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Unit Values in International Trade and Product Quality

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ABSTRACT

Is the unit value of traded goods representative of quality? To answer this question, we analyze unit value with respect to exporter country's capacity to export, which is determined by its production cost, tariff, and distance. The change in a country's export unit value is decomposed into the components associated with pure term-of-trade effect, quality effect, distance effect, and production cost effect. Our empirical results confirm that tariff, distance, and wages all significantly affect the unit values. Furthermore, by comparing CIF and FOB unit values, we show that quality is an important contributor on driving up the unit values: exporters increase unit price to distant trading partners through quality upgrading. This "Washington apple effect" is much larger than the pure distance effect or production cost increase.

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1.0 Introduction

Is the unit value of traded goods representative of quality? A vast literature associates cross-country variation in export unit-value with variation in product quality. Brooks (2006) uses unit value differences to infer the quality gap for Colombian firms. Many policy researches also derive countries' quality competitiveness from cross-country comparisons of export unit value (Aiginger, 1988; Verma, 2002; and Ianchovichina et al., 2003 IADB/World Bank 2003).

Although countries with higher exporter price are also likely to produce higher quality, a moment reflection suggests that many factors are ignored by this assumption. International variation in export prices can be influenced by both demand and supply side factors. Based on sectoral data for bilateral trade among 60 countries, Hallak (2006) finds that richer nations tend to import relatively more from partners that produce higher quality products. Harrigan (2010) shows that imports from distant trading partners have much higher unit values, and are much more likely to arrive by airplane. Khandelwal (2010) uses a discrete choice random coefficient model to show that conditional on price, imports with higher market shares are assigned higher quality. Hummels and Klenow (2005) argue that product varieties and quality differences are necessary to explain the observed differences in unit values. They find that countries with twice the per-capita income export varieties with 9 to 23 percent higher quality. Schott (2004) demonstrates that U.S. import unit values are positively associated with exporter per capita GDP, exporter relative endowments, and exporter production techniques across time and

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industries. Hallak and Schott (2011) link quality to the countries' trade flows and find that countries with trade surplus have higher quality-adjusted prices. Feenstra and Romalis (2014) theoretically develops a methodology to decompose unit values of internationally traded goods into quality and quality-adjusted price components for 185 countries over 1984-2011. They find that the differences in export unit values are predominantly attributed to quality.

Most of the studies focus on the demand side, our paper contributes to exploit the supply side factors for unit value variation. We conduct a formal assessment of within industry relationship between unit values of the international traded goods and exporters supply ability, which is determined by production costs, tariffs, and distance. Using highly disaggregate trade data in 1996, we find that tariff rates, distance, and wages all significantly affect the unit values. We take advantage of our trade data and compare how CIF (cost-insurance-freight) and FOB (free-on-board) unit values vary with respect to exporter supply abilities such as trade cost, transport cost, and production cost. We consider transportation cost and tariff-inclusive CIF prices capture the variations of transportation and tariff rates. So any difference in the FOB price from a given exporting firm must be due to quality. Through comparing how different factors influence importer and exporter unit values, we can decompose unit values of international traded goods into components associated with pure term-of-trade (TOT) effect, quality effect, distance effect, and production cost effect. We find empirically that quality is a significant fraction of FOB price: exporters increase unit price to distant trading partners by quality upgrading. Furthermore, this quality upgrade effect is far more important than distance in explaining the unit value increase.

To conduct the study, we take the formidable challenge to assemble a dataset connecting world bilateral trade, tariff, wage, and transportation cost data at Standard International Trade Classification (SITC) Rev. 2 4-digit industry level. In particular, we contribute by compiling the "industry wages around the world" (IWW thereafter) dataset based on the International Labor Organization (ILO) yearly manufacturing sectoral wage rates. We standardize the most far-ranging collection of world wages into a consistent series of pay across 733 industries and 115 countries over the period of 1969 to 2004. By cross-checing our IWW wage series with the "occupational world wage" (OWW thereafter) data set constructed by Freeman and Oostendrop (2000), and the UNIDO wage data from the INDSTAT3 database, we prove that our wage data are highly consistent and correlated with the other widely used wage datasets. As far as we know, this is the most complete world-wide wage data which should be useful for time-series or cross-country comparisons in international studies.

The rest of the paper is organized as follow. Section 2 introduces the econometric specification and hypotheses, section 3 describes the industry level world trade, tariff, wage, and transportation cost data used in the empirical analysis. Section 4 reports the estimation results, and section 5 concludes.

2.0 Econometric model and hypothesis

Consider the variation in product prices across countries. If we consider import tariffs and iceberg transportation cost in shipping, then the world price of product k produced by country j and imported to country i is:

$$P_{ijk} = P_{jk}(1+t_{ijk})(d_{ij})^{\gamma_k} = (\frac{\sigma_k}{\sigma_k - 1})w_{jk}(1+t_{ijk})(d_{ij})^{\gamma_k} \qquad (01)$$

Where $\boldsymbol{P_{jk}}$ is the price of product k manufactured and sold in exporter country j; $\boldsymbol{t_{ijk}}$ is the ad-valorem tariff on product k when country i import from partner country j; $\boldsymbol{w_{jk}}$ denotes the wage rate of product k in country j; $\boldsymbol{d_{ij}}$ is the distance between country pair i and j, and $\boldsymbol{\gamma_k}$ >0 is the scaling factor for transportation cost between i and j when transferring product k. The second equality comes from the assumption of monopolistic competition, so the product price $\boldsymbol{P_{jk}}$ is a constant markup over marginal cost. Thus we decompose the prices into factors that capture tariffs, production cost, and transportation cost.

Taking log on equation (1) and add some fixed effects; we can get the gravity-like regression equation as follows:

CIF: $\ln(UV_{ijk}) = \alpha_0 + \alpha_1 \ln(1+t_{ijk}) + \alpha_2 \ln(dist_{ij}) + \alpha_3 \ln(w_{jk}) + \alpha_4 D_i + \alpha_5 D_j + \alpha_6 D_k + \varepsilon_{ijk}$ (2a)

FOB: $\ln(UV_{ijk}) = \beta_0 + \beta_1 \ln(1+t_{ijk}) + \beta_2 \ln(dist_{ij}) + \beta_3 \ln(w_{jk}) + \beta_4 D_i + \beta_5 D_j + \beta_6 D_k + \varepsilon_{ijk}$ (2b)

Where the variables are:

$\boldsymbol{UV_{ijk}}$ denotes the unit value of imported product k by importer i from exporter j

$\boldsymbol{t_{ijk}}$ is the ad-valorem tariff levied by importer i on product k from exporter j

$\boldsymbol{w_{jk}}$ is the wage rates of product k in exporting country j, reflecting the production cost

D_i is the fixed effect for importing country

D_j is the fixed effect for exporting country

D_k is the fixed effect for product k, which controls for within product variation. So we can check unit value difference within narrow product categories.

ε_{ijk} represents the myriad other influences on the bilateral imports, assumed to be orthogonal

So the specification is a regression of bilateral sectoral export unit value on importer country dummies, exporter country dummies, factors that capture transport cost (bilateral distance), trade cost (tariff), and production cost (exporter wage). We explore the regressions by separating CIF and FOB prices. FOB denotes the producer reported free-on-board price of the products and does not include transportation cost, whereas CIF stands for cost-insurance-freight value of the traded products, which includes transport charges and tariff duties. Because CIF unit values capture the variations of transportation cost and tariff rates, we consider any difference in the FOB price from a given exporting firm must be due to quality. Our major hypotheses are:

1) $\alpha_1 \leq 0$ and $\beta_1 \leq 0$: We consider α_1 and β_1 reflect the pure terms-of-trade (TOT) effect. Based on the trade theory, levying tariff would lower the world price if importer is a large country, and has no effect on the world price if the importer is of small country case, with little import share in the world market. So we expect the tariffs to have negative signs to the extent that trade costs are passed on to consumers.

2) $\beta_2 > 0$: When trading with faraway countries, exporters will choose products with higher unit FOB price by adding product feature or quality upgrade. Since FOB price is exclusive of transportation cost, β_2 captures the pure quality upgrade or the "Washington apple effect"[2], meaning that unit values increase within narrow product categories systematically with distance.

3) $\alpha_2 > 0$ and $\alpha_2 > \beta_2$: α_2 denotes the elasticities of a country's CIF unit value with respect to country pair distance. Compare with FOB price, CIF price is more sensitive to distance. Given equal distance, a small increase of distance leads CIF price to increase more than FOB. The difference between CIF and FOB price exactly reflects the effect of distance on unit values. Longer distance drives up the transport cost and final product price.

4) $\alpha_3 > 0$ and $\beta_3 > 0$: We expect the producer wage rates to have positive effect on the export unit values. This is the pure price effect due to markups on the production cost.

3.0 Data in regression

From the regression specification, we need data on bilateral trade unit value, factors that capture trade cost, transport cost, and wage rate across the countries, all at the commodity level.

Trade data: Our primary data set is the Standard International Trade Classification (SITC) Revision 2 4-digit level "World Trade Flows, 1962-2000" (NBER-UN henceforth) compiled by Feenstra et. al (2005). The world trade dataset reports both quantity and value for each traded products. We compute the unit value or "price", by dividing trade value by quantity. Whenever possible, quantities for a given SITC code are converted into common units firsthand. If it is hard to convert the same product into common units, we treat each combination of STIC code and unit of quantity as a separate product. Availability of unit value information occupies 80% in 1996. For the period of 1984-2000, this dataset only covers imports and exports for 72 countries[3]. However, they are the relatively large countries in the world and accounts for 98% of world exports. We compute the bilateral FOB unit values of traded goods using reports from the export country. By focusing on the exporters' reports, we ensure that these unit values do not include any shipping costs. The bilateral CIF unit values are similarly obtained from importers reported trade data, which are transport cost and tariff-inclusive.

[2] "Washington apples" effect comes after the example by Alchian and Allen (1964, 74-75). They noted that while the state of Washington grows apples of many varieties, it appeared that the best apples were shipped the furthest distance, to east coast markets. This is explained by treating the transport costs as the same for each apple. Transport therefore acts like a specific price increase, which lowers the relative price of the higher-quality apples in more distance markets. Hummels and Skiba (2004) argue that this effect can be observed in trade data across countries.

[3] Readers are referred to Feenstra et. al (2005) Table 1 for the complete list of these 72 countries.

Distance: Bilateral distance across 225 countries are obtained from the Centre D'Etudes Prospectives Et D'Informations Internationales (CEPII)[4]. Distance is measured as the great circle distance between the capital cities of those two countries.

Tariff Rates: The primary source of ad-valorem tariff associated with most-favored-nation (MFN) status comes from the Trains-Haveman tariff data at UNCTAD. We convert the 6-digit HS level tariff rates to match the SITC 4-digit trade data.

Wage: To capture production cost varying by countries, industries, and years, we need consistent and complete wage data at SITC 4-digit level. We use three wage series in our estimation. The first one is the "industry wages around the world" (IWW) that we constructed based on the annual manufacturing sectoral wage data from United Nation's International Labor Organization (ILO)[5]. ILO collects detailed sectoral wages for countries around the world. However, the extent of variation in the ILO data complicates the direct use of cross-country comparison. Its wage information comes from 12 sources such as Administrative reports, Labor-related establishment survey, or even Insurance records. There are also 6 different worker coverage such as employees, skilled, unskilled, and wage earners. Some countries report wages for wage rates whereas others report earnings. The time span also varies from day, hour, to month or week. Wage earners gender is mixed with men, women, or both men and women. The data is also mingled with different industry classification such as ISIC revision 2 or ISIC revision 3. Furthermore, wages are all denominated in domestic currency whereas some country currencies experienced currency denomination change. So we painstakingly follow the method proposed by Freeman and Oostendorp (2000) to calibrate the diverse statistics into a normalized monthly wage rates for male wage earners.[6] The final dataset is organized by 733 SITC Rev. 2 4-digit industries in 115 countries, over the period of 1969 to 2004.

Table 1: Data coverage for three wage database

Wage Series	country	SITC 4-dig	year coverage	# of years covered
IWW	115	733	1969 ~ 2004	36
UNIDO	92	726	1963 ~ 2002	40
OWW	127	543	1983 ~ 1999	17

Notes: IWW is constructed by authors based on the ILO yearly manufacturing sectoral wage data; UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages.

To check the accuracy of our own IWW wage data, we also use two other widely used wage series in this cross-country study. The first source is the "Occupational wages around the world" (OWW) database constructed by Freeman and Oostendorp (2000). This dataset transforms the "October Inquiry" Survey from the ILO into a consistent data file for, which covers pays in 161 occupations over 151 countries from 1983 to 1998. The second standard wage dataset is the UNIDO wage coming from the INDSTAT3 database 2005 edition. It reports wages at the 3-digit level of ISIC Rev. 2 classification, covering the period 1963-2003 for 180 countries. Table 1 summarizes data coverage for the three wage databases. Compare with the two standard wage series, our own IWW dataset has the widest coverage at SITC 4-digit industry level. It standardizes the most far-ranging collection of wages into a consistent series of pay across industries, countries, and time. The IWW database will contribute significantly to international economic studies.

Table 2: Summary statistics of wages at SITC Rev.2 4-digit level

Variable	Observation	Mean	Std. Dev.	Min	Max
UNIDO wage	1298529	554.04	744.31	.06	20050.17
IWW: uniform weighting	1065060	647.19	693.71	4.68	5625.79
OWW: uniform weighting	299106	676.519	713.09	7.92	4007.50
OWW: Lexicographic weighting	299106	675.02	709.68	7.92	4007.50

Notes: IWW is constructed by authors based on the ILO yearly manufacturing sectoral wage data; UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages.

4 http://www.cepii.fr/anglaisgraph/bdd/distances.htm
5 http://laborsta.ilo.org/, Table 5B
6 Appendix available upon request on how to construct the IWW wage series.

Table 2 further compares summary statistics of the three wage datasets based on the same SITC Rev. 2 nomenclature. The range of OWW and IWW wages are quite similar, but the average monthly UNIDO has a much larger variance, ranging from 6 cents to $20,050.

Table 3: IWW monthly $wage regress on UNIDO monthly $wage, Equation (3)

	(1)	(2)	(3)	(4)	(5)
UNIDO	0.97**	0.96**	0.88**	0.64**	0.63**
	(402.53)	(378.29)	(246.61)	(132.63)	(111.21)
Constant	-0.20**	-0.39**	0.30	0.29	0.31
	(13.20)	(11.91)	(0.95)	(1.05)	(1.12)
Observations	16618	16618	16618	16618	16618
R-squared	0.91	0.91	0.94	0.96	0.96
Fixed effect: year		y		y	y
Fixed effect: country			y	y	y
Fixed effect: ISICr2					y

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Notes: UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; IWW is the industrial world wage rates constructed by us based on the ILO yearly manufacturing sectoral wage data.

Table 4: Regress IWW on OWW data based on ISICr2, Equation (4)

	OWW: uniform		OWW: lexicographic	
	(1)	(2)	(1)	(2)
OWW: uniform	1.013**	1.012**		
	(243.77)	(241.13)		
OWW: lexicographic			1.013**	1.012**
			(242.54)	(239.92)
Constant	-0.178**	-0.150**	-0.182**	-0.165**
	(6.89)	(3.72)	(7.01)	(4.06)
Observations	3704	3704	3704	3704
R-squared	0.94	0.94	0.94	0.94
Fixed effect: year		y		y

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Notes: IWW is constructed by authors based on the ILO yearly manufacturing sectoral wage data. OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages.

To check the substitutability of the three wage datasets, we further regress the IWW wage rates on UNIDO and OWW wages respectively.

$$\ln(IWW_{ijt}) = a_0 + a_1 UNIDO_{ijt} + \varepsilon_{ijt} \quad (03)$$

$$\ln(IWW_{ijt}) = b_0 + b_1 OWW_{ijt} + u_{ijt} \quad (04)$$

Where, i, j, t stand for industry, country, and year respectively. OLS estimates of equations (3) and (4) are reported in Tables 3 and 4. We can find a strong unit correlation across the three wage series. R^2 is also as high as 0.91 to 0.94, suggesting perfect fit and substitutability.

4.0 Result & discussion

We start testing our hypotheses with the broadest possible sample available. The summary statistics of the regression data for CIF price and FOB price are presented in Table 5a and 5b respectively. Since OWW wage covers

non-manufacturing sectors, we supplement the missing IWW wage with OWW wage (IWW_OWW henceforth) so as to extend to agriculture industries as well. The range of each variable is quite big, suggestive of substantial heterogeneity across products. Interestingly, the mean of CIF unit values is even smaller than FOB prices.

Table 5a: Summary Statistics of Importer CIF Price Dataset

Variable	Obs	Mean	Std. Dev.	Min	Max
tariff	210999	9.970795	16.31702	0	907.4
quantity	341358	688886.5	4.61e+07	1	8.64e+09
value	341358	9742.326	84144.62	100	2.56e+07
unit value	341358	34.23414	600.4512	2.49e-08	151413.6
distance	340004	5334.36	4560.834	59.61723	19747.4
UNIDO	156744	2115.242	1242.654	4.747856	5879.573
IWW	224131	1528.571	957.0368	21.36191	4587.043
OWW: uniform	112192	1365.565	922.351	15.35463	3816.705
OWW: lexicographic	112192	1368.563	929.5314	11.48537	3816.705

Table 5b: Summary Statistics of Exporter FOB Price Dataset

Variable	Obs	Mean	Std. Dev.	Min	Max
tariff	237264	10.91961	24.12807	0	2755.833
quantity	353680	871994.9	5.55e+07	1	8.81e+09
value	353680	9455.871	95232.73	100	2.46e+07
unit value	353680	36.46104	753.5247	3.41e-08	154544
distance	353680	5063.643	4443.913	59.61723	19747.4
UNIDO	164485	2315.874	1216.229	31.37391	5879.573
IWW	243500	1603.14	950.4937	25.07947	4587.043
OWW: uniform	126962	1464.002	910.8084	35.52106	3816.705
OWW: lexicographic	126962	1466.473	916.2817	31.8733	3816.705

Notes: UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; IWW is the industrial world wage rates constructed by us based on the ILO yearly manufacturing sectoral wage data; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages.

Table 6 reports the results of estimating equation (2), using the broadest data available and includes all countries that have non-missing trade, wage, transportation, or tariff data. Tables 6a and 6b present the results of CIF and FOB unit values, respectively. Each column uses a different wage: IWW wage, IWW_OWW wage, UNIDO wage, OWW using uniform weighting, and OWW using lexicographic weighting. Robust standard errors are reported in the parentheses.

Table 6a: Regression equation 2a (Based on Importers reported CIF Price)

	All Countries Available				
	(1)	(2)	(3)	(4)	(5)
	IWW	IWW_OWW	UNIDO	OWW: uniform	OWW: lexicographic
ln(tariff)	-.285*	-.325**	-.320*	-.400*	-.400*
	(.037)	(.035)	(.044)	(.053)	(.053)
ln(dist)	.183*	.183**	.169*	.206*	.206*
	(.003)	(.003)	(.003)	(.004)	(.004)
ln(exporter_wage)	.025	.093**	.066*	-.006	-.017
	(.019)	(.015)	(.020)	(.019)	(.019)
Constant	-1.523*	-2.019**	-2.179*	-2.232*	-2.185*
	(.338)	(.298)	(.480)	(.540)	(.539)
Observations	135038	155953	100930	70670	70670
R-squared	0.8190	0.8189	0.8252	0.8309	0.8309
Importer fixed effect	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Table 6b: Regression Equation 2b (Based on Exporters reported FOB Price)

	All Countries Available				
	(1)	(2)	(3)	(4)	(5)
	IWW	IWW_OWW	UNIDO	OWW: uniform	OWW: lexicographic
ln(tariff)	-.007	-.006	.009	-.025	-.026
	(.029)	(0.027)	(.033)	(.042)	(.042)
ln(dist)	.119**	.124**	.111**	.153**	.153**
	(.003)	(.003)	(.003)	(.004)	(.004)
ln(exporter_wage)	.040*	.228**	.049*	.136**	.126**
	(.019)	(.015)	(.018)	(.020)	(.019)
Constant	-1.229	-2.266	-.732*	-2.169**	-2.114**
	(2684.290)	(2249.345)	(.323)	(.600)	(.599)
Observations	159926	185208	114337	86654**	86654
R-squared	0.8400	0.8504	0.8414	0.8691	0.8691
Importer fixed effect	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Notes: UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; IWW is the industrial world wage rates constructed by us based on the ILO yearly manufacturing sectoral wage data; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages; IWW_OWW stands for the IWW supplemented by the OWW uniform weighting wage rates.

As the first row of Table 6a shows, the effect of tariff rate on CIF unit values is large, robust and significantly negative, supporting the large importing country TOT improvement hypothesis. On average a 10 percent increase in tariff rates lowers the exporters' price by 28-40 percent. Distance is positive and significantly correlated to unit value. The sign of wage rate coefficient is mixed: it is positively correlated with the unit values for IWW, IWW_OWW, and UNIDO wage, but negative for the two OWW wages, though not significantly differ from zero. Table 6b reports the results using importer reported FOB price. Overall the positive correlation between distance and unit value still remains highly significant. The estimated wage effect also improves to be significantly positive all the wage series, with the wage elasticity ranging from 0.04 to 0.23.

Tariff rates, however, have almost zero impact on the FOB unit values, supporting the small country scenario. The effect of distance on both CIF and FOB unit values are large, robust, and statistically significant. The estimated effects of distance are invariably larger for CIF unit values, supporting our hypothesis that the difference between CIF and FOB price reflects the pure distance effect. Overall, goods have higher unit values when they travel a greater distance. Given a 10 percent increase in bilateral trading partners' distance, exporters will increase FOB prices by 11-15 percent. This is exactly the "Washington Apple" effect because exporters try to update improve product quality and create more value-added to distant destinations. Importers reported CIF unit value will increase by 17-20 percent, indicating that 5-7 percent of prices increase is the pure distance effect. Hence quality effect is about twice important than the distance effect. This finding is consistent with Harrigan (2010), who finds that more distant exporters will choose to sell products with higher unit values, controlling for other country specific factors which might affect unit values.

Many possible reasons can explain why tariff rates are not significant for the FOB unit value. First, comparing with importer reports, it is easier for exporters make reporting errors when going through the customs office (Feenstra et al. 2005). Second, measurement errors may also be created on purposely for transfer pricing or tax evasion purposes. As shown by Fisman and Wei (2004), facing high import tariffs, exporters may on purposely under-report the unit value, under-report the taxable quantities, or mislabel the higher-taxed products as lower-taxed products. Thirdly, the difference is caused by the limitation of the NBER-UN world trade flow dataset, which only collects the import and export reports from 72 countries. Table A1 lists all the country pairs included in the two regressions. For importer reported CIF prices, there are 50 large countries importing from 182 countries in the regression sample. So the importers fit large country cases. Whereas for exporter reported FOB prices, there are 58 countries reporting exports to 103 countries, which contains many smaller importers compare with CIF prices. Hence the exporter reported FOB prices is more suitable for the small importing country case, whereas importer report is more suitable for the big importer country case.

To sort this problem out and make the coefficients comparable across country pair and sectors, we restrict the bilateral trade flows to the same 50 importers and 58 exporter countries in either CIF or FOB datasets. Table 7 reports the regressions of equation (2) again, based on the narrower sample.

The results with CIF prices are listed on the left panel, and FOB prices on the right. For each regression, we test three wage series: IWW, IWW_OWW, and UNIDO. A striking feature of these results is that the estimated tariff rate coefficients improves to be significantly negative for both CIF and FOB prices, and much larger compare with the unrestricted sample. This significant net terms-of-trade gain strongly supports the classical theory of large country welfare gain with small tariff protection case. Wage rate still enters positively, though only significant for IWW_OWW wage series. The coefficient estimates of distance remain robust and significantly positive: increasing export distance by 10 percent will result in 11-13 percent increase in product quality, and a further 2-3 percent increase in transportation cost. So after controlling for other country specific factors which might affect unit values, about 80 percent of the observed variations in export unit values can be attributed to quality, whereas the pure distance effect is much weaker. The predominance of quality to unit values is also found by Feenstra and Romalis (2014), where more distant exporters will choose to sell products with higher unit values,.

Table 7: Regressions 2a and 2b (Based on Common set of Importers and Exporters)

	Importer reported CIF (Equation 2a)			Exporter reported FOB (Equation 2b)		
	(1)	(2)	(3)	(1)	(2)	(3)
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-.291**	-.308**	-.249**	-.206**	-.178**	-.182**
	(.041)	(.038)	(.049)	(.040)	(.038)	(.048)
ln(dist)	.152**	.157**	.156**	.127**	.132**	.119**
	(.004)	(.004)	(.005)	(.004)	(.004)	(.004)
ln(w)	-.023	0.103**	0.01	.030	0.178**	0.03
	(.025)	(.020)	(0.025)	(.025)	(0.020)	(0.025)
Constant	-.148	-.521	-.185	-1.788**	-1.665**	-.268
	(.427)	(.363)	(.602)	(.423)	(.361)	(.584)
Observations	77857	89846	56304	77857	89846	56304
R-squared	0.8183	0.8234	0.8234	0.8287	0.8313	0.8384
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y
Standard errors in parentheses	* significant at 5%; ** significant at 1%					

Notes: UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; IWW is the industrial world wage rates constructed by us based on the ILO yearly manufacturing sectoral wage data; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages; IWW_OWW stands for the IWW supplemented by the OWW uniform weighting wage rates.

Then to see how these relationships vary across industries, we attempt the regression again, breaking down by SITC 1-digit (SITC1). We omit products belonging to the ninth SITC1 industry "Not Elsewhere Classified". So all together we report regression for eight SITC 1-digit industries in Table 8. Across industries, a negative relationship between tariff and unit value is evident in six out of eight industries, indicating the TOT effect. Wage effect is positive for five out of eight industries, though only statistically significant for SITC1=4 "Animal and Vegetable Oils".

Table 8: Regression 2 by Sector: Common set of Importer-Exporter Pair

Table 8a: SITC 1dig=1: Beverage and Tobacco

	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-.162	-.162	-.151	-.047	-.047	-.183
	(.132)	(.132)	(.197)	(.133)	(.133)	(.148)
ln(dist)	.102*	.102**	.131**	.065*	.065*	.056
	(.030)	(.030)	(.046)	(.030)	(.030)	(.035)
ln(w)	.376	0.376	0.434*	.281	0.281	0.375*
	(.210)	(.210)	(0.207)	(.211)	(0.211)	(0.155)
Constant	-3.25*	-3.250*	-.833	-.793	-.793	.054
	(1.653)	(1.653)	(1.447)	(1.657)	(1.657)	(1.083)
Observations	906	906	508	906	906	508

R-squared	0.8014	0.8014	0.7399	0.8099	0.8099	0.8201
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8b: SITC 1dig=2: Crude materials, inedible, except fuels

	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-1.29**	-1.18**	-1.14**	-.988**	-.754**	-.657
	(.270)	(.256)	(.352)	(.266)	(.258)	(.365)
ln(dist)	.177**	.184**	.193**	.103**	.112**	.122715**
	(.022)	(.020)	(.025)	(.021)	(.020)	(.026)
ln(w)	.059	0.068	0.121	.034	-0.066	-0.101
	(.110)	(.109)	(0.141)	(.109)	(0.109)	(0.146)
Constant	.720	-6.218**	-2.675	.852	-6.439**	-.278
	(.921)	(1.146)	(1.452)	(.906)	(1.152)	(1.504)
Observations	2668	3053	1824	2668	3053	1824
R-squared	0.7296	0.7251	0.6983	0.7537	0.7380	0.6966
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8c: SITC 1dig=3: Mineral Fuels, Lubricants and related materials

	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	.573	.743	1.852	.822	.926	.958
	(1.049)	(.951)	(1.070)	(.943)	(.858)	(1.057)
ln(dist)	.119*	.113*	.213**	.048	.049	.186**
	(.053)	(.047)	(.053)	(.047)	(.042)	(.052)
ln(w)	1.115	-1.104	-0.213	-.063	-0.033	-0.004
	(1.136)	(1.113)	(0.207)	(1.021)	(1.005)	(0.204)
Constant	-9.006	-8.901	-7.625**	-2.152	-2.409	-5.728*
	(6.225)	(6.089)	(1.831)	(5.594)	(5.497)	(1.807)
Observations	615	675	435	615	675	435
R-squared	0.6466	0.6430	0.648	0.7308	0.7269	0.6953
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8d: SITC 1dig=4: Animal and Vegetable Oils, Fats and Waxes

	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-.282	-.301	-.314	-.202	-.274	-.344
	(.283)	(.269)	(.290)	(.255)	(.245)	(.286)
ln(dist)	.096**	.107**	.112**	.062*	.078**	.062
	(.028)	(.024)	(.027)	(.025)	(.022)	(.027)
ln(w)	.340**	0.334**	0.085	.368**	0.354**	0.026*
	(.102)	(.099)	(0.094)	(.091)	(0.091)	(0.093)
Constant	-3.337	-3.079**	-1.586*	-3.365**	-3.154**	-.864
	(.790)	(.757)	(.539)	(.710)	(.689)	(.532)
Observations	845	1001	622	845	1001	622
R-squared	0.6248	0.6183	0.6478	0.6949	0.6809	0.6726
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8e: SITC 1dig=5: Chemicals and related products, N.E.S						
	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	.145	.203	.273	-.030	.078	-.134
	(.154)	(.142)	(.172)	(.160)	(.148)	(.176)
ln(dist)	.248**	.239**	.228**	.217**	.216**	.186**
	(.012)	(.010)	(.012)	(.012)	(.010)	(.013)
ln(w)	.051	0.172	0.521**	-.063	-0.038	0.365*
	(.288)	(.172)	(0.124)	(.301)	(0.179)	(0.126)
Constant	-4.224**	-.723	-6.916**	-3.910**	-.363	-6.267**
	(1.002)	(1.531)	(.826)	(1.044)	(1.597)	(.846)
Observations	14942	18165	10602	14942	18165	10602
R-squared	0.7374	0.7299	0.7384	0.7287	0.7202	0.7348
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8f: SITC 1dig=6: Manufactured Goods Classified chiefly by material						
	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-.311	-.349**	-.443**	-.256*	-.186	-.318*
	(.113)	(.104)	(.128)	(.112)	(.103)	(.125)
ln(dist)	.127**	.129**	.139**	.104**	.107**	.107**
	(.007)	(.007)	(.008)	(.007)	(.007)	(.008)
ln(w)	-.014	-0.06	-0.161**	.105*	0.195**	-0.178**
	(.050)	(.039)	(0.041)	(.049)	(0.038)	(0.040)
Constant	-.346	-.445	-6.639**	-1.640*	-1.525	-3.903**
	(.831)	(.803)	(1.018)	(.825)	(.796)	(.993)
Observations	22475	25219	16630	22475	25219	16630
R-squared	0.7545	0.7628	0.7505	0.7668	0.7767	0.7750
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y

Table 8g: SITC 1dig=7: Machinery and transport equipment						
	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	.130	.157	.336	.185	.224	.016
	(.156)	(.146)	(.172)	(.154)	(.143)	(.163)
ln(dist)	.165**	.172**	.214**	.143**	.147**	.172**
	(.010)	(.009)	(.011)	(.010)	(.009)	(.010)
ln(w)	-.208	-0.117	-0.259*	-.117	-0.087	-0.276**
	(.114)	(.085)	(0.109)	(.113)	(0.083)	(0.103)
Constant	5.047**	5.203**	(.182)	5.323**	4.587**	1.750*
	(1.120)	(1.028)	(.928)	(1.104)	(1.011)	(.880)
Observations	18105	21050	13607	18105	21050	13607
R-squared	0.7890	0.8109	0.8015	0.7964	0.8204	0.8182
Importer fixed effect	Y	y	y	y	y	y
Exporter fixed effect	Y	y	y	y	y	y
Sitc UV Fixed Effect	Y	y	y	y	y	y

Distance enters significantly positive for all the industries. The magnitude of quality improvement is highest for SITC1=5 “Chemicals and related products”, where a 10 percent increase in distance will improve quality by 19 to 24 percent. The smallest quality improvement takes place in SITC1=3 “Mineral Fuel and Lubricant”. Glimpsing through different estimates of distance between CIF and FOB prices, we can see that the pure distance elasticity is rather small overall, ranging from 2 to 7 percent across all the industries.

Table 8h: SITC 1dig=8: Miscellaneous Manufactured Articles						
	CIF price			FOB price		
	IWW	IWW_OWW	UNIDO	IWW	IWW_OWW	UNIDO
ln(tariff)	-.368	-.517*	-.404	-.580**	-.624**	-.465*
	(.191)	(.178)	(.208)	(.172)	(.160)	(.186)
ln(dist)	.154**	.155**	.173**	.145**	.148**	(.162)**
	(.0129)	(.012)	(.014)	(.012)	(.011)	(.012)
ln(w)	.184	0.062	.203**	(-.056)	-0.112	0.235**
	(.094)	(.066)	(.076)	(.084)	(0.059)	(0.068)
Constant	-5.287**	-6.669**	-5.048**	-3.799**	-7.978**	-5.203**
	(1.183)	(1.145)	(1.160)	(1.064)	(1.029)	(1.037)
Observations	8924	9883	6883	8924	9883	6883
R-squared	0.8619	0.8843	0.8744	0.8818	0.9042	0.8945
Importer fixed effect	y	y	y	y	y	y
Exporter fixed effect	y	y	y	y	y	y
Sitc UV Fixed Effect	y	y	y	y	y	y
Standard errors in parentheses		* significant at 5%; ** significant at 1%				

Notes: UNIDO wage is the average monthly dollar wages and salaries coming from INDSTAT3 database 2005 edition; IWW is the industrial world wage rates constructed by us based on the ILO yearly manufacturing sectoral wage data; OWW is the occupational world wage rates constructed by Freeman and Oostendorp (2000) based on the "October Inquiry" Survey of ILO wages; IWW_OWW stands for the IWW supplemented by the OWW uniform weighting wage rates.

In summary, our results demonstrate that unit values of internationally traded products are positively associated with distance across countries and industries. TOT gains due to tariff protection also prove to be large and significant, supporting large country case. More interestingly, the evidence of "Washington apple effect" is large and robust to a number of sensitivity analyses: faraway countries increase their export price by quality upgrading, and this effect is far more important in raising the unit values than distance and production costs.

5.0 Conclusion

This paper has focused on the supply side factors of product price changes. We decompose the variation of product unit values into TOT gain, pure quality effect, pure distance effect, and production cost effect. We construct a comprehensive dataset that interacts commodity trade, distance, tariff rates and production labor costs across countries. Our hypotheses find strong support by the data. The statistical analysis finds three strong and robust empirical relationships explaining product price variations. The first is that raising tariff rates do lower export prices. Interestingly, this negative relation is especially significant when we restrict our data sample to large importers in the world, which provides strong support to the classical large importer tariff protection case. So for a large importing country, implementing a tariff protection may indeed raise national welfare. The second is that exporter labor costs are in general positively associated with export unit values, though not significant for all the cases. The third result is that exports to faraway countries will have significantly higher unit values than goods shipped to nearby countries. But most interestingly, the "Washington Apple effect" dominates the pure distance effect, i.e. the price increases are mainly driven by quality upgrading instead of the increase in transportation cost. As a conclusion, on the supply side, quality effect is the largest contributor to unit value increase, compared with distance effect and production cost. So how should an exporter increase export prices? Our empirical findings suggest that a firm should target small importers, faraway destinations, and most important of all, improve quality!

Much can be done for further research. There are many factors that can affect unit values and we only control for some of them. We can further control for the supply side factors such as common language, border, and trade agreements. Importer-demand condition can be added to further decompose the unit values, such as income level of import market, import price indices, importer trade balance, and macro indicators of comparative advantage. We can also utilize our full sample from 1964 to 2003 and attempt panel regressions. More interesting results on international studies will be generated based on this comprehensive dataset.

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Appendix

Table A1: Importer and Exporter Country Pairs for CIF and FOB prices

CIF price (using Importer Report)				FOB price (using Exporter Report)		
Importer (50)			Exporter (182)	Importer (103)		Exporter (58)
Algeria	Afghanistan	France,Monac	Norway	Albania	Kenya	Algeria
Argentina	Afr.Other NS	Gabon	Oman	Algeria	Korea Rep.	Argentina
Australia	Albania	Gambia	Oth.Oceania	Angola	Kuwait	Australia
Austria	Algeria	Georgia	Pakistan	Argentina	Kyrgyzstan	Austria
Belgium-Lux	Angola	Germany	Panama	Armenia	Latvia	Belgium-Lux
Brazil	Areas NES	Ghana	Papua N.Guin	Australia	Lithuania	Brazil
Bulgaria	Argentina	Gibraltar	Paraguay	Austria	Malawi	Bulgaria
Canada	Armenia	Greece	Peru	Azerbaijan	Malaysia	Canada
Chile	Asia NES	Greenland	Philippines	Bahamas	Malta	Chile
China	Asia West NS	Guatemala	Poland	Bangladesh	Mauritius	China
China HK SAR	Australia	Guinea	Portugal	Barbados	Mexico	China HK SAR
Colombia	Austria	GuineaBissau	Qatar	Belarus	Myanmar	Colombia
Czech Rep	Azerbaijan	Guyana	Rep Moldova	Belgium-Lux	Netherlands	Czech Rep
Denmark	Bahamas	Haiti	Romania	Bermuda	New Zealand	Denmark

Ecuador	Bahrain	Honduras	Russian Fed	Bolivia	Nicaragua	Dominican Rp
Finland	Bangladesh	Hungary	Rwanda	Brazil	Norway	Ecuador
France,Monac	Barbados	Iceland	Samoa	Bulgaria	Pakistan	Finland
Germany	Belarus	India	Saudi Arabia	Cambodia	Panama	France,Monac
Greece	Belgium-Lux	Indonesia	Senegal	Cameroon	Papua N.Guin	Germany
Hungary	Belize	Iran	Seychelles	Canada	Peru	Greece
India	Benin	Iraq	Sierra Leone	Cent.Afr.Rep	Philippines	Hungary
Indonesia	Bermuda	Ireland	Singapore	Chad	Poland	India
Ireland	Bolivia	Israel	Slovakia	Chile	Portugal	Indonesia
Israel	Bosnia Herzg	Italy	Slovenia	China	Rep Moldova	Ireland
Italy	Br.Antr.Terr	Jamaica	Somalia	China HK SAR	Sierra Leone	Israel
Japan	Brazil	Japan	South Africa	China MC SAR	Singapore	Italy
Kazakhstan	Bulgaria	Jordan	Spain	Colombia	Slovakia	Japan
Korea Rep.	Burkina Faso	Kazakhstan	Sri Lanka	Costa Rica	Slovenia	Kazakhstan
Kuwait	Burundi	Kenya	St.Helena	Cote Divoire	South Africa	Korea Rep.
Malaysia	Cambodia	Kiribati	St.Kt-Nev-An	Croatia	Spain	Kuwait
Mexico	Cameroon	Korea D P Rp	St.Pierre Mq	Cyprus	Sri Lanka	Malaysia
Netherlands	Canada	Korea Rep.	Sudan	Czech Rep	St.Kt-Nev-An	Mexico
New Zealand	Cent.Afr.Rep	Kuwait	Suriname	Denmark	Suriname	Morocco
Norway	Chad	Kyrgyzstan	Sweden	Djibouti	Sweden	Netherlands
Pakistan	Chile	Lao P.Dem.R	Switz.Liecht	Dominican Rp	Switz.Liecht	New Zealand
Peru	China	Latvia	Syria	Ecuador	Taiwan	Nigeria
Philippines	China HK SAR	Lebanon	TFYR Macedna	Egypt	Thailand	Norway
Poland	China MC SAR	Liberia	Taiwan	El Salvador	Trinidad Tbg	Oman
Portugal	Colombia	Libya	Tajikistan	Estonia	Turkey	Pakistan
Singapore	Congo	Lithuania	Tanzania	Ethiopia	UK	Peru
Slovakia	Costa Rica	Madagascar	Thailand	Fiji	USA	Philippines
Slovenia	Cote Divoire	Malawi	Togo	Finland	Ukraine	Poland
South Africa	Croatia	Malaysia	Trinidad Tbg	Fr Ind O	Uruguay	Portugal
Spain	Cuba	Mali	Tunisia	France,Monac	Zambia	Romania
Sweden	Cyprus	Malta	Turkey	Germany	Zimbabwe	Russian Fed
Switz.Liecht	Czech Rep	Mauritania	Turkmenistan	Greece		Saudi Arabia
Thailand	Dem.Rp.Congo	Mauritius	UK	Guyana	Russian Fed	Singapore
Turkey	Denmark	Mexico	US NES	Hungary	Saudi Arabia	Slovakia
UK	Djibouti	Mongolia	USA	Iceland	Singapore	Slovenia
USA	Dominican Rp	Morocco	Uganda	India	Slovakia	Spain
	Ecuador	Mozambique	Ukraine	Indonesia	Slovenia	Sweden
	Egypt	Myanmar	Untd Arab Em	Iran	Spain	Switz.Liecht
	El Salvador	Nepal	Uruguay	Ireland	Sweden	Thailand
	Eq.Guinea	Neth.Ant.Aru	Uzbekistan	Israel	Switz.Liecht	Tunisia
	Estonia	Netherlands	Venezuela	Italy	Thailand	Turkey

	Ethiopia	Neutral Zone	Viet Nam	Japan	Tunisia	UK
	Eur.Other NE	New Calednia	Yemen	Jordan	Turkey	USA
	Falkland Is	New Zealand	Yugoslavia	Kazakhstan	UK	Venezuela
	Fiji	Nicaragua	Zambia		USA	
	Finland	Niger	Zimbabwe		Venezuela	
	Fr Ind O	Nigeria				