur content. For light and heating oil, do not include anything heavier than No. 3 oils. For light crude oil, we use crude oil testing 25 degrees API or more.

Grains

We do not include seeds, since these are very specialized and not part of the contracted deliverable. For the narrow classification, we also do not include processed grains (e.g., rolled, flaked, pearled, milled, flour, meal), since processing adds value-added, which could presumably be branded, so these categories may include branded products with market power. Finally, the narrow classification uses the varieties of the grain which corresponds most closely to the contracted varieties (e.g., include no 2 and 3 corn but exclude no. 4, include white meslin wheat but exclude durum wheat).

Meat and livestock

For meat/livestock, there were several issues: (1) whether to consider baby livestock; (2) whether to consider live breeding animals; (3) whether to consider live, fresh/chilled, or frozen livestock when one of

the three is specified in the contracts; (4) whether to consider boneless or processed meats; and (5) whether to consider parts or miscellaneous categories (NESOI), when full animals are specified in the contracts.

Following the principle of a narrow correspondence, we use live non-breeding bovine animals for live cattle. For frozen pork bellies, the pork belly is not explicitly classified, we therefore use the frozen miscellaneous swine meat categories (neither the ham, shoulder, nor the full or half carcasses). We do not distinguish between processed or unprocessed, however, since it is not clear how the pork belly would be classified. For the broader correspondence we include all of the above.

Metals

For metals there are again many issues to consider, including: (1) whether or not to include ores and concentrates; (2) whether or not to include ash or residues primarily containing the material; (3) whether or not to include wrought metals; (4) whether or not to include other forms, such as powders or flakes; (5) whether or not to include fabricated metals; (6) whether or not to include alloys containing the metal of interest; and (7) whether or not include scrap metal. For each metal, we attempt to most closely match the contract-specified commodity.

We do not include any ash/residues or fabricated/manufactured metals in either the narrow or broad classifications, since the former is viewed as too dissimilar to the final product, while the latter contains too much value-added, and so potentially differentiated products with market power. Otherwise the broad classification contains all of the above.

The details of the narrow classification are included below.

For the narrow classification, the only metal for which we use ores and concentrates is molybdenum, the contract for which calls for roasted concentrate of a specified molybdenum content. We use roasted molybdenum ores and concentrates but not unroasted ores/concentrates, wrought or unwrought molybdenum.

For aluminum/aluminum alloys, the contracts specify unwrought aluminum (T-bars, ingots, etc.). We include only unwrought aluminum, and exclude aluminum vanadium master alloy, which is not similar to the contracted aluminum alloy. We also exclude bauxite.

For cobalt, it is not possible to exclude powders, scrap, etc. The category simply distinguishes between unwrought and wrought cobalt, and we use the unwrought category.

For copper, the contract specifies Grade 1 electrolytically-refined copper. We use refined copper cathodes. We exclude ores/concentrates/ash/etc.; unrefined anodes, copper mattes, cement, powders, wire, billets, and scrap; and wrought copper.

For gold, we include only unwrought, non-monetary gold bullion, while for silver we include unwrought silver bullion. For both, we exclude powders, dore, ores, and leaf.

For lead, nickel, and tin, the contract calls for high purity levels. For lead, we use both unwrought refined lead and unwrought lead bullion, while for nickel we use unwrought non-alloyed nickel, and for tin we use unwrought non-alloyed tins. For all three, we exclude powders, flakes, scraps, and alloys.

For both platinum and palladium, the unwrought and powdered metals are combined under the same code, so we use this code. The broader classification also includes semi-manufactured platinum and palladium.

For zinc, the contract calls for 99.997 percent purity zinc. We use only unwrought zinc of greater than 99.99 percent purity, and exclude lower purity levels, alloys, powders, flakes, dust, and scrap.

Frozen concentrated orange juice

For orange juice several issues exist. Clearly, there are branded orange juice items at the retail level with market power, and also heterogeneous categories. To avoid retail items, we exclude all packages less than 3.785 liters (the next smallest category goes down to less than one liter). We also exclude all non-frozen and non-concentrated orange juice, and also vitamin fortified juice. The broader classification includes all of these.

Sugar

We include only raw cane sugar, which is the contracted commodity in the narrow classification. That is, we do not include refined sugar/beverage bases/etc., molasses, beet sugar products, or sugar cane itself. The broader classification contains all of these.

III. Sample Comparisons

The narrow classification contains 44 distinct HS-10 codes, while the broad classification contains 371 codes, and the conservative Rauch classification contains 438 codes.

The major differences between the former two are the broader classifications of goods as described above and the inclusion of commodities for which only index-based, financially settled futures are traded (cotton, electricity, hogs, jet fuel, milk, pulpwood, uranium, and whey).

The major difference between the latter two is that the Rauch classification contains additional commodities: sheep, goat, chickens, offals of animals, cured meat, fish (filets, fishmeal and roe), rye, grain sorghum, buckwheat, potatoes, various nuts, various juices, tea, oilcakes, tobacco, rubber, silk, other textile fibers beyond cotton, manganese and iron ores, steel, "other" motor fuels, fats and lards, other seed oils (e.g, cottonseed, corn, and sesame oil), common acids (hydrochloric, sulfuric, etc.), wool and other animal hairs, and miscellaneous base metals.

IV. Results

The results essentially show a small unit value-income relationship for the narrow sample, especially compared to the full sample. Moreover the average standard deviation in the log unit value is much lower in the narrow sample relative to the full sample, as is the average standard ratio of the standard deviations of log unit value to log wage. Nonetheless, the average standard deviation is still substantial, and so we cannot claim that the law of one price holds within the HS-10 categories. We can only claim that this variation is not closely tied with income or wages. The broader classification yields coefficients that are closer to the Rauch classification, though still somewhat smaller, and the Rauch classification yields coefficients that are less than half of the full sample. The average standard deviations of unit values are intermediate between the narrow classification and the full sample.

Using the narrow classification, we have 4253 observations. We get a coefficient of 0.023 (robust standard error of 0.016) on the log wage, which is substantially lower than our coefficient for the full sample of 0.165, and it is not statistically significant at even the 10 percent level.

The regression using the broad classification has 31,463 observations and yields a coefficient of 0.074 (0.020). The (conservative) Rauch classification uses 38,865 observations and yields a coefficient of 0.075 (0.023). The closeness of the results between these two classifications is a result that the samples are quite similar, and so much of the difference between the Rauch classification and our narrow classification is likely due to the fact that the Rauch classification contains goods that are not actually transacted commodities.

The average standard deviation of log unit value is 0.42 relative to 0.82 for the full sample. The values for the broad classification and Rauch samples are 0.58 and 0.56, respectively. The average ratio of the standard deviation of log unit value over the standard deviation of log wage is 0.74 in the narrow sample and 1.73 in the full sample. For the broad classification and Rauch samples these numbers are 1.34 and 1.15, respectively. Thus, we stress that the law of one price does not hold within HS-10 categories, even our narrowly defined group of goods transacted on an organized exchange.

Appendix H– Retail and Wholesale Distribution

Assume there is a combined retail and wholesale distribution sector that purchases goods from manufacturers, combines them with labor and then sells the modified product to searching consumers. We show that this model generates export and retail prices that are similar to the baseline model.

Households: Assume there is a continuum of differentiated goods indexed by their position on the unit interval $i \in [0, 1]$. A country j consumer sends shoppers, $n_j(i)$, with reservation prices, $r_j(i)$ for each good $i \in [0, 1]$ and agents to work to solve

$$\begin{aligned}
 C_j &= \max_{n_j(i), r_j(i)} \left(\int_0^1 c_j(i)^\theta di \right)^{\frac{1}{\theta}} \\
 &\quad \int p(i) c_j(i) di = w_j l_j + \pi_j \\
 \text{subject to} \quad & c_j(i) = n_j(i) H_{ji}(r(i)) \\
 & p_j(i) = \frac{\int_0^{r_j(i)} p dH_{ji}}{H_{ji}(r_i)} \\
 & l_j + \int n_j(i) di = 1
 \end{aligned}$$

This problem yields the following reservation price and demand equations,

$$\begin{aligned}
 r_j(i) &= w_j + p_j(i). \\
 n_j(i) &= \left(\frac{r_j(i)}{R_j} \right)^{\frac{1}{\theta-1}} C_j,
 \end{aligned}$$

where $R_j = \left(\int r_j(i)^{\frac{\theta}{\theta-1}} di \right)^{\frac{\theta-1}{\theta}}$, $P_j = \int p_j(i) \left(\frac{r_j(i)}{R_j} \right)^{\frac{1}{\theta-1}} di$, and $C_j = \frac{w_j l_j + \pi_j}{P_j}$. The term R_j measures the minimum resource cost of a unit of consumption and the term P_j denotes the market price of a unit of consumption. For the sake of exposition, we normalize $R_j = 1$. Given many identical households solving the same problem, the aggregate demand curve is $D_{ji}(r) = n_j(i)$ where $r_j(i) = w_j + p_j(i)$.

Distributor/Retailer: We assume that there are many independent firms that purchase good i at $p_m(i)$ and then incur a cost c_j to deliver the good to the consumer. Given the reservation price of consumers, and the cost of production $p_m(i) + c_j(i)$, this is the standard Burdett and Judd (1983) problem, which we have shown generates the following average price

$$p_j^{retail}(i) = p_m(i) + c_j(i) + \frac{q(i) w_j}{1 - q(i)}.$$

As we have already shown, this problem generates a distribution of retail prices with mean $p_j^{retail}(i)$ and maximum price,

$$r_j(i) = p_m(i) + c_j(i) + \frac{w_j}{1 - q(i)}.$$

Producers: Given this retail price and reservation price and the aggregate demand curve, we now can solve the producer's maximization problem. Suppose that the producer's cost is $c_m(i)$,

then the producer's problem is

$$\begin{aligned}\Pi(i) &= \max D(r(i))(p_m(i) - c_m(i)) \\ &= \max \left(p_m(i) + c_D(i) + \frac{w_j}{1-q(i)} \right)^{\frac{1}{\theta-1}} C^*(p_m(i) - c_m(i)).\end{aligned}$$

The producer charges $p_m(i) = \frac{(1-\theta)[c_D(i) + \frac{w_j}{1-q(i)}]}{\theta} + \frac{c_m(i)}{\theta}$. The producer's markup depends on both its own costs and the downstream costs including those of the consumer.²

Industry prices: Now, we solve for the prices at each level,

$$\begin{aligned}p_m(i) &= \frac{c_m}{\theta} + \frac{(1-\theta)}{\theta} \left[c_D(i) + \frac{w_j}{1-q(i)} \right], \\ p^{retail}(i) &= \frac{c_m + c_D(i)}{\theta} + \left[\frac{(1-\theta)}{\theta} + q(i) \right] \frac{w_j}{1-q(i)}, \\ r_j(i) &= \frac{w_j / (1-q(i)) + c_m + c_D(i)}{\theta}.\end{aligned}$$

As before, the manufacturer's price to the foreign market increases with the consumer's wage. Moreover, it is now also increases with the distribution cost in the destination market. We show below that the relationships between wages and prices in the baseline model are similar to those in the modified model with a distribution margin.

For comparison we modify the original model to include a local distribution cost and assume it is borne by the manufacturer. The final retail price will include this local cost. With the assumption that the manufacturer distributes its own good, there is no market price at the border. To derive a price at the border we assume that the gap between the retail price and the price at the border is the difference in costs due to distribution costs. In this case,

$$\begin{aligned}p_{border}^{direct}(i) &= c_m(i) + \frac{qw_j}{1-q}, \\ p^{direct}(i) &= c_m(i) + c_D(i) + \frac{qw_j}{1-q},\end{aligned}$$

where p_{border}^{direct} measures the price at the border and p^{direct} is the retail price.

Proposition 1 summarizes three results. First, the elasticity of reservation prices with respect to wages is the same in both models. Second, the elasticity of retail prices is stronger with a distribution sector so that there is more pricing-to-market at the retail level. Finally, we find that pricing-to-market at the border can be stronger or weaker in the model with distribution depending on the substitutability of varieties and the search costs. Pricing-to-market at the border is more likely to be stronger when varieties are less substitutable and more consumers have multiple offers.

Proposition 1 With respect to wages, the elasticity of:

²If downstream costs are proportional to upstream costs, then the producer charges a constant markup. For instance, suppose that $c_j(i) = (1 + \tau_D)p_m$ and $w_j(i) / (1 - q(i)) = (1 + \tau_R)c_D$. Then, the optimal price is $p_m(i) = \frac{c_m}{\theta - (1-\theta)(1+\tau_D)[2+\tau_R]}$ and markups are constant.

- a. Reservation prices is the same in both models.
- b. Retail prices is larger with distribution, even when there is no resource cost to distribution.
- c. Border prices is larger in the model with distribution iff $q < \frac{(1-\theta)(1+\tau_D)}{(1+(1-\theta)\tau_D)}$.

Even when no resources are used in distributing goods, as in our baseline model, we find that pricing-to-market at the retail level is stronger in the model with a separate distribution channel. This occurs because now both the retailer and producer take into account how the local wage affects the demand for its good. Most important, because the producer has some market power it considers how its price affects the reservation price of the consumer.

At the border, we find that pricing-to-market can be stronger or weaker in the model with retail distribution depending on the substitutability of varieties, search costs and distribution costs. Pricing-to-market in export prices is more likely to be stronger when varieties are less substitutable, more consumers have multiple offers and downstream distribution costs are higher.

Proof of Proposition 1

- a. Reservation price is the same, $\frac{\partial r^{retail}}{\partial w} \frac{w}{r^{retail}} = \frac{\partial r^{direct}}{\partial w} \frac{w}{r^{direct}} : \frac{\partial r^{retail}}{\partial w} \frac{w}{r^{retail}} = \frac{\frac{1}{\theta(1-q)}}{\frac{c_m+c_D}{\theta} + \frac{1}{\theta} \frac{w}{1-q}} = \frac{1}{(1-q) \frac{c_m+c_D}{w} + 1}, \frac{\partial r^{direct}}{\partial w} \frac{w}{r^{direct}} = \frac{\frac{1}{(1-q)}}{c_m+c_D + \frac{w}{1-q}} = \frac{1}{(1-q) \frac{c_m+c_D}{w} + 1}$
 - b. PPP effect stronger, $\frac{\partial p^{retail}}{\partial w} \frac{w}{p^{retail}} > \frac{\partial p^{direct}}{\partial w} \frac{w}{p^{direct}}, \frac{\partial p^{retail}}{\partial w} \frac{w}{p^{retail}} = \frac{[\frac{1-\theta}{\theta} + q] \frac{w}{1-q}}{\frac{c_m+c_D}{\theta} + [\frac{1-\theta}{\theta} + q] \frac{w}{1-q}} = \frac{(1-\theta)+\theta q}{(1-q) \frac{c_m+c_D}{w} + (1-\theta)+q}, \frac{\partial p^{direct}}{\partial w} \frac{w}{p^{direct}} = \frac{q \frac{w}{1-q}}{c_m+c_D+q \frac{w}{1-q}} = \frac{q}{(1-q) \frac{c_m+c_D}{w} + q}$ and clearly $(1-\theta) + \theta q > q$
 - c. Border prices, $\frac{\partial p_{border}^{direct}}{\partial w} \frac{w}{p^{direct}} = \frac{\frac{q}{1-q}}{c_m + \frac{qw}{1-q}} = \frac{q}{(1-q) \frac{c_m}{w} + q}$. Given $c_D = \tau_D w_j$, then $p_m^{retail} = \frac{c_m}{\theta} + \frac{(1-\theta)}{\theta} w_j \left[\tau_D + \frac{1}{1-q(i)} \right]$, and $\frac{\partial p_m^{retail}}{\partial w} \frac{w}{p_m^{retail}} = \frac{\frac{1-\theta}{\theta} [\tau_D + \frac{1}{1-q}] w_j}{\frac{c_m}{\theta} + \frac{(1-\theta)}{\theta} w_j \left[\tau_D + \frac{1}{1-q(i)} \right]} = \frac{(1-\theta)(\tau_D(1-q)+1)}{(1-q) \frac{c_m}{w} + (1-\theta)(\tau_D(1-q)+1)}$.
- Comparing these conditions we see that $\frac{\partial p_m^{retail}}{\partial w} \frac{w}{p_m^{retail}} \geq \frac{\partial p_{border}^{direct}}{\partial w} \frac{w}{p^{direct}}$ iff $\frac{(1-\theta)(1+\tau_D)}{(1+(1-\theta)\tau_D)} > q$. The term on the LHS is increasing in τ_D so that adding a distribution sector leads to more pricing-to-market at the border.