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SUPPLEMENT TO "THE MARGINS OF TRADE"

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APPENDIX A: DATA APPENDIX

A.1. *Data Construction*

We construct our data on bilateral trade and its margins as follows:

1. We download data on aggregate bilateral merchandise trade from 231 countries for 2007 from the UN Comtrade. For many exporter-importer dyads, both exporter and importer report total merchandise trade. We use the importer's report if available, and the exporter's report otherwise. The resulting total value of trade is US$13.8 trillion.
2. We eliminate countries without GDP or GDP per capita data in the World Bank Development Indicators.[1] We combine Singapore and Malaysia; Hong Kong, Macao and China, Belgium and Luxembourg into single country units. This step reduces our sample to 168 countries with a total value of trade of US$13.1 trillion.
3. We drop countries that don't directly report trade to Comtrade and that have GDP ranked 50$^{\text{th}}$ or above, losing Uzbekistan, Turkmenistan, and Equatorial Guinea.
4. Of the remaining countries we select the 100 largest in terms of GDP. Table A.I lists these countries together with their GDP and GDP per capita. The value of trade in our final sample with 100 countries is US$12.9 trillion, 93 percent of the value in the original sample of 231 countries and 98 percent of the value in the sample with GDP data.
5. Aggregate bilateral trade among these 100 countries, along with data on GDP and GDP per capita (from the World Development Indicators) and distance (from CEPII), are the basis for our gravity analysis of bilateral trade. Of the 9,900 potential exporter-importer dyads, 314 importer-exporter dyads report no trade, reducing our set of observations on aggregate bilateral trade to 9586.
6. To decompose the value of aggregate trade into the extensive and intensive margins we need data on the value of bilateral trade at the HS6 product level. For some exporter-importer dyads, aggregate merchandise trade, reported in HS0, is significantly larger than the sum of reported trade in individual HS6 categories. If this gap more than 15%, we eliminate the exporter-importer dyad from any further analysis of trade margins, losing 31, leaving us with 9555 exporter-importer dyads with which to calculate the extensive and intensive margins.
7. We construct data on prices using Comtrade data on quantities.[2] Of the 9555 exporter-importer dyads from the previous step, we have no quantity data for 37 dyads.

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[1] In Comtrade, we take trade with "Asia not elsewhere specified" to be trade with Taiwan. Data on GDP and GDP per capita for Taiwan was downloaded in Feb 12, 2015 from
http://www.economywatch.com/economic-statistics/Taiwan/GDP_Current_Prices_National_Currency/

[2] The original data set has 7,400,485 quantity observations, falling to 6,161,524 once countries without GDP data are eliminated.

8. For each product, we select the unit measuring quantity that has the most quantity observations. We keep the value of trade but drop the quantity of trade measured in other units. In this step we lose about 6 percent of the quantity observations.
9. We calculate price as value divided by quantity for each importer-exporter-product triad. We drop a price observation if it's less than 1/40 or more than 40 times the average price in the product category. This step, together with the selection of countries and the choice of units of measurement, leaves us with 4,520,030 quantity observations, 87 percent of the original, pertaining to 9455 exporter-importer dyads. The corresponding total value of trade is US$10.4 trillion. These data serve as the basis of our price regressions and our decomposition of trade into the quantity and price margins.

Table A.I lists the 100 countries in our data together with their GDP and GDP per capita. Table A.II summarizes the units of measure used to construct unit values.

A.2. *Supplementary tables for decomposition in Table I*

Table A.III reports the standard deviations of the variables in Table I, the bilateral trade values, trade margins and distance, and countries' population and income per capita. In Table A.IV, we report the standard errors of the decomposition of trade values into margins for the data and the model in Tables I and V. The main text shows only the coefficient point estimates.

A.3. *Product Classifications in Rauch (1999) and BEC*

Table III presents the results from repeating the price regression of Table II column (3) with different product categories: manufacturing, Rauch's differentiated goods (liberal classification), final goods, and capital and intermediate inputs. This appendix presents the same regressions for the excluded categories, such as non-manufactured goods and non-differentiated goods. The regressions in Table 3 are repeated for comparison.

Manufactures and Rauch (1999)'s classification. Table A.V presents the baseline price regression with subsamples using Rauch (1999)'s classification of goods into non-differentiated (commodities and goods traded in organized exchanges) and differentiated (all other goods). As expected, the coefficients on GDP per capita of the exporter and of the importer are larger for the differentiated goods. There is little difference between Rauch's liberal and conservative classifications.

The last two columns split the sample into manufacturing and non-manufacturing goods. Similarly to Rauch (1999)'s differentiated goods, the coefficients on GDP per capita is larger for manufacturing goods. But in all subsamples of Table A.V, the coefficients on GDP per capita and on distance are statistically significant and have similar magnitudes to the baseline (first column).

BEC end use The Statistics Division of the Department of Economic and Social Affairs of the United Nations classifies product categories by end use or Broad Economic Categories (BEC). We run the basic price regression of Table II column 3 separately for goods classified as (i) consumption goods, (ii) intermediate inputs, (iii) capital goods, or (iv) intermediate inputs plus capital goods plus goods used as both intermediates and capital (more than the sum of (ii) and (iii) categories).

Table A.VI presents the results. Relative to the baseline, consumption goods have higher a coefficient on importer GDP per capita. Goods classified as capital or intermediate inputs have higher coefficients on exporter GDP per capita, though the difference to the baseline is

TABLE A.I

LIST OF COUNTRIES

	country	GDP (US$ BI)	GDP per capita (US$)		country	GDP (US$ BI)	GDP per capita (US$)
1	USA	13,751	45,642	51	Kuwait	112	42,102
2	Japan	4,384	34,313	52	Peru	107	3,763
3	China[1]	3,608	2,721	53	Kazakhstan	105	6,772
4	Germany	3,317	40,324	54	Morocco	75	2,434
5	United Kingdom	2,772	45,442	55	Slovakia	75	13,891
6	France	2,590	41,970	56	Viet Nam	69	806
7	Italy	2,102	35,396	57	Bangladesh	68	434
8	Spain	1,437	32,017	58	Angola	59	3,376
9	Brazil	1,333	7,013	59	Croatia	59	13,201
10	Canada	1,330	40,329	60	Libya	58	9,475
11	Russian Federation	1,290	9,079	61	Slovenia	47	23,379
12	India	1,177	1,046	62	Fmr Sudan	46	1,143
13	Rep. of Korea	1,049	21,653	63	Ecuador	46	3,433
14	Mexico	1,023	9,715	64	Belarus	45	4,667
15	Australia	821	39,066	65	Dominican Rep.	41	4,248
16	Netherlands	766	46,750	66	Syria	41	1,978
17	Turkey	656	8,984	67	Bulgaria	40	5,163
18	Belgium	502	45,221	68	Lithuania	39	11,522
19	Sweden	454	49,662	69	Tunisia	35	3,425
20	Indonesia	432	1,914	70	Guatemala	34	2,549
21	Poland	425	11,143	71	Azerbaijan	33	3,851
22	Switzerland	424	56,207	72	Sri Lanka	32	1,617
23	Taiwan	393	17,122	73	Latvia	29	12,638
24	Norway	388	82,480	74	Kenya	27	718
25	Saudi Arabia	384	15,879	75	Costa Rica	26	5,887
26	Austria	373	44,880	76	Lebanon	25	6,036
27	Malaysia[2]	354	11,358	77	Uruguay	24	7,297
28	Greece	313	27,995	78	Yemen	22	968
29	Denmark	312	57,051	79	Cyprus	21	24,895
30	Iran	286	4,028	80	Estonia	21	15,621
31	South Africa	284	5,930	81	Trinidad and Tobago	21	15,662
32	Argentina	262	6,644	82	Cameroon	21	1,116
33	Ireland	259	59,324	83	El Salvador	20	3,336
34	Finland	245	46,261	84	Iceland	20	64,190
35	Thailand	237	3,533	85	Cote d'Ivoire	20	984
36	Venezuela	228	8,299	86	Panama	19	5,833
37	Portugal	223	20,998	87	Ethiopia	19	247
38	Colombia	208	4,724	88	Tanzania	17	408
39	Czechia	174	16,833	89	Jordan	17	2,891
40	Romania	166	7,703	90	Bosnia Herzegovina	15	4,008
41	Nigeria	166	1,121	91	Ghana	15	655
42	Israel	164	22,835	92	Bolivia	13	1,379
43	Chile	164	9,875	93	Jamaica	13	4,885
44	Philippines	144	1,624	94	Botswana	12	6,550
45	Pakistan	143	879	95	Honduras	12	1,722
46	Ukraine	143	3,069	96	Paraguay	12	1,997
47	Hungary	139	13,799	97	Uganda	12	388
48	New Zealand	136	32,086	98	Gabon	12	8,135
49	Algeria	134	3,967	99	Zambia	11	927
50	Egypt	130	1,630	100	Senegal	11	950

Notes: [1] includes Macao and Hong Kong. [2] includes Singapore.

TABLE A.II

UNITS OF MEASUREMENT FOR OBSERVATIONS WITH QUANTITY DATA

	no. observations	value (US$ trillion)
kilograms	3,600,121	7.58
number of items or pairs	840,775	2.53
other	79,134	0.24
total	**4,520,030**	**10.4**

TABLE A.III

STANDARD DEVIATIONS OF VARIABLES IN TABLE I

variable	**s.e.**	**variable**	**s.e.**
log X_{ni}	3.694	log GDP	1.682
log E_{ni}	2.148	log GDP per capita	1.421
log Y_{ni}	2.288	log population	1.490
log P_{ni}	0.538	log distance	0.863

Note: X_{ni} is the bilateral value of trade from i to n, E_{ni} is the extensive margin, Y_{ni} is the quantity margin and P_{ni} is the price margin. See Section 2 for the definition of these margins.

TABLE A.IV

DECOMPOSITION INTO MARGINS OF TABLES I AND V WITH STANDARD ERRORS

	data				model			
dependent variable →	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$
exporter GDP	1.346	0.880	0.446	0.020	1.369	0.840	0.474	0.046
	(0.052)	(0.038)	(0.042)	(0.015)	(0.007)	(0.017)	(0.016)	(0.011)
importer GDP	1.102	0.396	0.662	0.044	1.012	0.489	0.587	0.034
	(0.033)	(0.026)	(0.036)	(0.012)	(0.007)	(0.021)	(0.020)	(0.006)
distance	-1.183	-0.718	-0.523	0.058	-1.180	-0.647	-0.578	0.035
	(0.083)	(0.061)	(0.058)	(0.017)	(0.014)	(0.014)	(0.016)	(0.008)
R-squared	0.672	0.632	0.366	0.030	0.869	0.733	0.666	0.099
exporter GDP per capita	1.339	0.920	0.317	0.102	1.365	0.851	0.331	0.168
	(0.065)	(0.049)	(0.043)	(0.013)	(0.009)	(0.016)	(0.017)	(0.016)
exporter population	1.352	0.847	0.555	-0.049	1.373	0.831	0.588	-0.059
	(0.063)	(0.050)	(0.046)	(0.013)	(0.008)	(0.017)	(0.018)	(0.010)
importer GDP per capita	1.078	0.452	0.510	0.116	0.971	0.517	0.477	0.096
	(0.044)	(0.035)	(0.046)	(0.014)	(0.009)	(0.023)	(0.026)	(0.006)
importer population	1.122	0.348	0.793	-0.018	1.047	0.464	0.684	-0.018
	(0.040)	(0.028)	(0.035)	(0.012)	(0.009)	(0.020)	(0.016)	(0.008)
distance	-1.194	-0.681	-0.629	0.116	-1.197	-0.632	-0.673	0.105
	(0.084)	(0.061)	(0.057)	(0.012)	(0.014)	(0.014)	(0.015)	(0.009)
R-squared	0.672	0.636	0.401	0.217	0.870	0.734	0.739	0.979
observations (both panels)	9,455	9,455	9,455	9,455	9,455	9,455	9,455	9,455

Note: Standard errors are clustered by importer and by exporter.

TABLE A.V: Descriptive price regression separately for the classifications in Rauch (1999) and for manufactures

Dependent variable: p_{nik}

		Rauch (1999)'s classification					
		liberal		conservative			
	baseline	differentiated	non-diff.	differentiated	non-diff.	manufacturing	non-manuf.
exporter GDP per capita	0.168	0.170	0.167	0.171	0.164	0.176	0.154
	(0.018)	(0.018)	(0.020)	(0.018)	(0.020)	(0.019)	(0.018)
exporter population	-0.064	-0.077	-0.032	-0.077	-0.026	-0.076	-0.039
	(0.021)	(0.023)	(0.018)	(0.023)	(0.017)	(0.024)	(0.017)
importer GDP per capita	0.102	0.113	0.075	0.111	0.076	0.106	0.095
	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
importer population	-0.018	-0.007	-0.045	-0.008	-0.048	-0.006	-0.041
	(0.013)	(0.014)	(0.013)	(0.014)	(0.013)	(0.014)	(0.013)
distance	0.119	0.112	0.134	0.114	0.132	0.107	0.141
	(0.017)	(0.019)	(0.016)	(0.019)	(0.016)	(0.020)	(0.015)
product fixed effect	yes	yes	yes	yes	yes	yes	yes
number of observations	4,520,030	3,156,443	1,363,587	3,330,503	1,189,527	2,940,221	1,579,809
R-squared	0.768	0.767	0.670	0.764	0.671	0.772	0.619

Note: Standard errors are clustered by importer and by exporter. The dependent variable p_{nik} is the price of country i's exports of product k to country n. The baseline regression is repeated from Table II column (3). We take manufactures to be HS2 codes 50 through 96, thus excluding the initial processing of raw materials, such as raw hides and leather, and pulp, paper and cardboard. See Table A.VII for industry codes.

TABLE A.VI

DESCRIPTIVE PRICE REGRESSION BY BEC SUBSAMPLE OF END USE

Dependent variable: p_{nik}		BEC end use classification			
	baseline	consump.	intermed.	capital	cap. + int.
exporter GDP per capita	0.168	0.166	0.176	0.152	0.172
	(0.018)	(0.017)	(0.023)	(0.023)	(0.023)
exporter population	-0.064	-0.066	-0.062	-0.076	-0.066
	(0.021)	(0.020)	(0.022)	(0.022)	(0.022)
importer GDP per capita	0.102	0.154	0.079	0.075	0.079
	(0.015)	(0.016)	(0.017)	(0.016)	(0.016)
importer population	-0.018	0.001	-0.040	0.023	-0.028
	(0.013)	(0.016)	(0.014)	(0.015)	(0.013)
distance	0.119	0.090	0.146	0.077	0.132
	(0.017)	(0.016)	(0.019)	(0.021)	(0.019)
product fixed effect	yes	yes	yes	yes	yes
number of observations	4,520,030	1,028,272	2,096,688	483,989	2,643,031
R-squared	0.768	0.668	0.630	0.853	0.782

Note: Standard errors are clustered by importer and by exporter. The dependent variable p_{nik} is the price of country i's exports of product k to country n. The baseline regression is repeated from Table II column (3).

not statistically significant. The coefficient on exporter population is stable across samples, and the coefficient on importer population is small and generally statistically insignificant. The coefficient on distance is stable in magnitude and significance, except for the subsample with only capital goods, where it is 0.077 compared to 0.119 in the baseline.

A.4. *Industry Classifications*

Our analysis of unit values, both descriptive and analytic, is at the level of total merchandise trade. In describing the data and constructing price indices P_{ni} for estimation, we pooled observations across all importer-exporter-product triads in the Comtrade data. We now assess how much damage this level of aggregation inflicts.

As discussed in Section 2, Comtrade's finest level of product categorization is the 6-digit HS6 classification. Comtrade also provides three coarser partition tiers: the 4-digit HS4 level, the 2-digit HS2 level, and the pooling of HS2 categories into 21 sections. Table A.VII lists the sections along with their component HS2 categories. In this appendix, we examine whether our approach of pooling the data disregards important variation across industry categories.

For each of the 4,846 HS6 products with more than 20 importer-exporter pairs we run the regression:

$$\log p_{nik} = \delta_{0k} + \delta_{1k} \log w_n + \delta_{2k} \log w_i + \delta_{3k} \log Dist_{ni} + \epsilon_{nik} \tag{1}$$

where p_{nik} is the unit value of the imports of country n from country i of product k, w_n is the income per capita of importer n, w_i is the income per capita of exporter i, $Dist_{ni}$ is the distance between countries n and i, and δ_{0k}, δ_{1k}, δ_{2k}, and δ_{3k} are parameters estimated for each product k. In the data we use to analyse prices in Section 2, the products represented account for 97.2% of the total number of HS6 products and nearly all of international trade flows in terms of value.

Overall, 82 percent of the coefficients δ_{1k} on importer per capita income, 94 percent of the coefficients δ_{2k} on exporter per capita income, and 80 percent of the coefficients δ_{3k} on distance are positive. To summarize the results further, Table A.VII reports, for each section, the mean coefficient, the fraction of coefficients that are positive, and the fraction of coefficients that are positive and statistically significant at a 10 percent level. Positive coefficients on importer and exporter per capita income are pervasive within all individual sections. Footwear, Headgear (Section 12) and Works of Art (Section 21), sections where we might expect a high degree of quality differentiation, display particularly large shares of positive coefficients. The majority of the coefficients on distance are also positive in all sections, with the exception of Precious Metals and Stone (Section 14).

How much of the heterogeneity in the coefficients on income per capita at the HS6 level can we attribute to courser levels of classification? To answer this question we decompose the variances in our estimates $\hat{\delta}_{1k}$, $\hat{\delta}_{2k}$ and $\hat{\delta}_{3k}$ at the HS6 level into within and between industry classifications for the three courser tiers of classification. Table A.VIII reports the share of the variance that is between industry categories for each of the three. The twenty-one sections account for 21% of the variance across estimates $\hat{\delta}_{1k}$ and 14% of the variance across estimates $\hat{\delta}_{2k}$ and 11% of the variance across $\hat{\delta}_{3k}$. Although the number of HS4 product categories, 1,235, is not much smaller than the 4,846 HS6 categories, HS4 categories account for less than half of the variance. In sum, broader industry categories account for relatively small variation in the income elasticities across HS6 product categories. Analysis that focuses on broader industry classifications leaves a lot of within-industry heterogeneity on the table.

A.5. *Robustness of descriptive statistics*

Differences between rich and poor countries. Using data from USA imports, Hummels and Klenow (2005) report a decomposition of trade values similar to Table I. They find that the increasing relation between prices and exporter per capita income occurred only among rich countries. In the subsample with poor exporters, prices did not vary systematically with exporter per capita income.

To check if our stylized facts differ between rich and poor countries, we augment the regressions in Table I by substituting the independent variables importer GDP per capita and exporter GDP per capita with the same variable interacted with dummies for whether the country is rich or poor. We define rich and poor as the countries with GDP per capita above and below median. Table A.IX reports the results. For all margins and for both importer GDP per capita and exporter GDP per capita, the coefficients of the poor and of the rich countries are nearly identical.

Analogously, in Table A.X, we augment the main price regressions in Table II, columns (3) and (5). In both cases we find again that the coefficient is the same for rich and poor importers and for rich and poor exporters.

Units of measuring prices. As indicated in Table A.II, about 80% of our price observations are unit values per kg (or ton). Our results may be biased if higher-quality products are systematically heavier or lighter than lower-quality products. To evaluate this possibility, we repeat steps 8 and 9 of cleaning our data on prices in Appendix A.1, except that instead of selecting the most common unit of measurement in step 8, we keep only quantity observations measured in number of units or pairs. Table A.XI presents the results. The sample size decreases from 4,520,030 to 840,803, less than one-fifth of the original size. The statistically-significant coefficients on exporter population and exporter GDP per capita don’t change much. The coefficient on importer population changes signs but remains small and statistically insignificant.

TABLE A.VII: Summary by section of coefficients δ_{1k}, δ_{2k} and δ_{3k} in regression (1) by product

section		HS2	number of	importer per capita income			exporter per capita income			distance		
					percentage			percentage			percentage	
		categories	products	mean	positive	sig 10%	mean	positive	sig 10%	mean	positive	sig 10%
1	Animals, Animal Products	01-05	189	0.13	85	76	0.13	89	78	0.083	76	56
2	Vegetable Products	06-14	250	0.11	88	74	0.15	92	86	0.125	86	70
3	Animal or Vegetable Fats, Oils, Waxes	15	51	0.08	82	63	0.20	100	92	0.133	90	78
4	Food Items	16-24	177	0.10	88	81	0.18	97	92	0.091	87	73
5	Mineral Products	25-27	140	0.02	53	26	0.18	86	67	0.179	86	64
6	Chemicals and Allied Industries	28-38	733	0.07	73	52	0.17	91	77	0.102	82	59
7	Plastics, Rubbers	39-40	189	0.09	95	88	0.20	98	96	0.092	89	72
8	Raw Hides, Skins, Leather, Furs	41-43	62	0.17	92	84	0.16	94	82	0.036	71	40
9	Wood, Wood Products	44-46	75	0.07	80	63	0.13	89	79	0.087	79	64
10	Pulp, Paper, Cardboard	47-49	143	0.12	92	78	0.13	92	80	0.097	84	64
11	Textiles	50-63	798	0.15	96	89	0.23	98	96	0.054	79	55
12	Footwear, Headgear	64-67	55	0.21	98	95	0.18	100	100	0.052	84	56
13	Stone, Glass	68-70	133	0.09	78	67	0.25	99	96	0.119	89	71
14	Precious Metals and Stones	71	50	0.12	76	56	0.06	62	36	-0.018	42	20
15	Metals	72-83	542	0.08	81	63	0.23	98	93	0.097	88	72
16	Machinery, Electrical	84-85	757	0.07	73	60	0.21	94	87	0.061	76	54
17	Transportation	86-89	124	0.08	77	60	0.17	90	81	0.012	55	38
18	Medical and Musical Instruments	90-92	225	0.14	88	74	0.21	95	84	0.044	70	46
19	Arms, Amunition	93	17	0.05	71	59	0.29	100	88	0.053	71	35
20	Miscellaneous Manufactures	94-96	129	0.15	90	86	0.20	98	92	0.055	81	59
21	Works of Art	97-98	7	0.33	100	86	0.23	86	71	0.058	71	57
Total		**4846**		**0.10**	**82**	**69**	**0.19**	**94**	**87**	**0.080**	**80**	**60**

TABLE A.VIII

SHARE OF THE VARIANCE OF THE COEFFICIENTS δ_{1k}, δ_{2k} AND δ_{3k} IN REGRESSION (1) THAT IS WITHIN INDUSTRY CLASSIFICATION

	section	HS2	HS4	HS6
importer per capita income ($\hat{\delta}_{1k}$)	0.21	0.22	0.34	1.00
exporter per capita income ($\hat{\delta}_{2k}$)	0.14	0.16	0.39	1.00
distance ($\hat{\delta}_{3k}$)	0.11	0.13	0.31	1.00
number of categories	21	96	1,235	4,846

TABLE A.IX

DECOMPOSITION OF TRADE VALUES INTO MARGINS WITH SEPARATE COEFFICIENTS ON GDP PER CAPITA FOR RICH AND POOR COUNTRIES

dependent variable →	value	extensive margin	quantity	price
exporter GDP per capita x $\mathbb{1}\{\text{exp. rich}\}$	1.377	1.000	0.273	0.104
	(0.107)	(0.079)	(0.078)	(0.019)
exporter GDP per capita x $(1 - \mathbb{1}\{\text{exp. rich}\})$	1.395	1.038	0.251	0.106
	(0.144)	(0.108)	(0.105)	(0.024)
exporter population	1.356	0.852	0.553	-0.049
	(0.064)	(0.050)	(0.046)	(0.014)
importer GDP per capita x $\mathbb{1}\{\text{imp. rich}\}$	1.120	0.495	0.505	0.119
	(0.068)	(0.058)	(0.066)	(0.022)
importer GDP per capita x $(1 - \mathbb{1}\{\text{imp. rich}\})$	1.139	0.516	0.502	0.121
	(0.089)	(0.075)	(0.085)	(0.028)
importer population	1.126	0.351	0.794	-0.018
	(0.039)	(0.028)	(0.035)	(0.012)
distance	-1.200	-0.688	-0.628	0.116
	(0.086)	(0.063)	(0.057)	(0.012)
Observations	9,455	9,455	9,455	9,455
R-squared	0.673	0.639	0.403	0.218

Note: All variables are in logs and standard errors are clustered by importer and exporter. $\mathbb{1}\{\text{exp. rich}\}$ and $\mathbb{1}\{\text{imp. rich}\}$ are dummies for whether the exporting country has GDP per capita above median and the importing country has GDP per capita above median, respectively.

The coefficients on importer GDP per capita and on distance decrease but remain sizable and statistically significant at a 1 percent level.

Definition of margins Table I presents the decomposition of values into margins. Our definition of margins weights price and variety observations equally. Hummels and Klenow (2005) follow Feenstra (1994) in their definition of the price indices and extensive margins. Table A.XII presents the decomposition of trade into margins using the weights proposed by Feenstra (1994). Qualitatively, the results don't change relative to Tables I and A.IV. Quantitatively, the coefficient on exporter GDP, GDP per capita, and population all decrease in the extensive margin regression with Feenstra's proposed weights. The coefficients on importer and exporter GDP per capita in the price regression also decrease.

TABLE A.X

PRICE REGRESSIONS WITH SEPARATE COEFFICIENTS ON GDP PER CAPITA FOR RICH AND POOR COUNTRIES

	p_{nik}	P_{ni}
exporter GDP per capita x $\mathbb{1}\{\text{exp. rich}\}$	0.181	0.175
	(0.032)	(0.032)
exporter GDP per capita x $(1 - \mathbb{1}\{\text{exp. rich}\})$	0.187	0.181
	(0.043)	(0.042)
exporter population	-0.064	-0.063
	(0.022)	(0.021)
importer GDP per capita x $\mathbb{1}\{\text{imp. rich}\}$	0.105	0.104
	(0.022)	(0.022)
importer GDP per capita x $(1 - \mathbb{1}\{\text{imp. rich}\})$	0.106	0.105
	(0.027)	(0.028)
importer population	-0.018	-0.018
	(0.013)	(0.013)
distance	0.118	0.116
	(0.017)	(0.017)
product fixed effect	yes	n.a.
weighted by # price observations	-	yes
Observations	4,520,030	9,455
R-squared	0.768	0.488

Note: All variables are in logs and standard errors are clustered by importer and exporter. The dependent variable in the first column is the price by importer-exporter-product tuple, and in the second column, it is the price margin of country i's exports to n. $\mathbb{1}\{\text{exp. rich}\}$ and $\mathbb{1}\{\text{imp. rich}\}$ are dummies for whether the exporting country has GDP per capita above median and the importing country has GDP per capita above median, respectively.

Our critique on the price regressions of Table I also holds with the weights used by Hummels and Klenow (2005). The price indices P_{ni} of some importer-exporter dyads have large measurement error because they are based on few product-level price observations p_{nik}. The regression on Table II column (5) weights the dyads according to the number of price observations, down-weighting indices P_{ni} of dyads where we expect large measurement error.

A.6. *Other Years: 2001, 2002, 2012, 2017*

Our analysis in the main text uses only 2007 data. This appendix repeats all the results of the descriptive Section 2 for four additional years: 2001, 2002, 2012, 2017. We chose years roughly five years apart, with the exception of 2001 and 2002. There was a recession in 2001, and so the analysis of these two consecutive years, 2001 and 2002, shows that our results don't change visibly with the business cycles.

Table A.XIII repeats the decomposition of trade values into margins from Table I (Table A.IV with standard errors) for the four additional years. Tables A.XIV through A.XVII repeat the descriptive price regressions of Table II. Tables A.XVIII through A.XXI repeat the price regressions of Table III with subsamples. The magnitude and statistical significance of the coefficients are stable over the years.

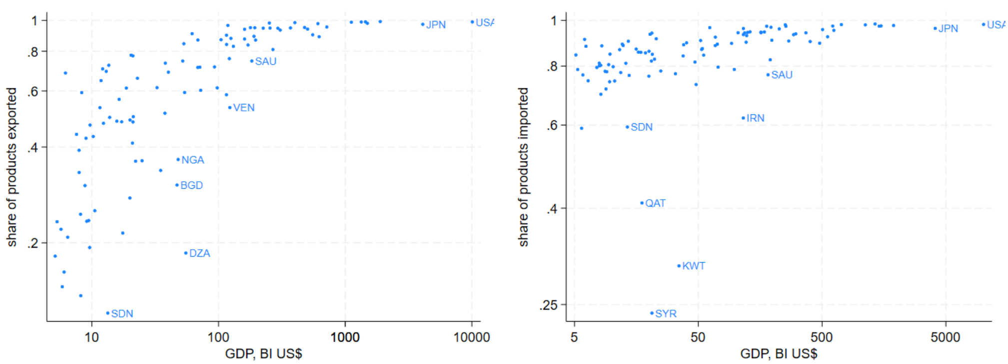
Figures A.1 through A.4 repeat the extensive margin graphs of Figure 2. These graphs have different scales across years as the importing and exporting extensive margins of trade have

TABLE A.XI

DESCRIPTIVE PRICE REGRESSION WITH PRODUCTS MEASURED IN UNITS OR PAIRS

Dependent variable: p_{nik}	baseline	prices in units or pairs only
exporter GDP per capita	0.168	0.139
	(0.018)	(0.016)
exporter population	-0.064	-0.078
	(0.021)	(0.017)
importer GDP per capita	0.102	0.064
	(0.015)	(0.018)
importer population	-0.018	0.022
	(0.013)	(0.016)
distance	0.119	0.068
	(0.017)	(0.021)
product fixed effect	yes	yes
number of observations	4,520,030	840,803
R-squared	0.768	0.867

Note: Standard errors are clustered by importer and by exporter. The dependent variable p_{nik} is the price of country i's exports of product k to country n. The baseline regression is repeated from Table II column (3).



(a) Exporter (b) Importer

FIGURE A.1.—Extensive margin and GDP 2001

increased over time. As emphasized in the main text, across countries within any year, there’s an increasing and concave relationship between GDP and the extensive margin of exporting, and GDP and the extensive margin of importing (all in logs). Also, as in 2007, the extensive margin of importing is generally larger than the extensive margin of exporting, especially for small countries.

TABLE A.XII: Decomposition of trade values into margins, weights as in Feenstra (1994)

	Baseline, Tables I and A.IV				Weights as in Feenstra (1994)			
dependent variable $\rightarrow$	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$
exporter GDP	1.346	0.880	0.446	0.020	1.346	0.735	0.611	0.000
	(0.052)	(0.038)	(0.042)	(0.015)	(0.052)	(0.040)	(0.043)	(0.009)
importer GDP	1.102	0.396	0.662	0.044	1.102	0.369	0.719	0.014
	(0.033)	(0.026)	(0.036)	(0.012)	(0.033)	(0.027)	(0.033)	(0.007)
distance	-1.183	-0.718	-0.523	0.058	-1.183	-0.609	-0.607	0.034
	(0.083)	(0.061)	(0.058)	(0.017)	(0.083)	(0.058)	(0.055)	(0.011)
R-squared	0.672	0.632	0.366	0.030	0.672	0.520	0.434	0.007
exporter GDP per capita	1.339	0.920	0.317	0.102	1.339	0.818	0.474	0.046
	(0.065)	(0.049)	(0.043)	(0.013)	(0.065)	(0.046)	(0.045)	(0.008)
exporter population	1.352	0.847	0.555	-0.049	1.352	0.664	0.727	-0.040
	(0.063)	(0.050)	(0.046)	(0.013)	(0.063)	(0.046)	(0.046)	(0.009)
importer GDP per capita	1.078	0.452	0.510	0.116	1.078	0.396	0.626	0.056
	(0.044)	(0.035)	(0.046)	(0.014)	(0.044)	(0.035)	(0.046)	(0.010)
importer population	1.122	0.348	0.793	-0.018	1.122	0.346	0.799	-0.023
	(0.040)	(0.028)	(0.035)	(0.012)	(0.040)	(0.030)	(0.034)	(0.007)
distance	-1.194	-0.681	-0.629	0.116	-1.194	-0.568	-0.695	0.068
	(0.084)	(0.061)	(0.057)	(0.012)	(0.084)	(0.059)	(0.057)	(0.010)
R-squared	0.672	0.636	0.401	0.217	0.672	0.529	0.454	0.101
observations	9,455	9,455	9,455	9,455	9,455	9,455	9,455	9,455

Note: Standard errors are clustered by importer and by exporter.

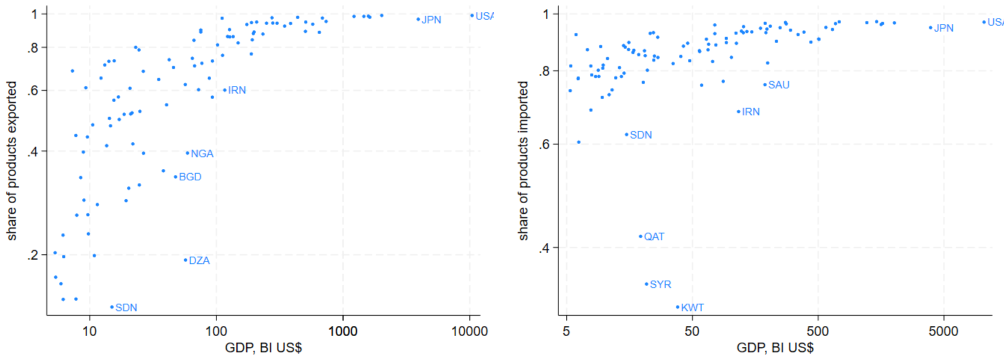
TABLE A.XIII

DECOMPOSITION OF TRADE VALUES INTO MARGINS FOR OTHER YEARS

	2001				**2002**			
dependent variable →	value	EM	quantity	price	value	EM	quantity	price
exporter GDP	1.294	0.915	0.359	0.020	1.317	0.920	0.379	0.018
	(0.049)	(0.040)	(0.034)	(0.012)	(0.051)	(0.041)	(0.035)	(0.013)
importer GDP	1.075	0.410	0.639	0.027	1.084	0.411	0.634	0.039
	(0.030)	(0.025)	(0.033)	(0.015)	(0.030)	(0.025)	(0.032)	(0.014)
distance	-1.297	-0.880	-0.472	0.055	-1.289	-0.852	-0.497	0.060
	(0.077)	(0.064)	(0.051)	(0.018)	(0.080)	(0.064)	(0.050)	(0.017)
R-squared	0.683	0.669	0.348	0.021	0.686	0.671	0.358	0.030
exporter GDP per capita	1.296	0.962	0.255	0.080	1.306	0.959	0.269	0.078
	(0.064)	(0.051)	(0.040)	(0.013)	(0.062)	(0.051)	(0.041)	(0.014)
exporter population	1.293	0.880	0.436	-0.024	1.325	0.890	0.462	-0.027
	(0.055)	(0.047)	(0.038)	(0.011)	(0.058)	(0.048)	(0.038)	(0.012)
importer GDP per capita	1.075	0.476	0.516	0.083	1.086	0.478	0.512	0.097
	(0.039)	(0.036)	(0.041)	(0.017)	(0.040)	(0.034)	(0.041)	(0.014)
importer population	1.075	0.360	0.731	-0.015	1.083	0.360	0.729	-0.006
	(0.036)	(0.027)	(0.036)	(0.014)	(0.035)	(0.027)	(0.032)	(0.013)
distance	-1.296	-0.849	-0.535	0.087	-1.292	-0.818	-0.570	0.097
	(0.079)	(0.064)	(0.049)	(0.016)	(0.081)	(0.064)	(0.048)	(0.014)
R-squared	0.683	0.675	0.373	0.129	0.686	0.677	0.386	0.151
observations	9,196	9,196	9,196	9,196	9,338	9,338	9,338	9,338

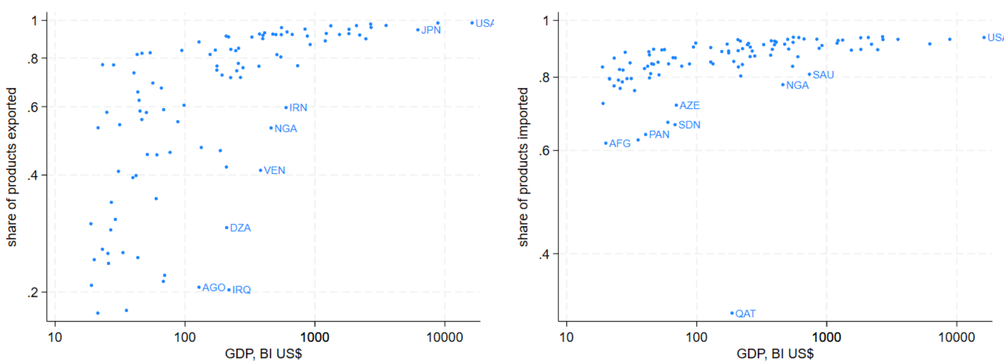
	2012				**2017**			
dependent variable →	value	EM	quantity	price	value	EM	quantity	price
exporter GDP	1.395	0.860	0.527	0.009	1.368	0.835	0.529	0.004
	(0.061)	(0.046)	(0.052)	(0.017)	(0.056)	(0.045)	(0.048)	(0.018)
importer GDP	1.166	0.413	0.708	0.045	1.151	0.379	0.729	0.043
	(0.041)	(0.031)	(0.036)	(0.012)	(0.038)	(0.028)	(0.033)	(0.011)
distance	-1.330	-0.778	-0.631	0.079	-1.343	-0.787	-0.652	0.096
	(0.086)	(0.061)	(0.062)	(0.016)	(0.073)	(0.054)	(0.056)	(0.015)
R-squared	0.642	0.579	0.372	0.034	0.675	0.598	0.424	0.053
exporter GDP per capita	1.524	0.977	0.460	0.087	1.521	0.992	0.438	0.092
	(0.082)	(0.058)	(0.074)	(0.017)	(0.078)	(0.058)	(0.065)	(0.016)
exporter population	1.306	0.780	0.571	-0.044	1.275	0.740	0.585	-0.049
	(0.074)	(0.059)	(0.054)	(0.016)	(0.061)	(0.054)	(0.046)	(0.016)
importer GDP per capita	1.162	0.496	0.557	0.109	1.193	0.495	0.586	0.111
	(0.058)	(0.043)	(0.052)	(0.017)	(0.056)	(0.038)	(0.048)	(0.016)
importer population	1.170	0.357	0.812	0.001	1.126	0.309	0.815	0.002
	(0.051)	(0.033)	(0.035)	(0.014)	(0.044)	(0.029)	(0.033)	(0.011)
distance	-1.298	-0.727	-0.686	0.115	-1.284	-0.706	-0.722	0.143
	(0.089)	(0.060)	(0.060)	(0.014)	(0.073)	(0.052)	(0.055)	(0.014)
R-squared	0.647	0.595	0.389	0.156	0.681	0.627	0.440	0.215
observations	9,451	9,451	9,451	9,451	9,713	9,713	9,713	9,713

Note: Standard errors are clustered by importer and by exporter.



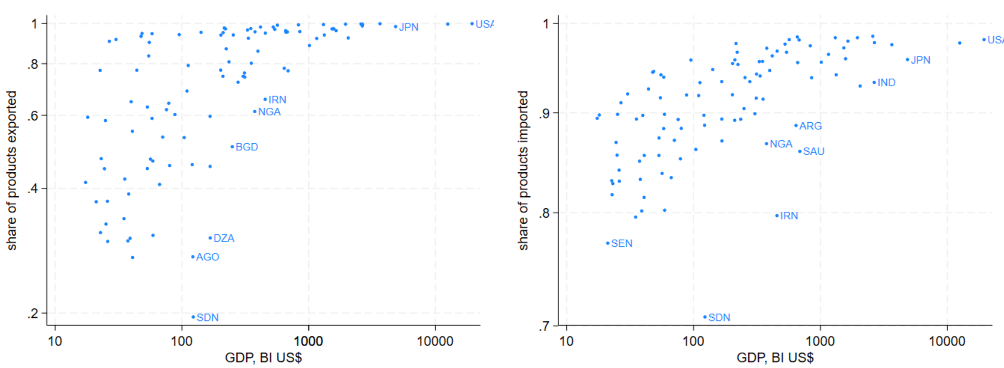
(a) Exporter (b) Importer

FIGURE A.2.—Extensive margin and GDP 2002



(a) Exporter (b) Importer

FIGURE A.3.—Extensive margin and GDP 2012



(a) Exporter (b) Importer

FIGURE A.4.—Extensive margin and GDP 2017

TABLE A.XIV

DESCRIPTIVE PRICE REGRESSIONS 2001

	Price for each importer, exporter, product p_{nik}				Weighted reg., P_{ni} ^{b}
	(1)	(2)	(3)	(4)	(5)
exporter GDP per capita	0.137		0.145	0.148	0.139
	(0.015)		(0.014)	(0.014)	(0.014)
exporter population	-0.034		-0.028	-0.029	-0.029
	(0.015)		(0.014)	(0.014)	(0.014)
importer GDP per capita		0.059	0.071	0.083	0.071
		(0.022)	(0.021)	(0.020)	(0.021)
importer population		-0.027	-0.019	-0.021	-0.019
		(0.014)	(0.014)	(0.014)	(0.014)
distance	0.127	0.113	0.093	0.087	0.093
	(0.018)	(0.017)	(0.019)	(0.019)	(0.019)
absolute difference in GDP per capita				0.030	
				(0.012)	
product-importer fixed effect	yes	no	no	no	-
product-exporter fixed effect	no	yes	no	no	-
product fixed effect	no	no	yes	yes	-
Number of observations	4,035,591	4,035,591	4,035,591	4,035,591	9,196
R-squared	0.857	0.833	0.800	0.800	0.341

Note: All variables are in logs. Standard errors are clustered by importer and by exporter. ^{a}The term equals |log(importer GDP per capita/exporter GDP per capita)|. ^{b} Each observation P_{ni} is weighted by the number of product-level price observations p_{nik} for the importer-exporter pair ni.

APPENDIX B: DESCRIPTIVE STATISTICS OF ALTERNATIVE DATA SETS

B.1. *Importer and Exporter Reports to Comtrade*

As described in Section A.1, we follow the standard procedure in the literature and prioritize information on bilateral trade flows reported by the importing country. In this Appendix, we compare the stylized facts about the data using information reported by the exporting country in 2007.

We follow the same steps 2-8 as in Appendix A.1 to clean data on variety and quantity of trade. We have information on all margins of trade, value, extensive and price, as reported by both the importing and exporting countries for 8,518 importer-exporter dyads. The correlation between the data with the importer reports and with the exporter reports is 0.92 for the total value of trade, $\log X_{ni}$, 0.91 for the extensive margin $\log E_{ni}$ and 0.31 for the price margin $\log P_{ni}$.

Table B.I reports the decomposition of trade flows into margins, from Table I, comparing the importing and the exporting reports. All the qualitative patterns of this decomposition discussed in the paper hold in the data reported by the exporting country. Quantitatively, the only significant difference is in the price margin. In the exporting country’s reports, prices increase more systematically with exporter per capita income and they vary less with importer per capita income, although the coefficients remain statistically significant. The coefficient on importer population changes signs, but it remains small and statistically insignificant.

As argued in the main text, the price margins for exporter-importer dyads with only a few products may be measured with error. Table B.II repeats these price regressions weighting ob-

TABLE A.XV

DESCRIPTIVE PRICE REGRESSIONS 2002

	Price for each importer, exporter, product p_{nik}				Weighted reg., P_{ni} [b]
	(1)	(2)	(3)	(4)	(5)
exporter GDP per capita	0.144		0.152	0.153	0.145
	(0.015)		(0.015)	(0.015)	(0.015)
exporter population	-0.042		-0.035	-0.036	-0.036
	(0.016)		(0.016)	(0.015)	(0.016)
importer GDP per capita		0.079	0.090	0.100	0.089
		(0.016)	(0.015)	(0.015)	(0.015)
importer population		-0.013	-0.003	-0.005	-0.005
		(0.013)	(0.012)	(0.012)	(0.012)
distance	0.133	0.129	0.105	0.099	0.104
	(0.018)	(0.014)	(0.017)	(0.017)	(0.017)
absolute difference in GDP per capita				0.027	
				(0.012)	
product-importer fixed effect	yes	no	no	no	-
product-exporter fixed effect	no	yes	no	no	-
product fixed effect	no	no	yes	yes	-
Number of observations	4,187,272	4,187,272	4,187,272	4,187,272	9,338
R-squared	0.854	0.838	0.804	0.804	0.441

Note: All variables are in logs. Standard errors are clustered by importer and by exporter. [a]The term equals |log(importer GDP per capita/exporter GDP per capita)|. [b] Each observation P_{ni} is weighted by the number of product-level price observations p_{nik} for the importer-exporter pair ni.

servations by the number of products each country pair reports. The coefficient on exporter GDP per capita is now more similar between importer and exporter reports, while the coefficients on importer per capita income remain smaller in the data reported by the exporting country.

Overall, moving to exporter reports has no major effect on the stylized facts from our data that we highlight.

TABLE A.XVI

DESCRIPTIVE PRICE REGRESSIONS 2012

	Price for each importer, exporter, product p_{nik}				Weighted reg., P_{ni} ^{b}
	(1)	(2)	(3)	(4)	(5)
exporter GDP per capita	0.159		0.164	0.169	0.159
	(0.023)		(0.023)	(0.023)	(0.022)
exporter population	-0.070		-0.063	-0.063	-0.061
	(0.028)		(0.028)	(0.027)	(0.027)
importer GDP per capita		0.088	0.105	0.117	0.105
		(0.021)	(0.021)	(0.021)	(0.021)
importer population		-0.010	0.002	0.001	0.003
		(0.014)	(0.014)	(0.014)	(0.014)
distance	0.174	0.151	0.131	0.125	0.128
	(0.018)	(0.016)	(0.017)	(0.017)	(0.017)
absolute difference in GDP per capita				0.038	
				(0.021)	
product-importer fixed effect	yes	no	no	no	-
product-exporter fixed effect	no	yes	no	no	-
product fixed effect	no	no	yes	yes	-
Number of observations	4,821,063	4,821,063	4,821,063	4,821,063	9,451
R-squared	0.804	0.796	0.752	0.752	0.411

Note: All variables are in logs. Standard errors are clustered by importer and by exporter. ^{a}The term equals |log(importer GDP per capita/exporter GDP per capita)|. ^{b} Each observation P_{ni} is weighted by the number of product-level price observations p_{nik} for the importer-exporter pair ni.

B.2. *BACI*

BACI is a commonly used data set compiled by Gaulier and Zignago (2010) at the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) using data from the UN Comtrade. The main differences in their cleaning procedure from ours are: (i) They combine information from both the importer and the exporter reports. They develop a method to estimate the reliability of the reports and use a weighted average between the two. (ii) They convert the values reported by importers from CIF (cost insurance and freight) to FOB (Free on Board) by estimating and removing the costs of insurance and freight. We use CIF data reported by the importer and compare them to the model with iceberg costs. (iii) All their unit values are measured in dollars per ton, while 20 percent of our data are measured in other units (see Table A.II).[3]

We downloaded the data from BACI and used the procedure from Appendix A.1 to clean data on extensive margin (step 6) and price information (step 9). We combine country units as in step 2 and select the same set of 100 countries as our final data (listed in Table A.I).

Table B.III compares the price regressions with the UN Comtrade data used in our analysis (panel A) to BACI (panel B). BACI has more observations per country pair (5M instead of 4.5M) because of their use of importer or exporter reports but they have fewer country pairs with information on all margins of trade (9,127 compared to 9,455). The first regression in

[3]Our main concern was that our estimated model would capture features of not only the (cleaned) raw data but also features of the model that Gaulier and Zignago (2010) use to select information from importers and exporters or to infer insurance and freight costs.

TABLE A.XVII

DESCRIPTIVE PRICE REGRESSIONS 2017

	Price for each importer, exporter, product p_{nik}				Weighted reg., P_{ni} [b]
	(1)	(2)	(3)	(4)	(5)
exporter GDP per capita	0.140		0.148	0.151	0.144
	(0.023)		(0.022)	(0.022)	(0.022)
exporter population	-0.078		-0.070	-0.069	-0.067
	(0.029)		(0.028)	(0.027)	(0.028)
importer GDP per capita		0.082	0.099	0.109	0.100
		(0.021)	(0.020)	(0.021)	(0.020)
importer population		-0.009	0.002	0.001	0.002
		(0.012)	(0.012)	(0.012)	(0.012)
distance	0.190	0.173	0.157	0.152	0.152
	(0.017)	(0.015)	(0.016)	(0.017)	(0.016)
absolute difference in GDP per capita				0.032	
				(0.021)	
product-importer fixed effect	yes	no	no	no	-
product-exporter fixed effect	no	yes	no	no	-
product fixed effect	no	no	yes	yes	-
Number of observations	5,292,954	5,292,954	5,292,954	5,292,954	9,713
R-squared	0.817	0.808	0.768	0.768	0.425

Note: All variables are in logs. Standard errors are clustered by importer and by exporter. [a]The term equals |log(importer GDP per capita/exporter GDP per capita)|. [b] Each observation P_{ni} is weighted by the number of product-level price observations p_{nik} for the importer-exporter pair ni.

each panel is main descriptive price regression using disagregated data pooled with product fixed effects (for panel A, it is also in column (3) of Table II). The dependent variable is the price at which country i exports product k to country n, $\log p_{nik}$. Within each panel, these regressions have similar coefficients to the regression of the price index $\log P_{ni}$ on country characteristics weighted by the number of observations in each country pair. The last column of the panel is the unweighted price regression (in Table I, panel B).

The results in panels A and B are similar. BACI's conversion of prices to FOB decreases the coefficient on distance by little, from 0.12 to 0.09 in the first regressions. The coefficients on exporter per capita income are larger for BACI, but the point estimates are within two standard deviations of each other.

In sum, all the features of our data used in descriptive statistics and in estimating the model are also present in the commonly used dataset BACI.

TABLE A.XVIII

DESCRIPTIVE PRICE REGRESSIONS BY PRODUCT CATEGORIES, 2001

Dependent variable: unit price by importer-exporter-product tuple p_{nik}.

	all products (Table A.XIV col (3))	manufact.	Rauch (1999) differentiated	BEC end use classification	
				consumption	capital, inputs
exporter GDP per capita	0.145	0.153	0.146	0.137	0.151
	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)
exporter population	-0.028	-0.037	-0.038	-0.032	-0.027
	(0.014)	(0.016)	(0.015)	(0.014)	(0.015)
importer GDP per capita	0.071	0.078	0.085	0.122	0.050
	(0.021)	(0.021)	(0.021)	(0.020)	(0.022)
importer population	-0.019	-0.006	-0.008	-0.010	-0.023
	(0.014)	(0.014)	(0.014)	(0.016)	(0.014)
distance	0.093	0.083	0.089	0.073	0.101
	(0.019)	(0.021)	(0.020)	(0.018)	(0.020)
product fixed effect	yes	yes	yes	yes	yes
Number of observations	4,035,591	2,656,334	2,825,945	863,471	2,322,776
R-squared	0.800	0.816	0.807	0.689	0.818

Note: All variables are in logs. The dependent variable is the unit price by importer-exporter-product tuple p_{nik}. Standard errors are clustered by importer and by exporter. [a] We use Rauch's liberal classification which has fewer differentiated goods. [b] BEC (Broad Economic Categories) refers to the United Nations classification of goods according to end use.

TABLE A.XIX

DESCRIPTIVE PRICE REGRESSIONS BY PRODUCT CATEGORIES, 2002

Dependent variable: unit price by importer-exporter-product tuple p_{nik}.

	all products (Table A.XV col (3))	manufact.	Rauch (1999) differentiated	BEC end use classification	
				consumption	capital, inputs
exporter GDP per capita	0.152	0.160	0.153	0.148	0.156
	(0.015)	(0.015)	(0.015)	(0.015)	(0.017)
exporter population	-0.035	-0.045	-0.045	-0.040	-0.034
	(0.016)	(0.017)	(0.017)	(0.016)	(0.016)
importer GDP per capita	0.090	0.097	0.103	0.144	0.068
	(0.015)	(0.016)	(0.016)	(0.017)	(0.015)
importer population	-0.003	0.009	0.007	0.003	-0.006
	(0.012)	(0.013)	(0.013)	(0.017)	(0.012)
distance	0.105	0.096	0.102	0.087	0.112
	(0.017)	(0.019)	(0.018)	(0.018)	(0.017)
product fixed effect	yes	yes	yes	yes	yes
Number of observations	4,187,272	2,773,675	2,957,683	902,649	2,414,834
R-squared	0.804	0.817	0.810	0.684	0.823

Note: All variables are in logs. The dependent variable is the unit price by importer-exporter-product tuple p_{nik}. Standard errors are clustered by importer and by exporter. [a] We use Rauch's liberal classification which has fewer differentiated goods. [b] BEC (Broad Economic Categories) refers to the United Nations classification of goods according to end use.

TABLE A.XX

DESCRIPTIVE PRICE REGRESSIONS BY PRODUCT CATEGORIES, 2012

Dependent variable: unit price by importer-exporter-product tuple p_{nik}.

	all products (Table A.XVI col (3))	manufact.	Rauch (1999) differentiated	BEC end use classification consumption	BEC end use classification capital, inputs
exporter GDP per capita	0.164	0.171	0.162	0.154	0.172
	(0.023)	(0.023)	(0.022)	(0.019)	(0.028)
exporter population	-0.063	-0.076	-0.078	-0.067	-0.063
	(0.028)	(0.032)	(0.031)	(0.025)	(0.029)
importer GDP per capita	0.105	0.113	0.120	0.168	0.080
	(0.021)	(0.021)	(0.021)	(0.023)	(0.021)
importer population	0.002	0.016	0.014	0.017	-0.005
	(0.014)	(0.015)	(0.015)	(0.017)	(0.014)
distance	0.131	0.117	0.121	0.103	0.143
	(0.017)	(0.019)	(0.018)	(0.016)	(0.019)
product fixed effect	yes	yes	yes	yes	yes
Number of observations	4,821,063	3,089,339	3,326,529	1,109,611	2,841,415
R-squared	0.752	0.757	0.751	0.659	0.765

Note: All variables are in logs. The dependent variable is the unit price by importer-exporter-product tuple p_{nik}. Standard errors are clustered by importer and by exporter. [a]We use Rauch's liberal classification which has fewer differentiated goods. [b] BEC (Broad Economic Categories) refers to the United Nations classification of goods according to end use.

TABLE A.XXI

DESCRIPTIVE PRICE REGRESSIONS BY PRODUCT CATEGORIES, 2017

Dependent variable: unit price by importer-exporter-product tuple p_{nik}.

	all products (Table A.XVII col (3))	manufact.	Rauch (1999) differentiated	BEC end use classification consumption	BEC end use classification capital, inputs
exporter GDP per capita	0.148	0.153	0.142	0.150	0.151
	(0.022)	(0.024)	(0.022)	(0.019)	(0.027)
exporter population	-0.070	-0.085	-0.086	-0.074	-0.070
	(0.028)	(0.032)	(0.030)	(0.025)	(0.030)
importer GDP per capita	0.099	0.097	0.106	0.163	0.071
	(0.020)	(0.021)	(0.021)	(0.024)	(0.021)
importer population	0.002	0.014	0.013	0.014	-0.005
	(0.012)	(0.012)	(0.012)	(0.014)	(0.012)
distance	0.157	0.140	0.147	0.137	0.166
	(0.016)	(0.017)	(0.017)	(0.015)	(0.018)
product fixed effect	yes	yes	yes	yes	yes
Number of observations	5,292,954	3,329,700	3,621,115	1,275,833	3,062,681
R-squared	0.768	0.772	0.767	0.663	0.785

Note: All variables are in logs. The dependent variable is the unit price by importer-exporter-product tuple p_{nik}. Standard errors are clustered by importer and by exporter. [a]We use Rauch's liberal classification which has fewer differentiated goods. [b] BEC (Broad Economic Categories) refers to the United Nations classification of goods according to end use.

TABLE B.I: Decomposition of trade flows into margins using Comtrade data reported by the importing and by the exporting country

	importer reports				exporter reports			
	value	EM	quantity	price	value	EM	quantity	price
exporter GDP per capita	1.228	0.861	0.260	0.108	1.282	0.916	0.187	0.179
	(0.059)	(0.046)	(0.043)	(0.014)	(0.066)	(0.052)	(0.056)	(0.022)
exporter population	1.291	0.824	0.515	-0.048	1.344	0.854	0.533	-0.043
	(0.056)	(0.046)	(0.045)	(0.014)	(0.062)	(0.051)	(0.046)	(0.017)
importer GDP per capita	1.028	0.429	0.482	0.117	0.942	0.442	0.458	0.041
	(0.042)	(0.037)	(0.045)	(0.014)	(0.050)	(0.030)	(0.037)	(0.006)
importer population	1.042	0.311	0.746	-0.015	1.036	0.438	0.587	0.010
	(0.034)	(0.030)	(0.031)	(0.012)	(0.040)	(0.028)	(0.027)	(0.005)
distance	-1.141	-0.659	-0.592	0.110	-1.303	-0.845	-0.571	0.114
	(0.074)	(0.058)	(0.053)	(0.013)	(0.080)	(0.065)	(0.056)	(0.050)
observations	8,514	8,514	8,514	8,514	8,514	8,514	8,514	8,514
R-squared	0.692	0.644	0.402	0.256	0.678	0.659	0.340	0.156

Note: All variables are in logs and standard errors are clustered by importer and by exporter.

TABLE B.II

PRICE REGRESSIONS OF TABLE B.I WEIGHTED BY THE NUMBER OF OBSERVATIONS FOR EACH IMPORTER-EXPORTER PAIR (AS IN TABLE II COLUMN (5))

Dependent variable: $\log P_{ni}$

	importer report	exporter report
exporter GDP per capita	0.163	0.200
	(0.018)	(0.024)
exporter population	-0.063	-0.077
	(0.021)	(0.022)
importer GDP per capita	0.100	0.036
	(0.015)	(0.006)
importer population	-0.018	0.011
	(0.013)	(0.005)
distance	0.115	0.097
	(0.018)	(0.018)
observations	8,514	8,514
R-squared	0.487	0.500

Note: All variables are in logs. Standard errors are clustered by importer and by exporter.

APPENDIX C: THEORY APPENDIX

C.1. *Toy Model: One quality and Price Overlaps*

This appendix presents a toy model to illustrate the difficulty of explaining the overlap in prices documented in Section 2 with one dimension of quality. There's perfect competition. Say that rich country 1 sells quality q_{A1} to market A at price p_{A1} and quality q_{B1} to market B at price p_{B1}. Country 2 sells quality q_{A2} to market A at price p_{A2} and quality q_{B2} to market B at price p_{B2}. Let's restrict $p_{A1} > p_{B1}$; $p_{A2} > p_{B2}$; (A is the higher price market for either seller) $p_{A1} > p_{A2}$; $q_{A1} > q_{A2}$; $p_{B1} > p_{B2}$; $q_{B1} > q_{B2}$ (1 is the higher price, higher quality seller in either market).

Let's also assume that 1 is located in A and 2 is located in B. Iceberg costs for home delivery are 1 and $d > 1$ for foreign delivery. Firm i 's unit cost of providing quality q is $c_i(q)$. Then in a competitive economy:

$$\begin{aligned} p_{A1} &= c_1(q_{A1}) \leq dc_2(q_{A1}) \\ p_{A2} &= dc_2(q_{A2}) \leq c_1(q_{A2}) \\ p_{B1} &= dc_1(q_{B1}) \leq c_2(q_{B1}) \\ p_{B2} &= c_2(q_{B2}) \leq dc_1(q_{B2}) \end{aligned}$$

Let us also insist on the single-crossing property. Country 1's comparative advantage in higher quality together with $dc_1(q_{B1}) \leq c_2(q_{B1})$ then implies

$$c_1(q) \leq c_2(q) \qquad \text{for all } q \geq q_{B1}. \tag{2}$$

Can we have $p_{B1} < p_{A2}$? That would imply:

$$c_1(q_{A2}) > dc_2(q_{A2}) = p_{A2} > dc_1(q_{B1}) = p_{B1}$$

TABLE B.III: Regressions comparing price information from BACI to Comtrade data used in the analysis

	A. Comtrade			B. BACI		
dependent variable →	p_{nik}	P_{ni}	P_{ni}	p_{nik}	P_{ni}	P_{ni}
exporter GDP per capita	0.168	0.162	0.102	0.196	0.188	0.136
	(0.018)	(0.018)	(0.013)	(0.021)	(0.020)	(0.015)
exporter population	-0.064	-0.063	-0.049	-0.044	-0.044	-0.034
	(0.021)	(0.021)	(0.013)	(0.020)	(0.020)	(0.014)
importer GDP per capita	0.102	0.100	0.116	0.099	0.099	0.109
	(0.015)	(0.015)	(0.014)	(0.013)	(0.013)	(0.012)
importer population	-0.018	-0.018	-0.018	0.008	0.008	-0.006
	(0.013)	(0.013)	(0.012)	(0.010)	(0.010)	(0.009)
distance	0.119	0.116	0.116	0.094	0.093	0.104
	(0.017)	(0.017)	(0.012)	(0.015)	(0.016)	(0.013)
product fixed effect	yes	-	-	yes	-	-
weighted regression	no	yes	no	no	yes	no
observations	4,520,030	9,455	9,455	5,043,536	9,127	9,127
R-squared	0.768	0.487	0.217	0.693	0.539	0.257

Note: All variables are in logs. Standard errors are clustered by importer and by exporter. In weighted regressions, the weights are the number of price observations by exporter-importer dyad.

which implies that:

$$c_1(q_{A2}) > c_2(q_{A2}) > c_1(q_{B1}).$$

These inequalities establish that $q_{A2} > q_{B1}$ since c_1 is increasing in q. Then the first inequality contradicts (2).

C.2. *Constants*

Here we report expressions for the constants Γ_1-Γ_{12}:

$$\Gamma_1 = \frac{\gamma}{1-\rho\overline{m}}$$

$$\Gamma_2 = \left(\frac{(1+\Gamma_1)^{(\beta/\rho)-1}}{\overline{m}\Gamma_1^{\gamma/\rho}}\right)^{1/(1+\gamma-\beta)}$$

$$\Gamma_3 = \frac{\overline{m}\Gamma_1^{\gamma/\rho}}{(1+\Gamma_1)^{(1+\gamma)/\rho}}$$

$$\Gamma_4 = \left(\frac{\overline{m}}{\overline{m}-1}\right)^{\overline{m}-1}$$

$$\Gamma_5 = \Gamma_4^{-1}\left(\frac{\overline{m}-1}{\overline{m}} - \frac{1}{\tilde{\theta}\overline{m}}\right)^{-1/\tilde{\theta}}$$

$$\Gamma_6 = \Gamma_1^{\tilde{\gamma}/\rho}\Gamma_4^{\tilde{\eta}-1}\left(\overline{m}-1\right)^{-\tilde{\gamma}\overline{m}}\,\overline{m}^{1+\tilde{\gamma}(\bar{m}-1)}\tilde{\alpha}^{-\tilde{\eta}}\left(\frac{\tilde{\alpha}\Gamma_3}{1-\tilde{\alpha}}\right)^{(1-\tilde{\alpha})-\nu(1-\tilde{\gamma})}$$

$$\Gamma_7 = \frac{\tilde{\theta}\overline{m}}{\tilde{\alpha}(\tilde{\theta}\overline{m}-1)}\left[\left(1+\frac{1}{\tilde{\alpha}(\tilde{\theta}\overline{m}-1)}\right)^{1-\tilde{\gamma}} + \left(\frac{1-\tilde{\alpha}}{\tilde{\alpha}}\right)^{1-\tilde{\gamma}}\right]^{-1}$$

$$\Gamma_8 = \kappa_0\left(\frac{\Gamma_3}{\Gamma_5}\frac{\tilde{\alpha}}{1-\tilde{\alpha}}\right)^{1-\tilde{\alpha}}\left(1-\frac{1}{\tilde{\theta}\overline{m}}\right)$$

$$\Gamma_9 = \Gamma_6\Gamma_7\left(\Gamma_5\Gamma_8^{(1-\varsigma_1)/(1-\tilde{\alpha})}\right)^{\tilde{\alpha}\tilde{\eta}+(\nu-1)(1-\tilde{\gamma})}\,\Gamma_8^{\varsigma_1[\tilde{\gamma}\overline{m}+(\overline{m}-1)(\tilde{\eta}-1)]}$$

$$\Gamma_{10} = \Gamma_9\left((1-\tilde{\alpha})^{-1}\tilde{\alpha}\Gamma_3\right)^{\nu(1-\tilde{\gamma})}\left[\tilde{\alpha}^{-\tilde{\alpha}}\left((1-\tilde{\alpha})\Gamma_3^{-1}\right)^{-(1-\tilde{\alpha})}\right]^{-\tilde{\eta}}$$

$$\Gamma_{11} = \kappa_2\left(\Gamma_4\Gamma_5\right)^{-\tilde{\theta}}\,\Gamma_8^{-\varsigma_1}$$

$$\Gamma_{12} = \left(\left[\kappa_0\left(1-\frac{1}{\tilde{\theta}\overline{m}}\right)\right]^{1-\tilde{\theta}(\overline{m}-1)}\tilde{\alpha}^{1-\tilde{\theta}\overline{m}+\tilde{\theta}+\tilde{\alpha}\tilde{\theta}\overline{m}-\tilde{\alpha}}\left(\frac{1-\tilde{\alpha}}{\Gamma_3}\right)^{(1-\tilde{\alpha})\left(\tilde{\theta}\overline{m}-1\right)}\Gamma_5^{\tilde{\theta}}\right)^{1/\left[\tilde{\theta}-(1-\tilde{\alpha})(\tilde{\theta}\overline{m}-1)\right]}$$

C.3. *Accounting*

We derive expressions relating labor and profit income to gross production, absorption, and trade deficits. Country i's trade deficit Δ_i is the difference between its total absorption, denoted

X_i, and its gross production, denoted Y_i:

$$X_i = Y_i + \Delta_i. \tag{3}$$

Conditional on entry, the share of firms in country n with $v(\omega) \geq v$ is:

$$F_n(v) = \left(\frac{v}{\underline{v}_n}\right)^{-\tilde{\theta}}.$$

Using the revenue equation (15), the ratio of the average sales per firm $\overline{x}_n$ to the sales of the cutoff firm $\underline{x}_n$ in destination market n is:

$$\begin{aligned}
\frac{\overline{x}_n}{\underline{x}_n} &= \int_{\underline{v}_n}^{\infty} \left(\frac{v}{\underline{v}_n}\right)^{1/(\bar{m}-1)} dF_n(v) \\
&= \tilde{\theta}\underline{v}_n^{\tilde{\theta}-1/(\overline{m}-1)} \int_{\underline{v}_n}^{\infty} v^{1/(\overline{m}-1)-\tilde{\theta}-1} dv \\
&= \left(1 - \frac{1}{\tilde{\theta}(\overline{m}-1)}\right)^{-1}.
\end{aligned}$$

The zero profit condition implies that the fixed cost equals the operating profit of the cutoff firm: $f_n = (1 - 1/\overline{m})\underline{x}_n$. Spending on fixed costs by firms selling in country n is thus:

$$\left(1 - \frac{1}{\overline{m}}\right)\left(1 - \frac{1}{\tilde{\theta}(\overline{m}-1)}\right) = \left(1 - \frac{1}{\overline{m}} - \frac{1}{\tilde{\theta}\overline{m}}\right) X_n.$$

Spending on labor for entry costs and for production in country i is, respectively:

$$\begin{aligned}
w_i L_i^F &= \tilde{\alpha}\left(1 - \frac{1}{\overline{m}} - \frac{1}{\tilde{\theta}\overline{m}}\right) X_i \\
w_i L_i^P &= \frac{\tilde{\alpha}}{\overline{m}} Y_i
\end{aligned}$$

The net profit of firms producing in country i is their operating profit minus the fixed cost:

$$\Pi_i = \left[1 - \frac{1}{\overline{m}} - \left(1 - \frac{1}{\overline{m}} - \frac{1}{\tilde{\theta}\overline{m}}\right)\right] Y_i = \frac{1}{\tilde{\theta}\overline{m}} Y_i. \tag{4}$$

Summing the last three expressions, value added in country i, $\tilde{X}_i$, is:

$$\begin{aligned}
\tilde{X}_i &= w_i L_i^F + \Pi_i + w_i L_i^P \\
&= \frac{\tilde{\alpha}}{\overline{m}}\left(\overline{m} - 1 - \frac{1}{\tilde{\theta}}\right) X_i + \frac{1}{\overline{m}}\left(\tilde{\alpha} + \frac{1}{\tilde{\theta}}\right) Y_i \\
&= \left(\tilde{\alpha} + \frac{(1-\tilde{\alpha})}{\tilde{\theta}\overline{m}}\right) X_i - \frac{1}{\overline{m}}\left(\tilde{\alpha} + \frac{1}{\tilde{\theta}}\right) \Delta_i
\end{aligned} \tag{5}$$

where the last line uses (3). Rearranging, we write:

$$X_i = \frac{\tilde{\theta}\overline{m}}{\tilde{\alpha}\tilde{\theta}\overline{m} + 1 - \tilde{\alpha}} \tilde{X}_i + \frac{\tilde{\alpha}\tilde{\theta} + 1}{\tilde{\alpha}\tilde{\theta}\overline{m} + 1 - \tilde{\alpha}} \Delta_i. \tag{6}$$

Labor income is:

$$w_iL_i = w_iL_i^F + w_iL_i^P = \tilde{\alpha}\left(1 - \frac{1}{\bar{m}\tilde{\theta}}\right)X_i - \frac{\tilde{\alpha}}{\bar{m}}\Delta_i. \qquad (7)$$

Solving for X_i and substituting into (5), we have:

$$\tilde{X}_i = \left[1 + \frac{1}{\tilde{\alpha}(\overline{m}\tilde{\theta} - 1)}\right] w_iL_i + \frac{1}{\overline{m}}\left(\frac{1}{\overline{m}\tilde{\theta} - 1} - \frac{1}{\tilde{\theta}}\right)\Delta_i. \qquad (8)$$

With balanced trade, consumer spending is $x_i^C = \tilde{X}_i/L_i$ so that equation (8) yields equation (30) in the main text.

Estimation error I. The first stage of our estimation, the gravity equation, uses the following proxy for absorption:

$$\hat{X}_i = \frac{\tilde{X}_i}{\tilde{\alpha}} + \Delta_i = \frac{\tilde{X}_i}{0.5} + \Delta_i \qquad (9)$$

where we use data on GDP for $\tilde{X}_i$ and the trade deficit for Δ_i.

We can't use the model's expression (6) because the coefficients on GDP and trade deficit depend on the parameter estimates from the second stage. *Ex post* evaluated at the parameter estimates $\hat{\gamma} = 0.146$, $\hat{\tilde{\theta}} = 5.824$, $\hat{\beta} = 0.557$, $\tilde{\alpha} = 0.5$ (calibrated), equation (6) becomes:

$$\widehat{X_i} = \frac{\tilde{X}_i}{0.542} + 0.603\Delta_i. \qquad (10)$$

To evaluate the magnitude of the error using this approximation, we calculate each country's absorption according to (10). We then recalculate trade shares π_{ni}, rerun the gravity equation, and obtain new estimates of Φ_n. Figure C.1 plots these new estimates of Φ_n against the original estimation using (9). The regression line has a coefficient of 1.003 (standard error 0.007) and an R-squared of 0.995.

Estimation error II. The estimation of the price equation assumes that wages are proportional to income per capita. In equation (8), this assumption holds if trade is balanced. Rearranging (8) and evaluating it at the parameter estimates, we have:

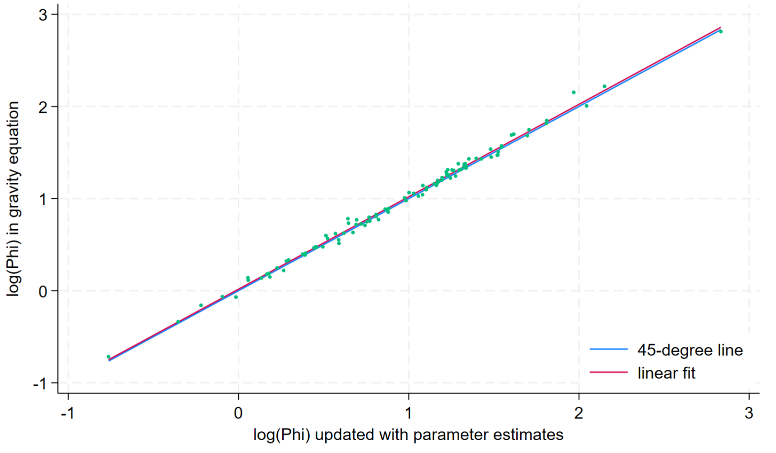
$$w_iL_i = \left[1 + \frac{1}{\tilde{\alpha}(\overline{m}\tilde{\theta} - 1)}\right]^{-1}\left[\tilde{X}_i + \frac{1}{\overline{m}}\left(\frac{1}{\tilde{\theta}} - \frac{1}{\overline{m}\tilde{\theta} - 1}\right)\Delta_i\right] = 0.847\tilde{X}_i + 0.033\Delta_i. \qquad (11)$$

The coefficient on the trade deficit is small, 0.033, and the median absolute value of the trade deficit is 14 percent of GDP. So, setting the deficits to zero in equation (11) yields an almost exact approximation to the model's predictions for wages.

C.4. *Extension: Inequality within countries*

Using firm-level data, recent papers document a positive relationship between firm sales and prices (e.g., Kugler and Verhoogen (2011), Manova and Zhang (2012), Fan et al. (2015)) and a positive relation between firm sales and wages (e.g., Verhoogen (2008), Fieler et al. (2018)).

FIGURE C.1.—Check on estimation error I: Φ



To relate to these elasticities, we extend the model to capture heterogeneity in skills and wages across workers and firms within countries.

Workers are heterogeneous in their skills e. We allow the worker's skills to affect the productivity and substitutable quality of the firm. In particular, we modify problem (17) as follows:

$$v^{-1} = \min_{m,Q,\ell} \quad \ell(w + X(m))$$

subject to

$$\begin{aligned} Qy &\geq 1 \\ y &= \ell e z m^{1-\alpha} \\ Q &= e^{\vartheta} z^{\eta} m^{\nu}. \end{aligned}$$

where ϑ captures the effect of e on substitutable quality. The inverse quality-adjusted cost becomes

$$v(z,e) = \frac{z^{1+\eta} e^{1+\vartheta}}{\tilde{c}} \left(\frac{w}{w(e)} \right)^{\tilde{\alpha}} \tag{12}$$

where w is the wage of workers with skill 1 and $w(e)$ is the wage of a worker with skill e, and where $\tilde{c}$ is the same as before (equation (18)). From (12), firms are indifferent to hiring workers of any skill e if $w(e) = we^{(1+\vartheta)/\tilde{\alpha}}$ for all e. This condition is necessary for labor markets to clear. It reduces v in (12) to the original function of z:

$$v(z) = \frac{z^{1+\eta}}{\tilde{c}} \tag{13}$$

The implied substitutable quality is:

$$Q(z,e) = \left(\frac{1-\tilde{\alpha}}{\tilde{\alpha}} \frac{wV}{\Gamma_3} \right)^{\nu/(1+\gamma)} z^{\eta} e^{\vartheta + \nu(1+\vartheta)/[\tilde{\alpha}(1+\gamma)]}. \tag{14}$$

A firm hiring more skilled workers spends more on materials per worker. It demands higher complementary quality and sells higher substitutable quality.

Since a firm's quality-adjusted cost $v(z)$ in (13) is the same as in the original model, the introduction of geography and trade flows do not change. Substituting (14) into the price equation (27), we get the new bilateral price:

$$p_{ni}(\epsilon,e,x) = \Gamma_6 \left(d_{ni} w_i^{\tilde{\alpha}} V_i^{-(1-\tilde{\alpha})}\right)^{\tilde{\eta}} \left[\left(\frac{f_n}{X_n}\right)^{\overline{m}-1} V_n\right]^{\tilde{\eta}-1} (w_i V_i)^{\nu(1-\tilde{\gamma})} \left(\frac{f_n}{X_n}\right)^{\tilde{\gamma}\bar{m}} (x V_n)^{\tilde{\gamma}}$$
$$e^{\vartheta+\nu(1+\vartheta)(1-\tilde{\gamma})/\tilde{\alpha}} \epsilon^{\tilde{\eta}-1+\tilde{\gamma}\overline{m}/(\overline{m}-1)} \tag{15}$$

The expression is the same as in (29) except for the added term on skills. Worker skill e increases price because it directly increases substitutable quality through ϑ and because firms equip their skilled workers with a larger bundle of material inputs.

Labor market There are at least three possibilities for linking e to ϵ. First is to assume that workers are randomly assigned to firms. Then, we would be back to the original model with an additional error term, e, in the price equation. Second is to assume that the worker skills e are an increasing function of firm productivity z. Then, a firm's unit cost would still depend on a single variable z and we would still identify the relation between prices and firm sales through selection into more distant markets. In the estimated model, this relationship is negative, contrary to firm-level data studied in Kugler and Verhoogen (2011), Manova and Zhang (2012), Fan et al. (2015).

We take a third route. We assume that firms hire different workers for producing goods for different destinations and that the skill of workers increase with the profitability of the market, that is, with the ratio of net profit to fixed cost. Combining (15), (22) and (28), this ratio is $\epsilon^{1/(\bar{m}-1)} - 1$ so that the skill of workers increase with ϵ.[4]

For simplicity, assume further that the set of worker skills has the same distribution of skills in all countries. Note that differences in skills across workers reflect only domestic inequality. The overall productivity of workers varies across countries through the productivity of firms governed by T_i. The distribution of skills has a density, $\mu(e)$ with support $\mathcal{E} \subset \mathbb{R}_+$. Assume its $[(1+\vartheta)/\tilde{\alpha}]^{\text{th}}$ moment exists and we normalize it to one:

$$\int_{e\in\mathcal{E}} e^{(1+\vartheta)/\tilde{\alpha}} \mu(e) de = 1. \tag{16}$$

so that the wage of skill 1 is also the average wage. Let $\psi(\epsilon)$ be a matching function specifying for each $\epsilon \in [1,\infty)$ a skill in $\mathcal{E}$. The labor market clears if the earnings of workers with skills less than $\psi(\epsilon)$ equals the share of revenue in firms with relative efficiency less than ϵ:

$$\int_0^{\psi(\epsilon)} e^{(1+\vartheta)/\tilde{\alpha}} \mu(e) de = 1 - \epsilon^{-\tilde{\theta}+1/(\bar{m}-1)} \tag{17}$$

for all $\epsilon \in [1,\infty)$, and the labor market clearing condition remains the same as in Section 3.3.

[4] There are several potential micro-foundations for this perfect assortative matching. All workers could prefer to working in more profitable divisions of firms, and that skilled workers get their first choice. Or the model could be a limiting case where skilled workers are relatively more productive at making goods with high profitability, and that this complementarity is taken to zero.

A tractable example arises if the distribution of e is Pareto with shape ϱ and lower bound $\underline{e} = [(1+\vartheta+\varrho\tilde{\alpha})/\varrho\tilde{\alpha}]^{-\tilde{\alpha}/(1+\vartheta)}$ normalized so that (16) holds. Then, assuming $\varrho\tilde{\alpha} > 1+\vartheta$, (17) reduces to:

$$1 - \left(\frac{\psi(\epsilon)}{\underline{e}}\right)^{-\varrho+(1+\vartheta)/\tilde{\alpha}} = 1 - \epsilon^{-\tilde{\theta}+1/(\overline{m}-1)}$$
$$\equiv \qquad \psi(\epsilon) = \underline{e}\epsilon^{\tilde{\alpha}[\tilde{\theta}(\overline{m}-1)-1]/\{(\overline{m}-1)[\varrho\tilde{\alpha}-(1+\vartheta)]\}}. \tag{18}$$

As before, we construct the bilateral price as a weighted average between the price of final goods to households and intermediate inputs to firms. Under the simplifying assumption that profits are distributed in proportion to labor income, spending per household of skill e is[5]

$$x_n^C(e) = \left(1 + \frac{1}{\tilde{\alpha}(\tilde{\theta}\overline{m}-1)}\right) e^{(1+\vartheta)/\tilde{\alpha}} w_n. \tag{19}$$

Spending per a worker of skill e is $x_n^F(e) = [(1-\tilde{\alpha})/\tilde{\alpha}]e^{(1+\varsigma)/\tilde{\alpha}} w_n$.

The average price of a firm exporting from source i to to destination n, with productivity ϵ is:[6]

$$\overline{p}_{ni}(\epsilon) = \frac{\displaystyle\int_{e\in\mathcal{E}} \left[x_n^C(e) + x_n^F(e)\right] \mu(e)de}{\displaystyle\int_{e\in\mathcal{E}} \left[x_n^C(e)/p_{ni}(\epsilon,\psi(\epsilon),x_n^C(e)) + x_n^F(e)/p_{ni}(\epsilon,\psi(\epsilon),x_n^F(e))\right] \mu(e)de}$$
$$= \Gamma_7' p_{ni}(\epsilon,\psi(\epsilon),w_n)$$

Substituting (25) and (31) into (15), we have:

$$\overline{p}_{ni}(\epsilon) = P_{ni}[\psi(\epsilon)]^{\vartheta+\nu(1-\tilde{\gamma})}\epsilon^{\tilde{\eta}-1+\tilde{\gamma}\overline{m}/(\overline{m}-1)}. \tag{20}$$

where

$$P_{ni} = \Gamma_9' d_{ni}^{\tilde{\eta}} S_i D_n$$

where S_i and D_n are the exporter and importer terms in (33).

The price expression does not change, but the firm-specific term in (20) does. Consider again the Pareto example in (18). Substituting $\psi(\epsilon)$ in (20) we get:

$$\overline{p}_{ni}(\epsilon) = P_{ni}\underline{e}^{\vartheta+\nu(1-\tilde{\gamma})}\epsilon^{\delta_\epsilon}$$

[5]This assumption only makes the expression for Γ_7' below more complicated. The other results only depend on $x_n^C(e)$ being proportional to w_n in all countries, which holds even if the assumption is dropped and

$$x_n^C(e) = \left(e^{(1+\vartheta)/\tilde{\alpha}} + \frac{1}{\tilde{\alpha}(\tilde{\theta}\overline{m}-1)}\right) w_n.$$

[6]The modified constants here and below are:

$$\Gamma_7' = \Gamma_7\left[\int_{\mathcal{E}} e^{(\vartheta+1)(1-\tilde{\gamma})/\tilde{\alpha}}\mu(e)de\right]^{-1}$$
$$\Gamma_9' = \Gamma_9\Gamma_7'/\Gamma_7.$$

where

$$\delta_\epsilon = \frac{1}{\bar{m}-1}\left\{\frac{\tilde{\alpha}[\tilde{\theta}(\bar{m}-1)-1]}{\varrho\tilde{\alpha}-(1+\vartheta)}[\vartheta+\nu(1+\vartheta)(1-\tilde{\gamma})/\tilde{\alpha}]+(\tilde{\eta}-1)(\bar{m}-1)+\tilde{\gamma}\right\} \tag{21}$$

Since sales are proportional to $\epsilon^{1/(\bar{m}-1)}$ the elasticity of output prices with respect to firm sales is the term in curly brackets. Wages increase with relative efficiency ϵ according to $\psi(\epsilon)^{(1+\vartheta)/\tilde{\alpha}}$. Then, in a given market, the elasticity of wages with respect to sales is

$$(1+\vartheta)\frac{[\tilde{\theta}(\bar{m}-1)-1]}{\varrho\tilde{\alpha}-(1+\vartheta)} \tag{22}$$

This elasticity holds for firms that do not export, and for exporters it's an approximation since wages are not separately observed for each destination market.

In sum, the extended model adds two parameters ϑ and ϱ which give us two degrees of freedom to match two new elasticities, output prices with respect to sales and wages with respect to sales. The model's predictions on the margins of trade remain unchanged.

Out of sample input prices A firm's spending on material inputs per worker in its workers of e is $x^F(e) = w(e)(1-\tilde{\alpha})/\tilde{\alpha}$. Setting the buyer's spending $x = x^F(e)$ in (15), the elasticity of input prices with respect to firm wages is $\tilde{\gamma}$. At the point estimates of Table IV, this elasticity is 0.13, which compares to 0.16 in Fieler et al. (2018) (Table 2).

The elasticity of input prices with respect to domestic sales in Kugler and Verhoogen (2011) is 0.011 (Table 1, panel B). For the model's prediction, take the elasticity of wages with respect to sales 0.156 from Verhoogen (2008).[7] The elasticity of input prices with respect to domestic sales is then $0.156\tilde{\gamma} = 0.020$.

Counterparts in firm-level data to our parameters ν and η are more difficult to find. Parameter ν governs how output quality, possibly measured as in Khandelwal (2010), Khandelwal et al. (2013), increases with quantity and quality of material inputs per worker controlling for worker skills and productivity, and parameter η governs how firm quality varies with firm productivity, controlling for worker skills and material inputs per worker.

APPENDIX D: ESTIMATION APPENDIX

D.1. *Estimation of Standard Errors*

The indirect inference estimator in (41) may be written as

$$\hat{\Xi} = \arg\min\{(M(\Xi) - M^{\text{data}})'\Omega(M(\Xi) - M^{\text{data}})\}$$

where M is the column vector with all moments, $[\log P_{ni} \quad \log E_{ni} \quad \log E_{\cdot i} \quad \log E_{\cdot n}]$, and Ω is a diagonal matrix with the weights in (41) as its diagonal elements.

[7]Table II reports separately the elasticity of white-collar wages with respect to domestic sales, 0.209, and the elasticity of blue-collar wages with respect to domestic sales, 0.133. Our chosen elasticity, 0.156, is the weighted average considering that the share of white-collar workers is 0.3 (Table I).

We use the procedure in Cameron and Trivedi (2005) for the Generalized Method of Moments (their equation (6.57)) for the variance of the parameter estimates:[8]

$$\widehat{Var(\Xi)} = (G_0'\Omega G_0)^{-1} G_0'\Omega\Sigma\Omega G_0 (G_0'\Omega G_0)^{-1} \tag{23}$$

where G_0 is the gradient and Σ is the variance-covariance matrix of the error terms (below). Matrix G_0 has dimensions (number of moments $\times$ number of parameters) with elements:

$$G_{0,mi} = \frac{\partial M_m(\Xi)}{\partial \Xi_j}$$

which we estimate numerically by recalculating the vector of moments $M(\Xi)$ given a small deviation of the j^{th} element in the vector of parameters Ξ.

Matrix Σ is the variance-covariance matrix of the error terms $u'u$ where $u = (M(\Xi) - M^{\text{data}})$. We parameterize Σ as follows. Consistent with (41), we assume that the variance of the price moments is inversely proportional to the number of products with price data that two countries trade. That is, we assume

$$\text{Var}(u_{P,ni}) = \frac{1}{\upsilon_{ni}} W_P$$

where we estimate

$$\hat{W}_P = \frac{1}{N_P} \sum_{n,i} \upsilon_{ni} (u_{P,ni})^2$$

where $N_P = 9,455$ is the number of price observations and $u_{P,ni} = (\log P_{ni}^{\text{model}}(\Xi) - \log P_{ni}^{\text{data}})$, an element of vector u. We assume homoskedasticity for the moments on the extensive margin. We estimate the variances of bilateral, exporting and importing extensive margins respectively as:

$$\widehat{\text{Var}(u_E)} = \frac{1}{N_E} u_E' u_E$$

$$\widehat{\text{Var}(u_{E\cdot i})} = \frac{1}{N} u_{E\cdot i}' u_{E\cdot i}$$

$$\widehat{\text{Var}(u_{E_n\cdot})} = \frac{1}{N} u_{E_n\cdot}' u_{E_n\cdot}$$

where u_E is the vector of all bilateral extensive margin error terms, $u_{E\cdot i}$ is the vector with the exporting extensive margin error terms and $u_{E_n\cdot}$ is the vector with the importing extensive margin error terms. Recall that $N_E = 9,555$ is the number of country pairs with extensive margin information.

[8]Equation (23) is a special case of Cameron and Trivedi (2005)’s equation (6.57) with the instrument $Z = I$, and it is a generalization of the Weighted Least Squares in their equation (4.31) with the matrix of data substituted for with the gradient as in (6.57). See also Dix-Carneiro (2014) (Appendix I) for the proof of (23).

For both the price margin and the bilateral extensive margin, we allow observations with the same exporter and the same importer to be correlated. We estimate these correlations as:

$$\hat{\rho}_{Pn} = \frac{\sum_{n=1}^{N}\sum_{i=1}^{N}\sum_{i'=1}^{N} \mathbb{1}^{\text{obs}}_{\{P_{ni},P_{ni'}\}} u_{P,ni} u_{P,ni'} \left(\upsilon_{ni}\upsilon_{ni'}\right)^{0.5}}{W_P \sum_{n=1}^{N}\sum_{i=1}^{N}\sum_{i'=1}^{N} \mathbb{1}^{\text{obs}}_{\{P_{ni},P_{ni'}\}}}$$

$$\hat{\rho}_{Pi} = \frac{\sum_{i=1}^{N}\sum_{n=1}^{N}\sum_{n'=1}^{N} \mathbb{1}^{\text{obs}}_{\{P_{ni},P_{n'i}\}} u_{P,ni} u_{P,n'i} \left(\upsilon_{ni}\upsilon_{n'i}\right)^{0.5}}{W_P \sum_{i=1}^{N}\sum_{n=1}^{N}\sum_{n'=1}^{N} \mathbb{1}^{\text{obs}}_{\{P_{ni},P_{n'i}\}}}$$

$$\hat{\rho}_{En} = \frac{\sum_{n=1}^{N}\sum_{i=1}^{N}\sum_{i'=1}^{N} \mathbb{1}^{\text{obs}}_{\{E_{ni},E_{ni'}\}} u_{E,ni} u_{E,ni'}}{\text{Var}(u_E) \sum_{n=1}^{N}\sum_{i=1}^{N}\sum_{i'=1}^{N} \mathbb{1}^{\text{obs}}_{\{E_{ni},E_{ni'}\}}}$$

$$\hat{\rho}_{Ei} = \frac{\sum_{i=1}^{N}\sum_{n=1}^{N}\sum_{n'=1}^{N} \mathbb{1}^{\text{obs}}_{\{E_{ni},E_{n'i}\}} u_{E,ni} u_{E,n'i}}{\text{Var}(u_E) \sum_{i=1}^{N}\sum_{n=1}^{N}\sum_{n'=1}^{N} \mathbb{1}^{\text{obs}}_{\{E_{ni},E_{n'i}\}}}$$

where $\hat{\rho}_{Pn}$ is the correlation of price observations with the same importer, $\hat{\rho}_{Pi}$ is the correlation of price observations with the same exporter, and $\hat{\rho}_{En}$ and $\hat{\rho}_{Ei}$ are the corresponding correlations for the extensive margins. Function $\mathbb{1}^{\text{obs}}$ is an indicator function of whether both of the variables in the subscript are observed from the data.

This completes the estimate of matrix Σ which enables us to apply the formula (23) to estimate the variance of parameters. For the variance of moments of the parameters in Table V, we use the delta method. A first-order approximation of the variance of a function of Ξ is

$$\widehat{\text{Var}(f(\Xi))} = \nabla f(\Xi)' \text{Var}(\Xi) \nabla f(\Xi)$$

where $\nabla f(\Xi)$ is the gradient of f, which we estimate numerically.

In the regressions in Section 2, to cluster the standard errors in more than one dimension, by importer and exporter, we follow the procedure in Cameron et al. (2011).

D.2. *Additional Estimation Results*

In Table A.IV above, we report the standard errors of the regressions in Table I decomposing gravity into margins, for the data and the model. In Table D.I, we decompose the coefficients of

TABLE D.I

PRICE DECOMPOSITION

	total	selection	substitutable quality	competition	non-homothetic demand
$d_{ni}^{-\tilde{\theta}}$	**-0.057**	-0.057	-	-	-
w_i	**0.168**	0.034	0.134	-	-
Φ_i	**-0.028**	-0.051	0.023	-	-
L_i	**-0.060**	-0.110	0.050	-	-
w_n	**0.097**	0.103	-	-0.234	0.227
Φ_n	**-0.099**	-0.098	-	-0.040	0.039
L_n	**-0.025**	0.087	-	-0.197	0.085

Note: The table reports the elasticities implied by the estimated parameters as they appear in equation (29) and labeled in (24). We report standard errors in Appendix Table D.I.

the empirical specification for prices in (32) into the mechanisms discussed in the price equation (29) using equation (31). Equation (29) and its mechanisms on the table are as follows:

$$p_{ni}(\epsilon, x) = \Gamma_6 \underbrace{\left(d_{ni} w_i^{\tilde{\alpha}} V_i^{-(1-\tilde{\alpha})}\right)^{\tilde{\eta}} \left[\left(\frac{f_n}{X_n}\right)^{\overline{m}-1} V_n\right]^{\tilde{\eta}-1}}_{\text{selection}} \underbrace{(w_i V_i)^{\nu(1-\tilde{\gamma})}}_{\text{substitutable quality}}$$
$$\underbrace{\left(\frac{f_n}{X_n}\right)^{\tilde{\gamma}\overline{m}}}_{\text{competition}} \underbrace{(x V_n)^{\tilde{\gamma}}}_{\text{non-homothetic demand}} \epsilon^{\tilde{\eta}-1+\tilde{\gamma}\overline{m}/(\overline{m}-1)} \tag{24}$$

APPENDIX E: DECOMPOSING WELFARE GAINS

We first modify Dekle et al. (2007) to derive the model's predictions for general counterfactuals without estimating T_i. We consider known changes in trade costs $\hat{d}_{ni}$, technologies $\hat{T}_i$ and labor $\hat{L}_i$.

The change in the cost of the input bundle in country i is

$$\hat{\hat{c}}_i = \hat{w}_i^{\tilde{\alpha}} \hat{V}_i^{\tilde{\alpha}-1} \tag{25}$$

The counterfactual trade shares are

$$\pi'_{ni} = \frac{\pi_{ni} \hat{T}_i (\hat{\hat{d}}_{ni} \hat{\hat{c}}_i)^{-\tilde{\theta}}}{\sum_{k=1}^{N} \pi_{nk} \hat{T}_k (\hat{\hat{d}}_{nk} \hat{\hat{c}}_k)^{-\tilde{\theta}}} \tag{26}$$

The change in the multilateral market access term is

$$\hat{\Phi}_n = \sum_{i=1}^{N} \pi_{ni} \hat{T}_i (\hat{\tilde{d}}_{ni} \hat{\tilde{c}}_i)^{-\tilde{\theta}} \tag{27}$$

Change in the inverse of the price index is

$$\hat{V}_n = \hat{w}_n^{\varsigma_1 - 1} \left(\hat{\Phi}_n^{1/\tilde{\theta}} \right)^{\varsigma_1} \hat{L}_n^{-\kappa_1 \varsigma_1} \tag{28}$$

In Appendix C.3, we derive the labor market clearing conditions. For each country i, wages in the counterfactual satisfy:

$$w_i' L_i = \tilde{\alpha} \left(1 - \frac{1}{\tilde{\theta} \bar{m}} \right) \sum_n \pi_{ni}' X_n' + \tilde{\alpha} \left(1 - \frac{1}{\bar{m}} - \frac{1}{\tilde{\theta} \bar{m}} \right) \Delta_i \tag{29}$$

where

$$X_n' = \left(1 - \frac{1}{\tilde{\theta} \bar{m}} \right)^{-1} \frac{w_n' L_n}{\tilde{\alpha}} + \left(\frac{\tilde{\theta}}{\tilde{\theta} \bar{m} - 1} \right) \Delta_n$$

where Δ_n is the trade deficit in country n. We use data on population L_i for each country, and initial wages w_i (GDP per capita is taken as a proxy). By the estimation procedure, these variables perfectly match those in the data. We iterate over guesses of w_i' and $\hat{V}_i$, where we normalize $\hat{w}_1 = 1$ (USA nominal wage). For each of these guesses, we calculate $\hat{w}_i = w_i'/w_i$ using data on initial wages (income per capita), $\hat{\tilde{c}}_i$ in (25), π_{ni}' in (26), and Φ_n in (27). We then check equations (29) and (28) to update the guesses of $\hat{w}_i$ and $\hat{V}_i$.

E.1. *Substitutable Quality Component*

In Section 5.2, we decompose the welfare gains from a shock as:

$$\hat{U}_n = \hat{\mathcal{M}}_n^{\bar{m}-1} \times \frac{\hat{w}_n \hat{\underline{v}}_n}{\hat{\tilde{Q}}_n} \times \hat{\tilde{Q}}_n.$$

The gains from the range of varieties consumed $\hat{\mathcal{M}}_n^{\bar{m}-1}$ are in (45). In this section, we derive the expression for the substitutable quality component $\hat{\tilde{Q}}_n$ in (46). The remaining component of wages relative to physical cost, $\hat{w}_n \hat{\underline{v}}_n / \hat{\tilde{Q}}_n$, is the residual.

Since substitutable quality in (20) varies with z and not with the destination specific $v_{ni}(z)$, we will need the distribution of z in each destination. For firms from country i selling in n, the share of $Z \geq z$ conditional on $z \geq (d_{ni} \tilde{c}_i \underline{v}_n)^{1/(1+\eta)}$ is:

$$G_{ni}(z) = \frac{T_i z^{-\theta}}{T_i (d_{ni} \tilde{c}_i \underline{v}_n)^{-\tilde{\theta}}} = \frac{z^{-\theta}}{(d_{ni} \tilde{c}_i \underline{v}_n)^{-\tilde{\theta}}}$$

Substitutable quality $\bar{Q}_n$ is the quality that makes country n as well off as it is (with varying quality levels across varieties) as if all its varieties had substitutable quality $\overline{Q}_{n\cdot}$:

$$\overline{Q}_{n\cdot} = \left[\frac{\sum_i T_i (d_{ni}\tilde{c}_i)^{-\tilde{\theta}} \int_{(d_{ni}\tilde{c}_i \underline{v}_n)^{1/(1+\eta)}}^{\infty} [v_{ni}(z)]^{1/(\bar{m}-1)} \, dG_{ni}(z)}{\sum_i T_i (d_{ni}\tilde{c}_i)^{-\tilde{\theta}} \int_{(d_{ni}\tilde{c}_i \underline{v}_n)^{1/(1+\eta)}}^{\infty} [v_{ni}(z)/Q_i(z)]^{1/(\bar{m}-1)} \, dG_{ni}(z)} \right]^{\bar{m}-1} \tag{30}$$

Inside the square brackets, the numerator is:

$$\frac{\tilde{\theta}}{\tilde{\theta} - 1/(\bar{m}-1)} \Phi_n \underline{v}_n^{1/(\bar{m}-1)}$$

The denominator is:

$$\begin{aligned}
&\sum_i T_i (d_{ni}\tilde{c}_i)^{-\tilde{\theta}} \int_{(d_{ni}\tilde{c}_i \underline{v}_n)^{1/(1+\eta)}}^{\infty} [v_{ni}(z)/Q_i(z)]^{1/(\bar{m}-1)} \, dG_{ni}(z) \\
&= \left(\frac{1-\tilde{\alpha}}{\tilde{\alpha}\Gamma_3} \right)^{-\nu(1-\tilde{\gamma})/(\bar{m}-1)} \sum_i T_i \left[d_{ni}\tilde{c}_i (w_i V_i)^{\nu(1-\tilde{\gamma})} \right]^{-1/(\bar{m}-1)} \underline{v}_n^{\tilde{\theta}} \theta \\
&\quad \times \int_{(d_{ni}\tilde{c}_i \underline{v}_n)^{1/(1+\eta)}}^{\infty} z^{1/(\bar{m}-1)-\theta-1} dz \\
&= \left(\frac{1-\tilde{\alpha}}{\tilde{\alpha}\Gamma_3} \right)^{-\nu(1-\tilde{\gamma})/(\bar{m}-1)} \frac{\theta}{\theta - 1/(\bar{m}-1)} \\
&\quad \times \sum_i T_i (d_{ni}\tilde{c}_i)^{-\tilde{\eta}/(\bar{m}-1)-\tilde{\theta}} (w_i V_i)^{-\nu(1-\tilde{\gamma})/(\bar{m}-1)} \underline{v}_n^{(1-\tilde{\eta})/(\bar{m}-1)}
\end{aligned}$$

Substituting the last two expressions into (30) and using $T_i(d_{ni}\tilde{c}_i)^{\tilde{\theta}} = \pi_{in}\Phi_n$, we have

$$\bar{Q}_n = \left(\frac{\tilde{\theta}(\bar{m}-1) - 1 + \tilde{\eta}}{\tilde{\theta}(\bar{m}-1) - 1} \right)^{\bar{m}-1} \left(\frac{1-\tilde{\alpha}}{\tilde{\alpha}\Gamma_3} \right)^{\nu(1-\tilde{\gamma})} \underline{v}_n^{\tilde{\eta}} \left[\sum_i \pi_{ni} (d_{ni}\tilde{c}_i)^{\tilde{\eta}/(1-\bar{m})} (w_i V_i)^{\nu(1-\tilde{\gamma})/(1-\bar{m})} \right]^{1-\bar{m}} \tag{31}$$

In changes, we get the expression we wanted to show (46)

$$\widehat{\overline{Q}}_n = \hat{\underline{v}}_n^{\tilde{\eta}} \left[\frac{\sum_i \pi'_{ni} (d'_{ni}\tilde{c}'_i)^{\tilde{\eta}/(1-\bar{m})} (w'_i V'_i)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}{\sum_i \pi_{ni} (d_{ni}\tilde{c}_i)^{\tilde{\eta}/(1-\bar{m})} (w_i V_i)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}} \right]^{1-\bar{m}}$$

E.2. *Uniform growth* $\hat{T}_i = \hat{T}$

Consider an increase in technologies that is proportionately the same in all countries, $\hat{T}_i = \hat{T} > 0$ for all i.[9] To derive closed form solutions in this theoretical exercise, we assume balanced trade, $\Delta_i = 0$ for all i.

We drop the country subscripts and conjecture (and confirm below) that the shock affects variables in all countries in the same proportion. Then, from (24) and (29), $\hat{w}_i = \hat{\pi}_{ni} = 1$ for all i and n. Then, $\hat{U}_n = \hat{V}_n \hat{w}_n = \hat{V}_n$.

Under this conjecture, equation (18), the definition of $\Phi_n = \sum_i T_i (d_{ni}\tilde{c}_i)^{-\tilde{\theta}}$, (25) and (31) imply:

$$\hat{\tilde{c}} = \hat{V}^{\tilde{\alpha}-1}$$

$$\hat{\Phi} = \hat{T}\hat{\tilde{c}}^{-\tilde{\theta}} \qquad = \hat{T}\hat{V}^{(1-\tilde{\alpha})\tilde{\theta}}$$

$$\widehat{\frac{X}{f}} = \hat{\Phi}^{\varsigma_1(1-\tilde{\alpha})/\tilde{\theta}} \qquad = \left(\hat{T}^{1/\tilde{\theta}}\hat{V}^{(1-\tilde{\alpha})}\right)^{\varsigma_1(1-\tilde{\alpha})}$$

$$\hat{V} = \left(\widehat{\frac{X}{f}}\right)^{\overline{m}-1-1/\tilde{\theta}} \hat{\Phi}^{1/\tilde{\theta}} \qquad = \left(\hat{T}^{1/\tilde{\theta}}\hat{V}^{(1-\tilde{\alpha})}\right)^{\varsigma_1}$$

Solving for $\hat{V}$ in the last equation and substituting it in $\widehat{X/f}$ yields:

$$\hat{V} = \hat{T}^{\varsigma_1/[\tilde{\theta}(1-\varsigma_1(1-\tilde{\alpha}))]}$$

$$\widehat{\frac{X}{f}} = \hat{V}^{1-\tilde{\alpha}}$$

The productivity cutoff is

$$\hat{\underline{v}}_n = \left(\frac{\hat{f}_n}{\hat{X}_n}\right)^{\bar{m}-1} \hat{V}_n = \hat{V}_n^{1-(1-\tilde{\alpha})(\bar{m}-1)}$$

Gains decomposition The contribution of the range of goods consumed to welfare is in (45) with $\hat{L} = 1$:

$$\hat{\mathcal{M}}^{\bar{m}-1} = \hat{U}^{(1-\tilde{\alpha})(\bar{m}-1)}$$

For the quality gain, we set $\pi'_{ni} = \pi_{ni}$, $d'_{ni} = d_{ni}$, $w'_i = w_i$, $\tilde{c}'_i = \tilde{c}_i\hat{\tilde{c}}$, $V'_i = V_i\hat{V}$ in (46) to get:

$$\hat{\overline{Q}}_n = \left(\hat{\underline{v}}\hat{\tilde{c}}\right)^{\tilde{\eta}} \hat{V}^{\nu(1-\tilde{\gamma})} = \hat{V}^{\nu(1-\tilde{\gamma})+\tilde{\eta}[1-\bar{m}(1-\tilde{\alpha})]}.$$

[9] The shock may be interpreted as an increase in the measure of firms, or as an increase in the productivity of each variety by $\hat{z}^{\tilde{\theta}} = \hat{T}$. In both cases, the measure of firms with productivity at least z in country i increases to $T_i\hat{T}z^{-\theta}$.

E.3. *Welfare differences across countries*

Denote the ratio of country n's variable x_n relative to a reference country 0 as $x_n^R = x_n/x_0$. Using (31), relative real income is

$$U_n^R = w_n^R V_n^R = \left(L_n^R\right)^{\kappa_1(1-\varsigma_1)/(1-\tilde{\alpha})} \left[w_n^R \left(\Phi_n^R\right)^{1/\tilde{\theta}}\right]^{\varsigma_1} \tag{32}$$

From the analysis in Section 3.2, the range of goods consumed in country n is $\mathcal{M}_n = \Phi_n \underline{v}_n^{-\tilde{\theta}}$. Using (22) and (25), we write the relative cutoffs as:

$$\underline{v}_n^R = \left(\frac{X_n^R}{f_n^R}\Phi_n^R\right)^{1/\tilde{\theta}}$$

Substituting in the range of goods, we get the gain from the range of goods consumed:

$$\left(\mathcal{M}_n^R\right)^{\bar{m}-1} = \left(\frac{X_n^R}{f_n^R}\right)^{\bar{m}-1} \tag{33}$$

$$= \left[w_n^R \left(\Phi_n^R\right)^{1/\tilde{\theta}}\right]^{\varsigma_1(1-\tilde{\alpha})(\bar{m}-1)} \left(L_n^R\right)^{-\kappa_1\varsigma_1(\bar{m}-1)}$$

$$= \left(U_n^R\right)^{(1-\tilde{\alpha})(\bar{m}-1)} \left(L_n^R\right)^{-\kappa_1(\bar{m}-1)} \tag{34}$$

where the second equality uses (31) and the third equality uses (32).

Then, using equation (31), we write:

$$\bar{Q}_n^R = \left(\underline{v}_n^R\right)^{\tilde{\eta}} \left[\frac{\sum_i \pi_{ni}(d_{ni}\tilde{c}_i)^{\tilde{\eta}/(1-\bar{m})}(w_i V_i)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}{\sum_i \pi_{0i}(d_{0i}\tilde{c}_i)^{\tilde{\eta}/(1-\bar{m})}(w_i V_i)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}\right]^{1-\bar{m}}$$

$$= \left(\underline{v}_n^R\right)^{\tilde{\eta}} \left[\frac{\sum_i \pi_{ni}(d_{ni}\tilde{c}_i^R)^{\tilde{\eta}/(1-\bar{m})}(w_i^R V_i^R)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}{\sum_i \pi_{0i}(d_{0i}\tilde{c}_i^R)^{\tilde{\eta}/(1-\bar{m})}(w_i^R V_i^R)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}\right]^{1-\bar{m}}$$

We use (32) for $w_i^R V_i^R$. From equation (18),

$$\tilde{c}_i^R = (w_i^R V_i^R)^{\tilde{\alpha}-1} w_i^R \tag{35}$$

We use (22) and (33) to write:

$$\underline{v}_n^R = \left(\mathcal{M}_n^R w_n^R\right)^{-1} w_n^R V_n^R \tag{36}$$

To calculate the variables above, we use our parameter estimates, the estimates for $d_{ni}^{-\tilde{\theta}}$, π_{ni} and Φ_n from gravity, and data on population and income per capita as proxies for L_n and w_n. With these data, we calculate U_n^R from (32) and $\mathcal{M}_n^R$ from (34). Variables $\tilde{c}_i^R$ and $\underline{v}_n^R$ are functions of U_n^R and $\mathcal{M}_n^R$ in (35) and (36). The remaining variables in $\bar{Q}_n^R$ above are taken from the gravity estimates.

For the decomposition, we separately regress, in logs, U_n^R on the product range term $(\mathcal{M}_n^R)^{\bar{m}-1}$, on the quality term $\bar{Q}_n^R$ and on the residual term $w_n^R \underline{v}_n^R/\bar{Q}_n^R = U_n^R/[\bar{Q}_n^R(\mathcal{M}_n^R)^{\bar{m}-1}]$.

We report in the main text the slope of these regressions. By construction, these slopes add up to one and do not depend on the reference country, which only affects the intercept of the regressions.

E.4. *Decomposing the welfare gains from trade*

Starting with the estimated equilibrium with trade, we experiment with a move to autarky, $d_{ni} \to \infty$ for all $n \neq i$ and assume no change in internal trade costs $\hat{d}_{nn} = 1$. The new trade shares are $\pi'_{ni} = 0$ for all $n \neq i$, $\pi_{nn} = 1$ and $\hat{\pi}_{nn} = \pi_{nn}^{-1}$. Without loss of generality, we can set all countries' wages to their current levels so that $\hat{w}_n = 1$ for all n.

From Section 5.1, we get:[10]

$$\hat{U}_n = \hat{V}_n = (\pi_{nn})^{-1/\left[\tilde{\theta}-(1-\tilde{\alpha})(\tilde{\theta}\bar{m}-1)\right]} \tag{37}$$

The gains from a greater range in variety are in (45) with $\hat{L}_n = 1$. From (25) and $\hat{w}_n = 1$,

$$\hat{\tilde{c}}_i = \hat{V}_n^{\tilde{\alpha}-1} \tag{38}$$

With $d_{ni} \to \infty$ for all $n \neq i$, equation (27) becomes:[11]

$$\hat{\Phi}_n = \pi_{nn} \hat{\tilde{c}}_n^{-\tilde{\theta}} = \pi_{nn} \hat{V}_n^{\tilde{\theta}(1-\tilde{\alpha})}$$

Combining (22) and (25), the change in cutoff is:

$$\hat{\underline{v}}_n = \left(\frac{\widehat{X_n}}{f_n} \hat{\Phi}_n \right)^{1/\tilde{\theta}}$$

Substituting in $\mathcal{M}_n = \Phi_n \underline{v}_n^{-\tilde{\theta}}$, we get:

$$\hat{\mathcal{M}}_n = \frac{\widehat{X_n}}{f_n}$$

Substituting back in (22) we write the change in cutoffs as functions of total welfare and the range of varieties, which we have from equations (37) and (45):

$$\hat{\underline{v}}_n = \left(\hat{\mathcal{M}}_n\right)^{\overline{m}-1} \hat{V}_n. \tag{39}$$

Dividing the numerator and denominator by a reference country, we rewrite the quality gains in (46) as:

$$\hat{\tilde{Q}}_n = \hat{\underline{v}}_n^{\tilde{\eta}} \left[\frac{(d'_{nn} \hat{\tilde{c}}_n \tilde{c}_n^R)^{\tilde{\eta}/(1-\bar{m})} (w_n^R \hat{V}_n V_n^R)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}}{\sum_i \pi_{ni} (d_{ni} \tilde{c}_i^R)^{\tilde{\eta}/(1-\bar{m})} (w_i^R V_i^R)^{\nu(1-\tilde{\gamma})/(1-\bar{m})}} \right]^{1-\bar{m}}$$

[10]Note that we report in the main text the decomposition of the gains from trade, which are the inverse of the welfare changes calculated here. Clearly, the decomposition of the components of the gains from trade and of the loss from the move to autarky as shares is the same.

[11]We obtain an equivalent expression combining (28) and (37).

TABLE F.I

PARAMETER ESTIMATES VARYING THE VALUE OF $\tilde{\alpha}$

	$\tilde{\alpha}=0.5$		$\tilde{\alpha}=0.4$		$\tilde{\alpha}=0.6$	
	param.	std. dev.	param.	std. dev.	param.	std. dev.
γ	0.146	0.014	0.138	0.014	0.15	0.014
η	0.490	0.058	0.564	0.075	0.43	0.046
ν	0.085	0.009	0.101	0.011	0.071	0.007
θ	8.68	0.70	9.49	0.86	8.18	0.63
β	0.557	0.005	0.663	0.007	0.449	0.003
κ_1	-0.423	0.007	-0.508	0.008	-0.336	0.006
κ_2	5.11	0.045	5.10	0.045	5.11	0.045
$\tilde{\kappa}_0$	0.714	0.131	0.82	0.184	0.645	0.104

We follow the procedure in Appendix E.3 to get the variables with subscript R. The variables $\hat{V}_n$, $\hat{\tilde{c}}_n$ and $\hat{\underline{v}}_n$ are from equations (37), (38) and (39). The remaining variables, trade shares and costs, are from the gravity estimation.

APPENDIX F: ROBUSTNESS OF ESTIMATION AND COUNTERFACTUAL

F.1. *Intermediate Labor Share* $\tilde{\alpha}$

We set $\tilde{\alpha}=0.5$ in the estimation. To show that $\tilde{\alpha}$ is not separately identified from other parameters, we repeat the estimation of the margins by separately setting $\tilde{\alpha}=0.4$ and $\tilde{\alpha}=0.6$. The model's predictions for all margins $\log P_{ni}$, $\log E_{ni}$, $\log E_{n\cdot}$, and $\log E_{\cdot i}$ do not change (the correlation with the original is higher than 99.9%). Table F.I presents the parameter estimates with $\tilde{\alpha}=0.5$ (baseline in Table IV), $\tilde{\alpha}=0.4$ and $\tilde{\alpha}=0.6$. The value of some parameters change but the magnitude of most changes is small and their interpretation remains. For example, the trade elasticity is 5.82 when $\tilde{\alpha}=0.5$, 6.07 when $\tilde{\alpha}=0.4$ and 5.72 when $\tilde{\alpha}=0.6$.

One parameter that changes significantly is β. The implied elasticity of substitution, between varieties $\beta/(1-\beta)$ changes from 2.3 when $\tilde{\alpha}=0.5$, to 3.0 when $\tilde{\alpha}=0.4$, and to 1.8 when $\tilde{\alpha}=0.6$. As a result, the share of welfare changes accounted for by range of goods in shocks with $\hat{L}_n=1$ for all n also changes. This share $(\bar{m}-1)(1-\tilde{\alpha})$ is 53% when $\tilde{\alpha}=0.5$, 43% when $\tilde{\alpha}=0.4$, and 62% when $\tilde{\alpha}=0.6$.

F.2. *Data from 2017*

The results in the main text all use data from 2007. In this appendix, we re-estimate the model using data from 2017. The parameter estimates are in Table F.II and the R-squared is in Table F.III. For comparison, the original 2007 parameters appear in the first column of Table F.II. The sign and statistical significance of the parameters do not change. The effect of non-homothetic demand γ on import price decreases from 0.15 to 0.10 and the effect of material inputs in increasing substitutable quality ν decreases from 0.085 to 0.028, while the effect of firm productivity on substitutable quality η increases from 0.49 to 0.72. Parameter $\tilde{\kappa}_0$ decreases to accommodate the increase in the number of exporter-importer-product triads from 5.3 million in 2007 to 6.4 million in 2017. The trade elasticity $\theta/(1+\eta)$ remains almost

TABLE F.II

PARAMETER ESTIMATES USING DATA FROM 2007 (BASELINE) AND 2017

	2007		2017	
	parameter	std. dev.	parameter	std. dev.
γ	0.146	0.014	0.100	0.014
η	0.490	0.058	0.720	0.096
ν	0.085	0.009	0.028	0.015
θ	8.68	0.70	9.53	0.92
β	0.557	0.005	0.613	0.009
κ_1	-0.423	0.007	-0.432	0.005
κ_2	5.11	0.045	4.57	0.025
$\tilde{\kappa}_0$	0.714	0.131	0.086	0.001

TABLE F.III

R-SQUARED AND NUMBER OF OBSERVATIONS FOR ESTIMATION WITH 2017 DATA

	observations	R-squared
$\log \overline{P}_{ni}$	9713	0.39
$\log E_{ni}$	9769	0.15
$\log E_{n\cdot}$	100	0.52
$\log E_{\cdot i}$	100	0.46

unchanged, 5.82 in 2007 and 5.54 in 2017, and the elasticity of substitution between varieties increases from 2.3 in 2007 to 2.6 in 2017.

The remaining tables and figures present the implications of these parameters for the predictions of the model. Table F.IV shows the decomposition of trade into margins. We find no significant changes from 2007.

Figure F.1 shows the relationship between per capita GDP (on the x-axes) and the importer and exporter fixed effects from the price regressions (on the y-axes) in the data and in the model. We perform the same variance decomposition of the predicted $\log P_{ni}$ and the actual $\log P_{ni}$ as we did for 2007 data. In the model, the contribution to the variance of prices of the fixed effect of exporters, the fixed effect of importers, and distance is respectively 0.73, 0.20, and 0.21. For the data, these numbers are respectively 0.49, 0.29, and 0.27. Similar to 2007, the model overestimates the role of the fixed effect of exporters.

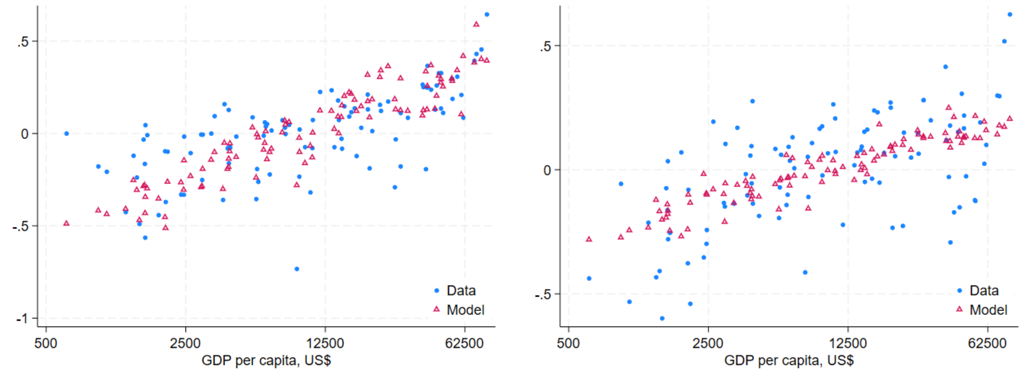
Figure F.2 compares the extensive margins of exporting and importing to the data. Like in 2007, the model captures the increasing, concave relation between these margins and a country's total GDP (all in logs).

The distribution of the number of exporters per product is in Table F.V. This distribution is related to targetted moments but not itself targetted. The estimation captures the increase in exporters per product from 2007 to 2017. Like in 2007, the model underestimates the number of exporters per product in the lower tail of the distribution and it captures the mean and upper tail well.

TABLE F.IV: Decomposition of trade into margins in 2017

	data				model			
dependent variable →	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$	X_{ni}	E_{ni}	Y_{ni}	$\overline{P}_{ni}$
exporter GDP	1.368	0.835	0.529	0.004	1.385	0.690	0.652	0.018
	(0.056)	(0.045)	(0.048)	(0.018)	(0.008)	(0.011)	(0.013)	(0.011)
importer GDP	1.151	0.379	0.729	0.043	1.091	0.366	0.703	0.041
	(0.038)	(0.028)	(0.033)	(0.011)	(0.008)	(0.011)	(0.011)	(0.006)
distance	-1.343	-0.787	-0.652	0.096	-1.346	-0.601	-0.647	0.059
	(0.073)	(0.054)	(0.056)	(0.015)	(0.014)	(0.010)	(0.014)	(0.009)
R-squared	0.675	0.598	0.424	0.053	0.858	0.636	0.814	0.099
exporter GDP per capita	1.521	0.992	0.438	0.092	1.544	0.818	0.373	0.159
	(0.078)	(0.058)	(0.065)	(0.016)	(0.010)	(0.013)	(0.019)	(0.018)
exporter population	1.275	0.740	0.585	-0.049	1.289	0.612	0.815	-0.067
	(0.061)	(0.054)	(0.046)	(0.016)	(0.008)	(0.011)	(0.012)	(0.009)
importer GDP per capita	1.193	0.495	0.586	0.111	1.113	0.410	0.581	0.100
	(0.056)	(0.038)	(0.048)	(0.016)	(0.010)	(0.012)	(0.018)	(0.008)
importer population	1.126	0.309	0.815	0.002	1.077	0.339	0.785	0.006
	(0.044)	(0.029)	(0.033)	(0.011)	(0.008)	(0.011)	(0.008)	(0.008)
distance	-1.284	-0.706	-0.722	0.143	-1.292	-0.550	-0.768	0.118
	(0.073)	(0.052)	(0.055)	(0.014)	(0.014)	(0.010)	(0.013)	(0.009)
R-squared	0.681	0.627	0.440	0.215	0.867	0.658	0.832	0.968
observations (both panels)	9,713	9,713	9,713	9,713	9,713	9,713	9,713	9,713

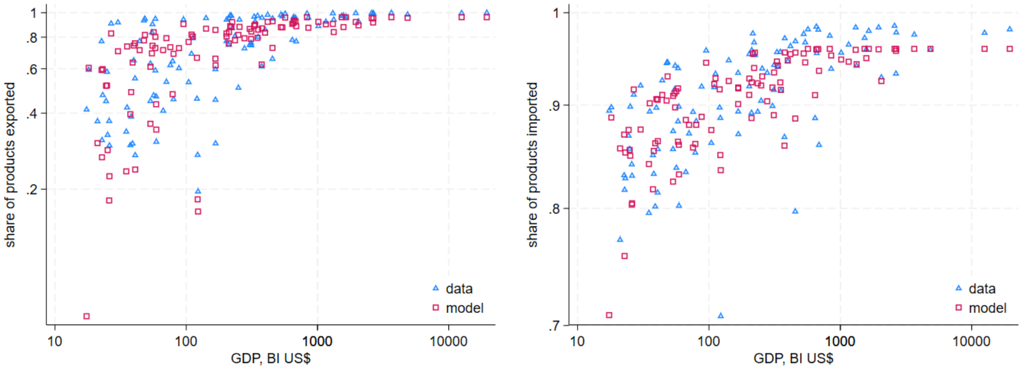
Note: Standard errors are clustered by importer and by exporter.



(a) Exporter FE

(b) Importer FE

FIGURE F.1.—Fixed effects from price regression in 2017



(a) Exporting

(b) Importing

FIGURE F.2.—Extensive margins in 2017

TABLE F.V

DISTRIBUTION OF THE NUMBER OF EXPORTERS PER PRODUCT IN 2017

	percentile of the distribution					
	10%	25%	50%	75%	90%	**mean**
data	47	59	74	88	96	**73**
model	24	63	85	93	96	**73**

Decomposition of welfare gains in 2017. Table F.VI summarizes the implications of these parameters for the decomposition of welfare into margins in Table VII for 2007. The role of range of goods decreases from 0.52 to 0.40 in all exercises. Recall from equation (45) that the share of range of goods in welfare is $(1-\tilde{\alpha})(\bar{m}-1)$ where the markup is $\bar{m}=(1+\gamma)/\beta$. The lower estimate of γ in 2017 implies lower markups and hence a lower role for the range of

TABLE F.VI

DECOMPOSITION OF WELFARE CHANGES IN 2017

	Range of varieties $\left(\mathcal{M}_n^{\bar{m}-1}\right)$	Inverse physical cost $\left(\frac{w_n v_n}{Q_n}\right)$	Substitutable quality $\left(\bar{Q}_n\right)$
Uniform worldwide growth	0.40	0.53	0.07
Welfare differences across countries	0.38 (0.03)	0.47 (0.03)	0.16 (0.01)
Gains from trade	0.40	0.15 (0.21)	0.46 (0.21)

Note: This table presents the results of Table VII using 2017 data. It displays the average contribution of each component of welfare to total welfare changes for the two counterfactual exercises and the cross-country welfare comparison. In each row, the columns add to one. Where standard errors are not zero, they appear in parenthesis.

goods relative to inverse physical cost. Recall that quality plays a larger role in the gains from trade compared to the gains from economic growth because selection into exporting implies that foreign goods are typically of higher quality than domestic goods. The parameter that governs this selection is η, which increased from 0.49 to 0.72. As a result, the role of quality in the gains from trade is much larger in 2017 than 2007.

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