Online Appendix for:
"Trade Liberalization, Quality, and Export Prices"

Haichao Fan* SUFE
Yao Amber Li† HKUST
Stephen R. Yeaple‡ PSU, NBER and CESifo

November 2014

A Data Description

The Chinese Customs Database covers the universe of all Chinese trade transactions, including import and export values, quantities, products, source and destination countries, custom's regime (e.g. "Processing and Assembling"and "Processing with Imported Materials"), type of enterprise (e.g. state owned, domestic private firms, foreign invested, and joint ventures), and contact information for the firm (e.g., company name, telephone, zip code, contact person). Note that the Chinese Customs data we use in this paper contain only realized transactions rather than the "reported" transactions from invoice records. Thus, we are not concerned about the possibility of fake invoicing.

We selected a subsample of firms from the Customs database that met several requirements. First, as our interest is the effect of tariff reduction on export quality, we excluded from our main analyses export processing firms. Second, we also exclude all intermediary firms from the customs data, following the similar method as in Ahn et al. (2011) and Tang and Zhang (2012).

The initial customs data at the HS 8-digit product level are aggregated to the HS 6-digit level so as to be able to concord it consistently over time because the concordance for HS 8-digit codes in China is not available to us. To ensure the consistency of the product categorization over time (2001-2006), we adopt HS 6-digit codes maintained by the World Customs Organization (WCO) and use the conversion table from the UN Comtrade to convert the HS 2002 codes into the HS 1996 codes. The trade data is then aggregated to firm-HS6 product-country-year.

*Fan: School of International Business Administration, Shanghai University of Finance and Economics. Email: fan.haichao@mail.shufe.edu.cn. URL: http://fanhaichao.weebly.com. Tel: (86)21-65907041.

†Li: Department of Economics and Faculty Associate of the Institute for Emerging Market Studies (IEMS), Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong SAR-PRC. Email: yaoli@ust.hk. URL: ihome.ust.hk/∼yaoli. Tel: (852)23587605; Fax: (852)2358 2084. Research Affiliate of the China Research and Policy Group at University of Western Ontario.

‡Yeaple: Corresponding author. Department of Economics, Pennsylvania State University. Email: sry3@psu.edu. Research Associate at National Bureau of Economic Research and Research Affiliate at Ifo Institute.

The process of our sample construction can be summarized by five steps:

1. We organize the export data from the Chinese Customs Database by the following procedure:

   1.1 We delete all trade intermediaries from exporting firms. Similar to Ahn et al. (2011) and Tang and Zhang (2012), we identify trade intermediaries by finding the presence of phrases (such as "trading", "exporting", and "importing") in their company names.[1] We further drop all exports under processing trade regime and only keep ordinary trade in our sample.[2]

   1.2 We drop all observations with no destination information or destination country reported as PRC China. We further drop all observations with zero or missing quantity or value.

   1.3 We use the conversion table from the UN Comtrade to convert the HS 2002 codes into the HS 1996 codes at HS 6-digit level. Then we aggregate the export value and export quantity for each product at either HS6 or HS6-destination.

   1.4 We deflate the export value using output deflators from Brandt et al. (2012).[3] Note that the deflators in Brandt et al. (2012) are by 4-digit CIC industry in China, while there is no information about CIC industry code in the Customs Data. Therefore, we use the concordance between the Input-Output (I-O) sectors and the HS codes and the concordance between the I-O sectors and the CIC industries by the NBSC to merge each HS code with a CIC industry. Eventually, we are able to compute the deflated value at HS6 level.

   1.5 We estimate product quality and quality-adjusted price by following Khandelwal et al. (forthcoming). See Section 5.1.2 for details.

   1.6 We merge the above sample with Rauch's product classification (Rauch, 1999) to divide sample into differentiated goods and homogeneous goods.

2. We organize the import data from the Chinese Customs Database by the following procedure:

   2.1-2.3 are similar with 1.1-1.3.

   2.4 We deflate the import value using input deflators from Brandt et al. (2012). The process is similar to Step 1.4.

   2.5 We merge import data with import tariff at HS6 level and compute different measures of the effective import tariff reduction faced by each firm. See Section 5.2 for more details of each tariff measure.

3. We merge the export data (based on Step 1) and the import data (based on Step 2) together to obtain a large sample based on the Customs Database solely. This sample serves as the basis for the robustness check when we use the whole customs data.

[1] As company names in the Customs Database are written in Chinese, we search for "mao yi", "wai mao", "wai jing", "jin chu kou", "jing mao", "gong mao", and "ke mao" in firm names.

[2] Move 1.1 after 1.5 does not alter our estimation results.

[3] The deflator data are downloaded from http://www.econ.kuleuven.be/public/N07057/China/.

4. To obtain firm-level characteristics and industry-level competition control, we merge the above sample based on customs data with the NBSC manufacturing firm survey data. Our matching procedure is done in three steps: (1) by company name, (2) by telephone number and zip code, and (3) by telephone number and contact person name together (see detailed description of the matching process in Fan et al., 2012).

   Compared with all the exporting and importing firms under the ordinary trade regime reported by the Customs Database, the matching rate of our sample (in terms of the number of firms) covers 45.3% of exporters and 40.2% of importers, corresponding to 52.4% of total export value and 42% of total import value reported by the Customs Database. Compared with the manufacturing exporting firms in the NBSC Database, the matching rate of our sample (in terms of the number of firms) varies from 54% to 63% between 2001 and 2006, which covers more than 60% of total value of firm exports in the manufacturing sector reported by the NBSC Database. We cannot compare our sample with the NBSC Database regarding the number of importers and total import value because the NBSC Database does not contain any information on firms' imports. To explore whether the reduction in the sample due to the merging of the databases is an issue, we compare the relationship between export prices and quality and import tariffs in the full sample of the Customs Database to the smaller merged sample and find no significant differences..

5. We further delete some unsatisfactory observations and outliers according to the following criteria in Cai and Liu (2009) and the General Accepted Accounting Principles, due to mis-reporting by some firms in the NBSC database: (i) the total assets must be higher than the liquid assets; (ii) the total assets must be larger than the total fixed assets; (iii) the total assets must be larger than the net value of the fixed assets; (iv) a firm's identification number cannot be missing and must be unique; and (v) the established time must be valid.

B Measures of Quality Differentiation

- **Rauch's (1999) homogeneous-good dummy**. Source: Rauch (1999).
  At the 4-digit SITC Revision 2 level, Rauch (1999) categorizes industries into three categories: (1) "homogeneous" goods that are mainly traded on organized exchanges; (2) "reference-priced" goods; (3) goods that neither have reference prices nor are traded on organized exchanges. The dummy variable $HOMOGENEOUS$ equals one if the product falls into category (1) or (2) and zero otherwise. We concord the data into HS 6-digit level (2002 version) from SITC Rev.2. The concordance table is from the United Nations Statistics Division.

- **Gallop-Monahan Index** (based on US firms). Source: Kugler and Verhoogen (2012).

The index is defined as follows:

$$GM_k = \sum_{j,k,t} w_{jt} \left(\sum_i \frac{|s_{ijkt} - \bar{s}_{ikt}|}{2} \right)^{1/2}$$

where i, j, k, and t stand for inputs, plants, industries and years; s_{ijkt} is the expenditure share on input i of plant j in industry k in year t; $\bar{s}_{ikt}$ is the average expenditure share on input i by all plants in industry k in year t; w_{jt} is the share of revenues of plant j in year t in total revenues of all plants in all years in industry k. The term inside the brackets measures how dissimilar input mix of plant j is from other plants in its industry in the corresponding year. The measure then averages those plant-specific measures over plants and years, using revenues as weights. We adopt this measure already constructed by Kugler and Verhoogen (2012) since we do not have complete information on input mix at the firm level in our Chinese data. Their method is building upon Bernard and Jensen (2007). Their original data are available at the ISIC Rev.2. 4-digit level, and we concord to HS6 using the concordance from the UN Comtrade.

C Measurement of Productivity

Our TFP measure is based on the augmented Olley-Pakes (hereafter OP) method (Olley and Pakes, 1996).[4] The augmentation takes into account a number of additional firm level decisions. For instance, we allow a firm's trade status in the TFP realization, as in Amiti and Konings (2007), by including two trade-status dummy variables-an export dummy (equal to one for exports and zero otherwise) and an import dummy (equal to one for imports and zero otherwise). Finally, we include a WTO dummy (i.e., one for a year since 2002 and zero for before) in the Olley-Pakes estimation as the accession to WTO represents a positive demand shock for China's exports. We use value-added to measure production output, and deflate firms' inputs (e.g., capital) and value added, using the input price deflators and output price deflators from Brandt et al. (2012).[5] Then we construct the real investment variable by adopting the perpetual inventory method to investigate the law of motion for real capital and real investment. To measure the depreciation rate, we use each firm's real depreciation rate provided by the NBSC firm-production database.

[4]Our results are robust to different approaches in estimating TFP, including the OLS method, the Levinsohn-Petrin method (Levinsohn and Petrin, 2003), and the Ackerberg-Caves-Frazer augmented O-P and L-P methods (Ackerberg et al., 2006). These results are available upon request.

[5]The output deflators are constructed using "reference price"information from China's Statistical Yearbooks, and the input deflators are constructed based on output deflators and China's national input-output table (2002). The data can be accessed via http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/.

D More Figures and Tables

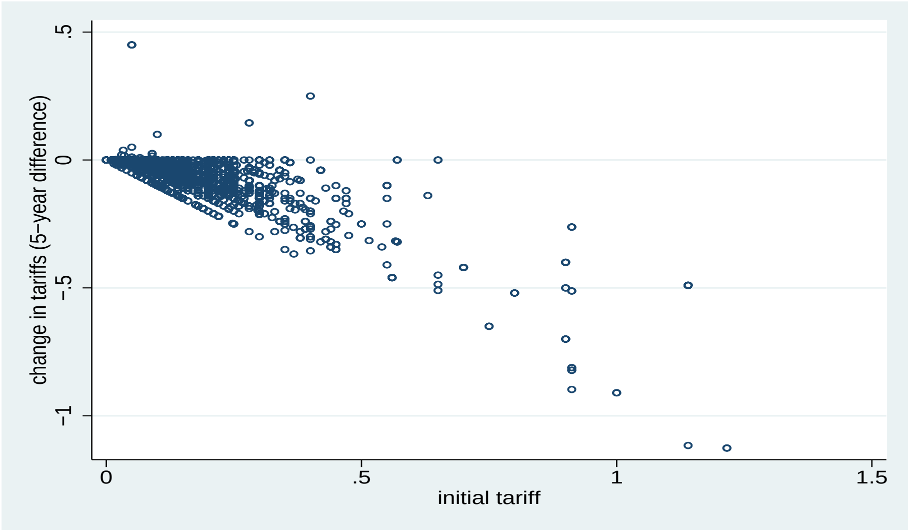

Figure A.1: Change in Tariffs for HS6 Products, 2001-2006, Relative to Initial Levels
Note: Some products experienced an increase in their tariff over the sample period.

Table A.1: Change in Export Prices year by year: Differentiated vs. Homogeneous Products

	(1) Whole Sample	(2) Differentiated Goods	(3) Homogeneous Goods
	Panel A: 1-year difference		
Change in Export Prices (HS6):			
Per Firm-product, median	0.94%	1.31%	-0.46%
Per Firm-product, mean	2.64%	2.91%	0.89%
Change in Export Prices (HS6-country):			
Per Firm-product-country, median	0.24%	0.55%	-1.10%
Per Firm-product-country, mean	1.93%	2.22%	-0.34%
	Panel B: 2-year difference		
Change in Export Prices (HS6):			
Per Firm-product, median	3.58%	4.41%	-0.44%
Per Firm-product, mean	5.98%	6.70%	1.20%
Change in Export Prices (HS6-country):			
Per Firm-product-country, median	2.11%	2.74%	-1.54%
Per Firm-product-country, mean	4.65%	5.25%	-0.04%
	Panel C: 3-year difference		
Change in Export Prices (HS6):			
Per Firm-product, median	6.41%	7.61%	-0.44%
Per Firm-product, mean	9.50%	10.58%	2.38%
Change in Export Prices (HS6-country):			
Per Firm-product-country, median	4.62%	5.68%	-1.93%
Per Firm-product-country, mean	7.95%	8.84%	1.11%
	Panel D: 4-year difference		
Change in Export Prices (HS6):			
Per Firm-product, median	9.74%	11.18%	0.12%
Per Firm-product, mean	12.60%	14.18%	2.10%
Change in Export Prices (HS6-country):			
Per Firm-product-country, median	6.82%	8.27%	-1.97%
Per Firm-product-country, mean	10.26%	11.64%	-0.58%
	Panel E: 5-year difference		
Change in Export Prices (HS6):			
Per Firm-product, median	11.80%	14.10%	-1.19%
Per Firm-product, mean	15.72%	17.35%	3.43%
Change in Export Prices (HS6-country):			
Per Firm-product-country, median	9.14%	10.36%	-0.02%
Per Firm-product-country, mean	13.30%	14.68%	0.90%

Table A.2: Results with Different-period Difference

	Dependent Variable					
	$\Delta\ln(ExportPrice)_{fhct}$			$\Delta\ln(ExportPrice)_{fht}$		
	(1)	(2)	(3)	(4)	(5)	(6)
In 2 period difference: $\Delta Duty_{t-(t-2)}$	-0.180*			-0.255*		
	(0.108)			(0.137)		
In 3 period difference: $\Delta Duty_{t-(t-3)}$		-0.196*			-0.397**	
		(0.119)			(0.173)	
In 4 period difference: $\Delta Duty_{t-(t-4)}$			-0.271**			-0.468**
			(0.153)			(0.200)
Year fixed effects	yes	yes	yes	yes	yes	yes
Industry-level Competition Control	yes	yes	yes	yes	yes	yes
Firm-level Controls	yes	yes	yes	yes	yes	yes
Observations	158,616	79,777	37,427	69,040	37,203	18,483
R-squared	0.002	0.002	0.001	0.001	0.002	0.001

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year of the difference period at the 4-digit CIC industry in China. Firm-level controls include the changes in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment).

Table A.3: Baseline Regressions with Only $\Delta\ln(TFP)$ as Firm Control

	Dependent Variable: Δprice			Dependent Variable: $\Delta\ln(\hat{q}_{fhc})$		
	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta\ln(p_{fhc})$	$\Delta\ln(p_{fh})$	$\Delta(p_f)$	σ=5	σ=10	$\sigma = \sigma_i$
ΔDuty	-0.487**	-0.669**	-0.638**	-3.133**	-6.419***	-3.370***
	(0.218)	(0.282)	(0.302)	(1.233)	(2.283)	(1.040)
$\Delta\ln$(TFP)	0.0448***	0.0449***	0.0507***	0.314***	0.526***	0.243***
	(0.011)	(0.016)	(0.017)	(0.062)	(0.116)	(0.055)
Observations	14439	7595	2368	14439	14439	14439
R-squared	.003	.003	.006	.005	.004	.005

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term.

Table A.4: Effect of Tariff Reductions on Quality Upgrading with Bootstrapped Standard Errors

	Dependent Variable: $\Delta \ln(\hat{q}_{fhc})$					
	$\sigma = 5$		$\sigma = 10$		$\sigma = \sigma_i$ Broda and Weinstein (2006)	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔDuty	-3.093**	-3.125**	-6.351***	-6.623***	-3.339***	-3.304***
	(1.262)	(1.253)	(2.331)	(2.340)	(1.063)	(1.054)
Δln(TFP)		0.301***		0.496***		0.236***
		(0.063)		(0.118)		(0.056)
Δln(Capital/Labor)		0.159*		0.230		0.0948
		(0.088)		(0.160)		(0.071)
Δln(Labor)		0.263***		0.210		0.278***
		(0.092)		(0.163)		(0.091)
Δln(Wage)		0.150		0.251		0.110
		(0.111)		(0.209)		(0.090)
Δln(Import Varieties)		0.118*		0.181		0.118**
		(0.064)		(0.125)		(0.051)
HHI		-1.690		-4.386		-1.227
		(1.501)		(2.903)		(1.209)
Observations	14439	14439	14439	14439	14439	14439
R-squared	.001	.007	.001	.006	.002	.008

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Bootstrapped standard errors are in parentheses. All regressions include a constant term. Herfindahl index (HHI) is computed in the initial year (2001) at the 4-digit CIC industry in China.

Table A.5: Effect of Tariff Reductions on Export Prices and Quality with Industry Fixed Effects

	Dependent Variable							
	$\Delta\ln(\text{Price}_{fhc})$		$\Delta\ln(\text{Quality}_{fhc})$		$\Delta\ln(\text{Price}_{fh})$		$\Delta\text{Price Index}_f$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDuty	-0.467**	-0.531**	-6.602**	-6.997***	-0.666**	-0.728***	-0.701**	-0.694**
	(0.223)	(0.229)	(2.656)	(2.684)	(0.275)	(0.279)	(0.312)	(0.317)
Δln(TFP)		0.035***		0.320**		0.034**		0.043**
		(0.012)		(0.133)		(0.016)		(0.017)
Δln(Capital/Labor)		0.024		0.173		0.037		0.002
		(0.016)		(0.166)		(0.024)		(0.022)
Δln(Labor)		0.003		0.223		0.017		-0.006
		(0.017)		(0.175)		(0.025)		(0.027)
Δln(Wage)		0.016		0.073		0.029		0.045*
		(0.020)		(0.215)		(0.024)		(0.025)
Δln(Import Varieties)		0.005		0.151		0.013		0.004
		(0.013)		(0.135)		(0.015)		(0.018)
HHI		-0.548*		-5.517*		-0.699*		-0.159
		(0.284)		(3.157)		(0.390)		(0.274)
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	14439	14439	14439	14439	7595	7595	2368	2368
R-squared	.013	.016	.012	.014	.015	.018	.026	.031

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term. Herfindahl index (HHI) is computed in the initial year (2001) at the 4-digit CIC industry in China. Quality estimates are based on elasticities of substitution from Broda and Weinstein (2006).

Table A.6: Effect of Tariff Reductions on the Change in Quality-Adjusted Prices

	Dependent Variable: the change in effective quality-adjusted price $\Delta \ln(\widetilde{p}_{fhct}) \equiv \Delta [\ln(p_{fhct}) - \ln(\hat{q}_{fhct})]$					
	$\sigma = 5$		$\sigma = 10$		$\sigma = \sigma_i$	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔDuty	2.611**	2.608**	5.870***	6.106***	2.858***	2.787***
	(1.086)	(1.075)	(2.128)	(2.136)	(0.926)	(0.912)
Δln(TFP)		-0.260***		-0.454***		-0.194***
		(0.054)		(0.107)		(0.049)
Δln(Capital/Labor)		-0.136*		-0.208		-0.0720
		(0.075)		(0.145)		(0.061)
Δln(Labor)		-0.261***		-0.208		-0.276***
		(0.081)		(0.148)		(0.085)
Δln(Wage)		-0.131		-0.232		-0.0906
		(0.094)		(0.189)		(0.078)
Δln(Import Varieties)		-0.106**		-0.169		-0.106**
		(0.053)		(0.112)		(0.044)
HHI		1.249		3.945		0.785
		(1.234)		(2.607)		(0.992)
Observations	14439	14439	14439	14439	14439	14439
R-squared	.001	.008	.001	.006	.001	.008

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term. Herfindahl index (HHI) is computed in the initial year (2001) at the 4-digit CIC industry in China.

E Supplementary Discussions

E.1 Estimating Quality Using IV Estimation

To avoid parameterizing σ_i based on the values given in the existing literature, we also estimate quality using IV estimation. The method is as follows.

We first estimate σ_i sector by sector using Chinese data by transforming equation (14) to the following:

$$\ln(x_{fhct}) = -\sigma_{i_{(h)}} \ln(p_{fhct}) + \varphi_h + \varphi_{ct} + \epsilon_{fhct} \tag{1}$$

where $i_{(.)}$ refers to the industry that product h belongs to; $\sigma_{i_{(h)}}$, industry-specific elasticity of substitution, can be estimated by regressing export quantity $\ln(x_{fhct})$ on unit value price $\ln(p_{fhct})$, product fixed effects, and country-year fixed effects for each industry i. Since ϵ_{fhct} is potentially correlated with the product price $\ln(p_{fhct})$, instrumental variable estimation is needed to identify the parameters. We use local average wages as instruments for prices in the first stage of instrumental variable estimation of equation (1). The local average wage is computed as average wage per worker across all firms producing at the same location in China, which mainly captures common cost shocks at supply side.[6] Although the local wages obviously affect production costs of firms and, therefore, product prices, one

[6] We use average local wage in each province.

may be concerned that local wages may be correlated with product quality, if, for example, higher-wage workers produce better products. However, the exclusion restrictions remain valid as long as local wages do not affect *deviations* from average quality.[7] In other words, if a firm chooses to export higher quality products to a destination market because of shocks to local wages (which is less likely), the instruments remain valid as long as shocks to local average wages do not affect deviations from the firm's average quality choice. Hence, we are not concerned about the potential correlation between local average wages and quality. The instrumental variable estimations are conducted industry by industry. Here we define industry i by 2-digit HS2 sector. There are in total 91 HS2 industries, after dropping one industry with less than 10 observations.

Next, as in the approach described in Section 5.1.2 (Quality Equation) in the main text, we use an estimate of the residual $\hat{\epsilon}_{fhct}$ from equation (1) to infer quality and then to infer quality-adjusted price. We report estimation results when regressing quality and quality-adjusted price on tariff reductions based on σ_i recovered from Chinese data in Table A.7. All results here are consistent with the results reported in the main text, i.e. a reduction in import tariff induces an incumbent importer/exporter to raise the quality of its exports but to lower its quality-adjusted prices.

Table A.7: Changes in Quality and Quality-Adjusted Prices vs. Tariff Reductions

(Based on σ_i Recovered from Chinese Data)

	Dependent Variables					
	changes in quality $\Delta \ln(\hat{q}_{fhc})$			changes in quality-adjusted price $\Delta \ln(\widetilde{p}_{fhc})$		
	(1)	(2)	(3)	(4)	(5)	(6)
ΔDuty	-2.747**	-2.756**	-2.531**	2.082*	2.089*	1.833
	(1.253)	(1.239)	(1.243)	(1.166)	(1.159)	(1.161)
Firm-level controls	no	yes	yes	no	yes	yes
Industry-level competition control	no	no	yes	no	no	yes
Observations	12083	12083	12083	12083	12083	12083
R-squared	.001	.003	.005	.001	.002	.004

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year (2001) at the 4-digit CIC industry in China. Firm-level controls include the changes between 2001 and 2006 in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment). The number of observations in this table is smaller than that in Tables 5 and A.6 because we dropped a few sectors due to the estimated σ_i for those sectors were out of range when we estimated σ_i using Chinese data. The deleted observations in this process account for only 4.2% of the original sample.

[7] Here, our argument about the validity of instruments shares the similar spirit of Khandelwal (2010).

E.2 Effect of Tariff Reductions for Growing and Shrinking Product and Product-Country

We further present regression results for the effect of tariff reduction for growing and shrinking product or product-country categories in Table A.8. Panels A and B in Table A.8 report the change in price and quality, respectively, as the dependent variable, for growing and shrinking using all goods (see columns 1 and 2), differentiate goods (see columns 3 and 4), and homogeneous goods (see columns 5 and 6). For example, in column 1 we use the subsample of growing type only and regress the change in price on tariff reduction. The coefficients on tariff reduction for growing type are always significantly negative for all goods and differentiated goods (see columns 1 and 3), and the coefficients for shrinking type are also negative but less significant (see columns 2 and 4). The effect for homogeneous goods is less significant and sometimes ambiguous (see columns 5 and 6). This is consistent with Propositions 1 and 2 in our model.

Panel C of Table A.8 reports the results at the firm-product level. The effects of tariff reduction on the price change for continuing products (either growing or shrinking) are all significantly negative in the sample of all goods (see columns 1 and 2) and differentiated goods (see columns 3 and 4), indicating that firms improve quality and thus increase price for their continuing products, including both growing products and shrinking products. It is also worth noting that the effect of tariff reduction on shrinking type at fhc level in panel A is insignificant while becomes significant at fh level in panel C. This is due to a modest compositional effect: firms may redirect their exports to countries where higher prices can be charged for a continuing product, even though the total export sales for that product may be shrinking. This is also consistent with our previous discussion of the baseline results that the estimated effects of tariff reductions tend to be larger in the more aggregated measures of export prices (see Table 4). Lastly, in panel C the effect of tariff reduction on price change for homogeneous goods is, again, positive or less significant (see columns 5 and 6). This further corroborates our previous discussion of the role of quality differentiation.

Table A.8: Effect of Tariff Reductions for Different Types at Firm-Product-Country or Firm-Product Level

	all goods		differentiate goods		homogeneous goods	
	(1)	(2)	(3)	(4)	(5)	(6)
sample	growing	shrinking	growing	shrinking	growing	shrinking
Panel A: dependent variable $= \Delta \ln(p_{fhc})$						
ΔDuty	-0.669***	-0.390	-0.816***	-0.486	1.046*	-0.0492
	(0.259)	(0.329)	(0.278)	(0.386)	(0.633)	(0.425)
Observations	8807	5632	7823	4982	984	650
R-squared	.005	.007	.005	.007	.009	.020
Panel B: dependent variable $= \Delta \ln(\hat{q}_{fhc})$						
ΔDuty	-5.950***	-1.436	-6.706***	-2.383*	0.966	2.274
	(1.146)	(1.278)	(1.278)	(1.407)	(2.738)	(2.489)
Observations	8807	5632	7823	4982	984	650
R-squared	.009	.010	.009	.012	.018	.026
Panel C: dependent variable $= \Delta \ln(p_{fh})$						
ΔDuty	-0.760**	-0.792*	-1.055***	-1.146**	1.660**	-0.002
	(0.316)	(0.429)	(0.342)	(0.555)	(0.756)	(0.419)
Observations	4846	2749	4237	2383	609	366
R-squared	.004	.016	.005	.019	.011	.030
Panels A, B and C:						
Firm-level Controls	yes	yes	yes	yes	yes	yes
Industry-level Competition Control	yes	yes	yes	yes	yes	yes

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term, firm-level controls, and industry-level competition control. Industry-level competition control refers to Herfindahl index (HHI), which is computed in the initial year (2001) at the 4-digit CIC industry in China. Firm-level controls include the changes between 2001 and 2006 in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment). Quality estimates are based on elasticities of substitution from Broda and Weinstein (2006).

E.3 Level Regressions with Industry Tariffs

To provide more evidence on the relationship between tariffs and export prices, we also conduct the baseline regression in levels with industry input/output tariffs in Table A.9.[8] Columns 1-3 and 4-6 present the results with export prices for HS6-country product and HS6 product, respectively. In separate regressions, the coefficients on output tariffs and on input tariffs are both significantly negative (see columns 1-2 and 4-5); in combined regressions, the effect of input tariffs are still significantly negative (see columns 3 and 6). This further provides evidence on the negative relationship between the levels of export prices and the levels of input tariffs, i.e., higher export prices are also associated with lower input tariffs.

Table A.9: Regressions in Levels with Industry Input/Output Tariffs

	Industry Input/Output Tariff					
	Dependent variable: $\ln(p_{fhct})$			Dependent variable: $\ln(p_{fht})$		
	(1)	(2)	(3)	(4)	(5)	(6)
$Duty^{output}$	-0.409***		0.344***	-0.738***		0.0457
	(0.087)		(0.115)	(0.145)		(0.196)
$Duty^{input}$		-1.457***	-1.814***		-1.633***	-1.678***
		(0.137)	(0.182)		(0.209)	(0.283)
Year fixed effects	yes	yes	yes	yes	yes	yes
Firm-product-country fixed effects	yes	yes	yes			
Firm-product fixed effects				yes	yes	yes
Industry-level Competition Control	yes	yes	yes	yes	yes	yes
Firm-level Controls	yes	yes	yes	yes	yes	yes
Observations	1161028	1161028	1161028	420034	420034	420034
R-squared	.981	.981	.981	.969	.969	.969

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI) at the 4-digit CIC industry in China. Firm-level controls include TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment).

E.4 Instrumental Variable Estimation

Now, we address the issue of the potential endogeneity of tariff changes. It is common in literature to use the past levels of tariffs as instruments for changes in tariffs (e.g., Goldberg and Pavcnik, 2005; Amiti and Konings, 2007). The idea is that the past tariffs are usually strongly correlated with the current changes in tariffs, but the past tariffs are uncorrelated with the error term or any other determinants of the dependent variable in the baseline regressions (i.e., the exclusion restriction). Therefore, we also employ past levels of tariffs as instruments and report the results in Table A.10. In specifications 1 and 2, we employ the 1997 tariff level as the fixed past level to instrument the change

[8]We present the level regressions with industry- instead of firm-specific tariffs because we do not have theoretical justification of firm-specific tariffs in levels. Our theoretically derived firm-specific measures refer to tariff reductions at the firm level.

in tariffs between 2001 and 2006; in specifications 3 and 4, we use the initial level to instrument the change, i.e., we use the 2001 tariff level to instrument $\Delta Duty_{2001-2006}$. Again, we report results for both firm-product-country prices in Panel A and firm-product prices in Panel B.

Table A.10: Instrumental Variable Estimation

	instrumented by $Duty_{1997}$		instrumented by $Duty_{2001}$	
	(1)	(2)	(3)	(4)
Panel A: dependent variable $= \Delta \ln(p_{fhc})$				
ΔDuty	-1.339***	-1.542***	-1.000***	-1.237***
	(0.405)	(0.402)	(0.299)	(0.306)
ΔDuty $\times HOMOGENEOUS$		2.066***		1.941***
		(0.381)		(0.356)
Industry-level Competition Control	yes	yes	yes	yes
Firm-level Controls	yes	yes	yes	yes
Kleibergen-Paap rk LM $\chi^2(1)$ statistic	107.266†	111.730†	33.513†	33.977†
Weak Instrument (F statistic)	239.197†	124.807†	317.716†	150.973†
Observations	14439	14439	14439	14439
R-squared	.002	.004	.003	.005
Prob > F	.000	.000	.000	.000
Panel B: dependent variable $= \Delta \ln(p_{fh})$				
ΔDuty	-1.539***	-1.821***	-1.026***	-1.383***
	(0.509)	(0.498)	(0.381)	(0.375)
ΔDuty $\times HOMOGENEOUS$		2.246***		2.108***
		(0.457)		(0.419)
Industry-level Competition Control	yes	yes	yes	yes
Firm-level Controls	yes	yes	yes	yes
Kleibergen-Paap rk LM $\chi^2(1)$ statistic	94.272†	99.725†	35.359†	39.634†
Weak Instrument (F statistic)	200.338†	110.314†	630.419†	382.221†
Observations	7595	7595	7595	7595
R-squared	.004	.006	.005	.007
Prob > F	.001	.000	.002	.000

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. † indicates significance at the 0.01 percent level (p-value < 0.0001). Robust standard errors corrected for clustering at the firm level in parentheses. The dummy variable $HOMOGENEOUS$ is equal to 1 for homogeneous goods and 0 other wise. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year (2001) at the 4-digit CIC industry in China. Using ΔHHI as industry-level competition control does not alter the main results. Firm-level controls include the changes between 2001 and 2006 in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment).

We conduct two tests to verify the quality of the instruments. The first diagnostic statistic for assessing the strength of identification is based on a Langrange-Multiplier (LM) test for underidentification using the Kleibergen and Paap (2006) rk statistic, because in our econometric model, the error term is assumed to be heteroskedastic and thus the usual canonical correlation likelihood ratio test (Anderson, 1984) is invalid.[9] The Kleibergen and Paap (2006) rk statistic is to test whether an instrument is relevant to an endogenous variable (i.e., the change in tariffs). The null hypothesis that

[9] In all of the specifications, the Cragg-Donald F statistic is also well above the critical values listed in Stock and Yogo (2005). However, we do not report them since critical values are for i.i.d. errors while in our econometric model the error term is assumed to be heteroskedastic.

the model is underidentified is rejected at the 0.1 percent significance level. The second diagnostic test we perform is the Kleibergen and Paap (2006) Wald statistic to check whether the instrument is weakly correlated with the endogenous variable. The Kleibergen and Paap (2006) Wald F-statistics provide strong evidence to reject the null hypothesis that the first stage is weakly identified at a highly significant level. That is to say, in all specifications, the instruments provide a good fit in the first stage, and perform as valid instruments.

Table A.10 clearly illustrates that in all specifications, the coefficients on the interaction terms (ΔDuty $\times$ $HOMOGENEOUS$) are significantly positive, and the coefficients on tariff change are all significantly negative, at 1 percent significance level. This is consistent with the main predictions of our model that tariff reductions lead to higher export prices while this effect increases in product differentiation and thus, the goods with small scope for quality differentiation have a smaller increase, or even a reduction, in their export prices.

The fact that coefficients in the IV regressions are considerably larger than the OLS coefficients could have multiple explanations. On the one hand, this could simply be an issue of measurement error as relating tariff reductions to marginal costs of individual products within the firm is by necessity indirect. On the other hand, it could be that the firms that faced the highest average tariffs on their imported intermediates were those with the greatest potential for increasing their product quality once tariffs came down.

E.5 Markup Adjustments and Market Shares

According to Melitz and Ottaviano (2008) and Amiti et al. (forthcoming), in markets where the firm has a small market share, it has a small markup and so it is hard for the firm to adjust its markup in those markets. The change in prices in those markets is mainly driven by the change in marginal costs. Therefore, we rank all firms based on their market share in each destination market and keep the firms with small market shares by picking up the bottom 10, 30, and 50 percentiles. This exercise would alleviate the concern that our results reflect markup variation rather than quality adjustments. The price and quality estimation results are reported in Table A.11. All coefficients on tariff reduction are significantly negative, and the interaction term with homogeneous goods are always significantly positive. Further note the stability of the coefficients across different samples, suggesting that potential market power plays a relatively unimportant role in export markets.

E.6 Other Potential Mechanisms

Prior to its accession to the WTO, China was vulnerable to the sudden loss of MFN status in its trade relations with the United States, where such status required annual congressional action to maintain. Pierce and Schott (2013) have shown that this vulnerability depressed Chinese exports to the U.S., particularly in industries where non-MFN tariffs were very high. To remove the potential for

Table A.11: Results for Firms with Small Market Shares

	≤10 percentile		≤30 percentile		≤50 percentile	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: dependent variable = $\Delta\ln(p_{fhc})$						
ΔDuty	-0.580**	-0.725***	-0.657***	-0.798***	-0.597**	-0.732***
	(0.241)	(0.246)	(0.239)	(0.243)	(0.232)	(0.234)
ΔDuty × *HOMOGENEOUS*		1.574***		1.620***		1.601***
		(0.393)		(0.380)		(0.365)
Observations	9394	9394	10126	10126	11029	11029
R-squared	.005	.007	.005	.007	.005	.006
Panel B: dependent variable = $\Delta\ln(\hat{q}_{fhc})$						
ΔDuty	-4.368***	-4.968***	-4.718***	-5.326***	-4.240***	-4.830***
	(1.183)	(1.260)	(1.185)	(1.252)	(1.112)	(1.159)
ΔDuty × *HOMOGENEOUS*		6.520***		6.947***		7.023***
		(2.218)		(2.167)		(2.061)
Observations	9394	9394	10126	10126	11029	11029
R-squared	.007	.008	.008	.009	.008	.010
Panels A and B:						
Firm-level Controls	yes	yes	yes	yes	yes	yes
Industry-level Competition Control	yes	yes	yes	yes	yes	yes

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term, firm-level controls, and industry-level competition control. Firm-level controls include the changes between 2001 and 2006 in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment). Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year (2001) at the 4-digit CIC industry in China. Using ΔHHI as industry-level competition control does not alter the main results. Quality estimates are based on elasticities of substitution from Broda and Weinstein (2006).

this mechanism to drive our results, we remove the U.S. from our sample and reestimated our main equations. The resulting estimates are shown in columns 1 and 2 for firm-product-country level price change and columns 5 and 6 for firm-product level price change in Table A.12. All coefficients on tariff reductions are virtually unchanged.

Also note that our export price is denominated in US dollars. One may be concerned that the price increase is partially due to the appreciation of *Renminbi* (Chinese currency, hereafter RMB). It is possible that a stronger RMB reduces firms' costs to purchase imported inputs with local currency, and thus provides firms more incentive to switch to better inputs.

To test the sensitivity of our results to RMB appreciation, we use the data during the period before the appreciation to test whether export prices indeed increase without currency appreciation. As the RMB appreciated in late 2005, we dropped data of 2005 and 2006, and conduct the long-difference estimation for the period between 2001 and 2004 in columns 3 and 4 for $\Delta\ln p_{fhc}$ and columns 7 and 8 for $\Delta\ln p_{fh}$ in Table A.12, respectively. At firm-product level, all coefficients on $\Delta Duty$ are significantly negative at the (at least) 5 percent level. At firm-product-country level, the effect of tariff reduction is less significant, but remains its negative signs. The insignificance at firm-product-country level is perhaps due to two reasons: First, the difference estimation for currency appreciation

Table A.12: Sensitivity to Other Potential Mechanisms

	Dependent Variable=Δ ln(Export Price$_{fhc}$)				Dependent Variable=Δ ln(Export Price$_{fh}$)			
	policy uncertainty		RMB appreciation		policy uncertainty		RMB appreciation	
Regressor:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta Duty$	-0.487**	-0.658***	-0.114	-0.157	-0.689**	-1.004***	-0.422**	-0.511***
	(0.235)	(0.246)	(0.118)	(0.124)	(0.285)	(0.298)	(0.179)	(0.192)
$\Delta Duty \times HOMOGENEOUS$		1.308***		0.483*		1.841***		0.660**
		(0.326)		(0.279)		(0.395)		(0.293)
Industry-level Competition Control	yes	yes	yes	yes	yes	yes	yes	yes
Firm-level Controls	yes	yes	yes	yes	yes	yes	yes	yes
Observations	12911	12911	18809	18809	6883	6883	9253	9253
R-squared	.006	.006	.001	.001	.005	.007	.001	.001

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. The dummy variable $HOMOGENEOUS$ is equal to 1 for homogeneous goods and 0 other wise. All regressions include a constant term, firm-level controls, and industry-level competition controls. Firm-level controls include the changes between 2001 and 2006 in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment). Industry-level competition control refers to Herfindahl index (HHI), which is computed in the initial year (2001) at the 4-digit CIC industry in China. Using ΔHHI as industry-level competition control does not alter the main results.

is based on a 3-year difference which is shorter than our main estimation period (5-year difference) and thus the quality adjustment may not be sufficient. Second, a compositional effect may play a role here such that the effect of tariff reduction at more aggregated levels is more significant, which is also consistent with our previous discussion of a modest compositional effect in the baseline results in Table 4. The coefficients on the interaction term are also significantly positive, consistent with previous discussion. Last, but not least, the RMB appreciation should presumably affect both differentiated and homogeneous goods in the same way. Thus, the fact that there is a differential response suggests that the rise of prices could not be driven by the RMB appreciation. All these tests confirm that export prices indeed increase even without currency appreciation.

E.7 Processing Exporters

We use processing exporters as comparison group to show that processing firms, which never paid tariffs on inputs, do not significantly increase export prices. Table A.13 reports the results of equation (12) for those pure processing firms, which can be compared with the baseline regressions for ordinary exporters in Table 4. As shown by Table A.13, there is no evidence that pure processing exporters increase their export prices in response to tariff reductions.

Our previous main results are based on the sample of all ordinary trade transactions, but it is possible that some firms in the sample switch their trade regimes. To show the robustness of our main results to the changes in the margins of trade regimes, we deleted firms that switched from hybrid to ordinary regime from the main sample and report results in Table A.14. Note that the firms who switch from ordinary trade to hybrid is not our concern, because they could only attenuate the effect

Table A.13: Comparison Group: Processing Exporters

	Dependent Variable							
	$\Delta\ln(\text{Export Price}_{fhc})$				$\Delta\ln(\text{Export Price}_{fh})$			
Regressor:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDuty	0.265	0.264	0.256	0.259	0.420	0.427*	0.357	0.363
	(0.261)	(0.261)	(0.233)	(0.234)	(0.258)	(0.259)	(0.224)	(0.224)
ΔDuty $\times HOMOGENEOUS$		1.137**		0.722		0.537		0.403
		(0.530)		(0.684)		(0.847)		(0.913)
Industry-level Competition Control			yes	yes			yes	yes
Firm-level Controls			yes	yes			yes	yes
Observations	1771	1771	1771	1771	1036	1036	1036	1036
R-squared	.002	.003	.010	.011	.003	.003	.009	.010

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. The dummy variable $HOMOGENEOUS$ is equal to 1 for homogeneous goods and 0 other wise. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year at the 4-digit CIC industry in China. Using ΔHHI as industry-level competition control does not alter the main results. Firm-level controls include the changes in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment).

of tariff reductions on price increase if any effect existed. All results here are consistent with our main results.

Table A.14: Robustness: Excluding Firms that Switched Trade Regimes

	Dependent Variable							
	$\Delta\ln(\text{Export Price}_{fhc})$				$\Delta\ln(\text{Export Price}_{fh})$			
Regressor:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDuty	-0.472**	-0.638***	-0.513**	-0.677***	-0.600**	-0.889***	-0.640**	-0.922***
	(0.234)	(0.244)	(0.233)	(0.242)	(0.300)	(0.316)	(0.288)	(0.301)
ΔDuty $\times HOMOGENEOUS$		1.375***		1.343***		1.730***		1.681***
		(0.331)		(0.326)		(0.398)		(0.384)
Industry-level Competition Control			yes	yes			yes	yes
Firm-level Controls			yes	yes			yes	yes
Observations	12825	12825	12825	12825	6795	6795	6795	6795
R-squared	.001	.002	.004	.005	.001	.003	.006	.008

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors corrected for clustering at the firm level in parentheses. All regressions include a constant term. Industry-level Competition Control refers to Herfindahl index (HHI), which is computed in the initial year at the 4-digit CIC industry in China. Firm-level controls include the changes in the following variables: TFP, the number of imported varieties, capital intensity, average wage, and firm size (measured by total employment).

References

Ackerberg, Daniel, Kevin Caves, and Garth Frazer, "Structural identification of production functions," MPRA Paper 38349, University Library of Munich, Germany December 2006.

Ahn, JaeBin, Amit K. Khandelwal, and Shang-Jin Wei, "The role of intermediaries in facilitating trade," *Journal of International Economics*, May 2011, *84* (1), 73–85.

Amiti, Mary and Jozef Konings, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review*, December 2007, *97* (5), 1611–1638.

_ , Oleg Itskhoki, and Jozef Konings, "Importers, Exporters, and Exchange Rate Disconnect," *American Economic Review*, forthcoming.

Anderson, T. W., *An introduction to multivariate statistical analysis* Wiley series in probability and mathematical statistics, 2 ed., New York: Wiley, 1984. T.W. Anderson; ;25 cm; Includes index; Bibliography: p. 643-665.

Bernard, Andrew B and J. Bradford Jensen, "Firm Structure, Multinationals, and Manufacturing Plant Deaths," *The Review of Economics and Statistics*, May 2007, *89* (2), 193–204.

Brandt, Loren, Johannes Van Biesebroeck, and Yifan Zhang, "Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing," *Journal of Development Economics*, 2012, *97* (2), 339–351.

Broda, Christian and David E. Weinstein, "Globalization and the Gains From Variety," *The Quarterly Journal of Economics*, 2006, *121* (2), 541–585.

Cai, Hongbin and Qiao Liu, "Competition and Corporate Tax Avoidance: Evidence from Chinese Industrial Firms," *Economic Journal*, 04 2009, *119* (537), 764–795.

Fan, Haichao, Edwin L.-C. Lai, and Yao Amber Li, "Credit Constraints, Quality, and Export Prices: Theory and Evidence from China," MPRA Paper 40857, University Library of Munich, Germany August 2012.

Goldberg, Pinelopi Koujianou and Nina Pavcnik, "Trade, wages, and the political economy of trade protection: evidence from the Colombian trade reforms," *Journal of International Economics*, May 2005, *66* (1), 75–105.

Khandelwal, Amit, "The Long and Short (of) Quality Ladders," *Review of Economic Studies*, 2010, *77* (4), 1450–1476.

Khandelwal, Amit K., Peter K. Schott, and Shang-Jin Wei, "Trade Liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters," *American Economic Review*, forthcoming.

Kleibergen, Frank and Richard Paap, "Generalized reduced rank tests using the singular value decomposition," *Journal of Econometrics*, July 2006, *133* (1), 97–126.

Kugler, Maurice and Eric Verhoogen, "Prices, Plant Size, and Product Quality," *Review of Economic Studies*, 2012, *79* (1), 307–339.

Levinsohn, James and Amil Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables," *The Review of Economic Studies*, 2003, *70* (2), pp. 317–341.

Melitz, Marc J. and Gianmarco I. P. Ottaviano, "Market Size, Trade, and Productivity," *Review of Economic Studies*, 2008, *75* (1), 295–316.

Olley, G. Steven and Ariel Pakes, "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 1996, *64* (6), pp. 1263–1297.

Pierce, Justin and Peter Schott, "The Surprisingly Swift Decline of U.S. Manufacturing Employment," Working Papers 13-59, Center for Economic Studies, U.S. Census Bureau December 2013.

Rauch, James E., "Networks versus markets in international trade," *Journal of International Economics*, June 1999, *48* (1), 7–35.

Stock, James H. and Motohiro Yogo, "Testing for Weak Instruments in Linear IV Regression," in Donald W. K. Andrews and James H. Stock, eds., *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, New York: Cambridge University Press., 2005, pp. 80–108.

Tang, Heiwai and Yifan Zhang, "Quality Differentiation and Trade Intermediation," Technical Report 2012.