The Production Relocation and Price Effects of U.S. Trade Policy: The Case of Washing Machines

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Online Appendix

A A Simple Model of Production Relocation, Prices, and Tariffs

We describe a simple model of a firm's production relocation and pricing decisions and how these decisions respond to tariffs. The goal of this section is to illustrate theoretically that under imperfect competition the price effect of tariffs may be non-monotone when production relocation to third countries is taken into account.

Suppose consumers have CES preferences over a continuum of sectors.[24] We focus on one of these sectors—the washing machine sector. We assume that there is a foreign monopolist that supplies washers to the United States. We further assume that the foreign supplier has constant marginal cost in each of the available production locations. Regardless of the production location, washing machines are made with the same blueprint owned and supplied by the foreign monopolist, and are considered perfect substitutes by consumers. Note that for simplicity we assume away any domestic producers of washing machines, since for the foreign production relocation the existence of domestic producers is not essential, and the graphical analysis below is easier to convey without them. Tariffs are of the ad-valorem type. Our assumptions on demand and production cost imply that the monopolist charges a constant mark-up over marginal cost times one plus the tariff.

Consider first the textbook case without production relocation by the foreign monopolist. This case is depicted in Figure A1a. If the U.S. government charges an ad-valorem tariff on washing machine imports of t, the U.S. consumers pay the foreign monopolist price times one plus the tariff rate, $(1+t)$. The loss in consumer surplus is $a+b$, the government revenue collected is equal to region a, and the overall welfare loss for the United States is b.

Next, let us consider the case of Figure A1b, in which the foreign monopolist has the option to produce in country C or in country V. If the fixed cost to establish production in these countries is the same, and there are no import restrictions, the foreign monopolist chooses the production location with the lower marginal cost—here, country C. However, under sufficiently high import tariffs against country C, the producer obtains higher profits from producing in country V instead. This leads to an increase in the domestic price by $p_V - p_C \leq tp_C$. The consumer surplus falls by a_1 and b_1, and no government revenue is being collected. Note, however, that under the option of production relocation the decline in U.S. consumer surplus from tariff is smaller than in the example of Figure A1a.[25] The

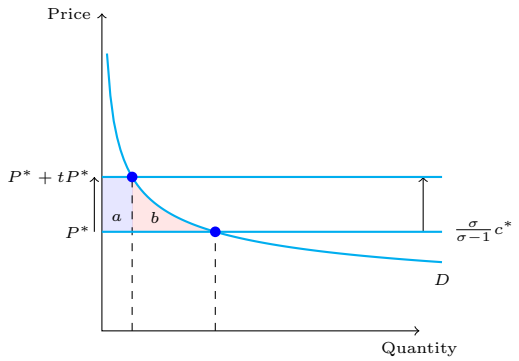
[24] Specifically, consumers have a utility function $U = \left(\int_0^1 q(j)^{(\sigma-1)/\sigma} dj\right)^{(\sigma/(\sigma-1)}$, where j denotes a sector.

[25] While under production relocation from C to V the consumer surplus declines less than in the textbook case (Figure A1a), the U.S. welfare loss may be higher as no tariff revenue is collected.

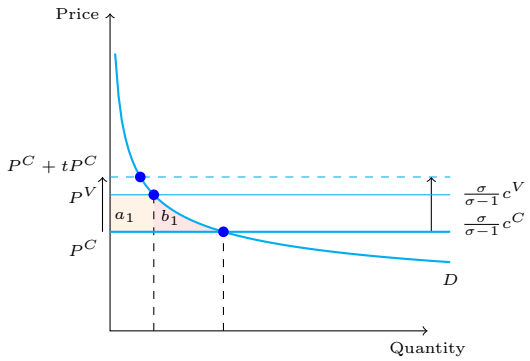
case presented in Figure A1b is an example of trade diversion due to asymmetric tariffs across countries.[26] Note that a similar response to the tariff would arise also under perfect competition if there are multiple foreign countries in which the good can be produced.

Figure A1: A Simple Model of Production Response to Tariffs

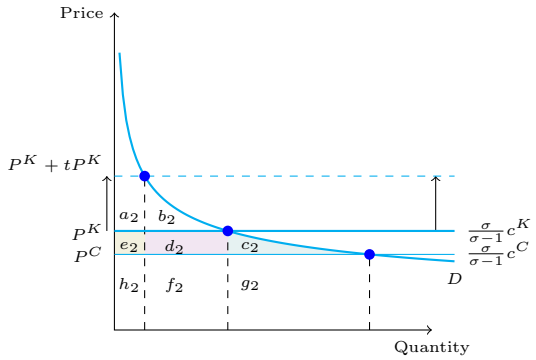
(a) Textbook Example



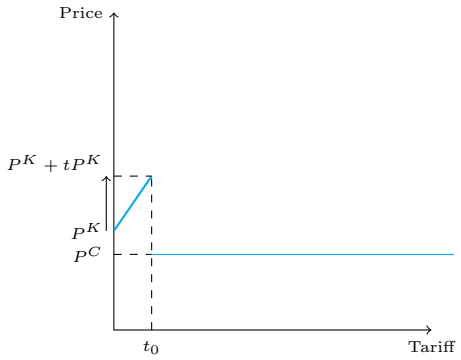
(b) Relocation Dampens the Consumer Price Increase



(c) Relocation Reduces the Consumer Price



(d) Price Change in (c)



Finally, consider the case depicted in Figure A1c. Here, in addition to producing in country K, the foreign monopolist has also the option of producing in country C, in which the marginal cost of producing the good is lower than in country K. Suppose the monopolist faces additional fixed cost F to establish production in C. If the foreign monopolist is headquartered in country K, the assumption of higher fixed cost of foreign production is common in the literature on multinational firms (e.g., Brainard (1997), Helpman, Melitz and Yeaple (2004)). In the depicted figure, $R_K = e_2 + d_2 + f_2 + h_2$ denotes the firm's revenue when producing in K, while the firm makes revenues of $R_C = h_2 + f_2 + g_2$ when producing in country C. As the monopolist charges a constant mark-up that depends on the demand elasticity, the monopolist's variable profits are proportional to revenue, and therefore in the absence of any tariffs, the firm produces washing machines in country K if $\frac{1}{\sigma}(R_C - R_K) \leq F$, where σ denotes the elasticity of demand. As long as the fixed costs of opening a plant in C are sufficiently large, or tariffs on imports from K are sufficiently small, this inequality will

[26] Trade diversion is often discussed in context of regional free trade agreements. The main idea being that in response to a tariff reduction for only selected countries, one may forgo tariff revenue and purchase the good from a producer within the regional free trade area, even though the cheapest producer (without tariffs) would be outside the free trade area. Of course, the same logic also applies to tariff increases against specific countries.

still hold resulting in full pass-through of the tariffs to the prices faced by U.S. consumers. If the tariff increase is so large, however, that the revenues under import tariffs on K, depicted in the graph by $e_2 + h_2$ have fallen sufficiently compared to the revenues the firm would make when producing in C, the foreign monopolist switches the production location in response to the tariff and produces in C instead. Quite interestingly, as a consequence, the prices U.S. consumers would pay for washing machines would *fall* in response to the import restrictions on K. While no tariff revenue is being collected, the increase in the U.S. consumer surplus is equal to $e_2 + d_2 + c_2$.[27]

Hence, as depicted in Figure A1d, the presence of fixed costs and production relocation imply that the effect of tariffs on U.S. prices is non-monotone. It is important to point out, that the example depicted in Figure A1c would not occur in a competitive market. Under perfect competition, production would occur in the lower cost place (country C) in the absence of tariffs. Given the presence of patents on washer technology and strong market power associated with branding, the washing machine market is best characterized as non-competitive.

[27] In this example, overall U.S. welfare increases due to the tariff and equals the change in the U.S. consumer surplus.

B Extended Detail on Timeline

Table B1: Important Event Dates Relative to Three Cases of Tariff

Date	Event
Antidumping against Korea and Mexico	
Dec 2011	Whirlpool files antidumping petition
Feb 2012	USITC issues initial report
Jul 2012	Department of Commerce announces affirmative preliminary determination of AD/CvD duties
Aug 2012	Firms are required to post cash bonds for imports of affected washers
Dec 2012	Department of Commerce announces final determinations of AD/CvD duties
Feb 2013	Final duties go into effect (Perhaps this is when the posted cash bonds (from August 2012 forward) are now taken as duties, and duties are taken immediately on others going forward.)
Antidumping against China	
Dec 2015	Whirlpool files antidumping petition
Feb 2016	USITC issues preliminary report
Jul 2016	Department of Commerce announces AD/CvD import duties
Jul 2016	Duties first applied
Dec 2016	Department of Commerce released its final antidumping determination
Jan 2017	USITC released its final determination
Feb 2017	Department of Commerce issued the final order
Safeguard tariffs 2018	
May 2017	Whirlpool files petition for global safeguard investigation
Oct 2017	USITC issues preliminary report (link)
Jan 2018	Executive office issues new import duties (link)
Feb 2018	Tariffs first applied
Oct 2018	Quota limit reached, second tier of tariffs applied
HS codes	
Washers	8450200040, 8450200080, 8450200090, 8450110040, 8450110080
Washer parts	8450902000, 8450906000
Chapter 99	99034501 (washers within quota), 99034502 (washers beyond quota) 99034505 (washer parts within quota) and 99034506 (washer parts beyond quota)

Table B2: Extensive Detail on Antidumpings

	Rate(%)	Effective date	Period of review	Note
Antidumping against Korea				
Daewoo	79.11	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	82.41	12/26/2012	10/01/2010 to 09/30/2011	Final determination
	79.11	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	79.11	09/16/2015	08/03/2012 to 01/31/2014	Deposit rate change
LG	12.15	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	13.02	12/26/2012	10/01/2010 to 09/30/2011	Final determination
	13.02	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	1.38	09/16/2015	08/03/2012 to 01/31/2014	Deposit rate change
	1.62	09/12/2016	02/01/2014 to 01/31/2015	Deposit rate change
	0	09/12/2017	02/01/2015 to 01/31/2016	Deposit rate change
	0.64	01/31/2018	02/01/2016 to 01/31/2017	Deposit rate change
Samsung	9.62	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	9.29	12/26/2012	10/01/2010 to 09/30/2011	Final determination
	9.23	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	82.35	09/16/2015	08/03/2012 to 01/31/2014	Deposit rate change
All others	11.36	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	11.86	12/26/2012	10/01/2010 to 09/30/2011	Final determination
	11.8	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
Antidumping against Mexico				
Electrolux	33.3	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	36.52	12/27/2012	10/01/2010 to 09/30/2011	Final determination
	36.52	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	6.22	09/15/2015	08/03/2012 to 01/31/2014	Deposit rate change
	2.47	09/12/2016	02/01/2014 to 01/31/2015	Deposit rate change
	3.67	07/12/2017	02/01/2015 to 01/31/2016	Deposit rate change
	72.41	03/19/2018	02/01/2016 to 01/31/2017	Deposit rate change
Samsung	72.41	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	72.41	12/27/2012	10/01/2010 to 09/30/2011	Final determination
	72.41	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
Whirlpool	72.41	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	72.41	12/27/2012	10/01/2010 to 09/30/2011	Final determination
	72.41	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
All others	33.3	08/03/2012	10/01/2010 to 09/30/2011	Preliminary determination
	36.52	12/27/2012	10/01/2010 to 09/30/2011	Final determination
	36.52	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
Antidumping against China				
LG	49.88	07/26/2016	04/01/2015 to 09/30/2015	Preliminary determination
	32.12	12/15/2016	04/01/2015 to 09/30/2015	Final determination
	32.12	12/15/2016	04/01/2015 to 09/30/2015	Deposit rate change
	38.43	02/03/2017	04/01/2015 to 09/30/2015	Order issurance
Samsung	111.09	07/26/2016	04/01/2015 to 09/30/2015	Preliminary determination; amendment.
	52.51	12/15/2016	04/01/2015 to 09/30/2015	Final determination
	57.37	02/03/2017	04/01/2015 to 09/30/2015	Order issurance
All others	80.49	07/26/2016	04/01/2015 to 09/30/2015	Preliminary determination; amendment.
	44.28	12/15/2016	04/01/2015 to 09/30/2015	Final determination
	49.72	02/03/2017	04/01/2015 to 09/30/2015	Order issuance

Table B3: Extensive Detail on Averaging of Firm Antidumping Rates

Firm Name	Firm Specific Antidumping Rate	Firm-Specific Shares	Firm Name	Firm Specific Antidumping Rate
Korea			**Mexico**	
Daewoo	82.41%	0.011	Electrolux	36.52%
LG	13.02%	0.202	Samsung	72.41%
Samsung	9.29%	0.685	Whirlpool	72.41%
Others	11.86%	0.102	Others	33.30%
Weighted Avg	**11.11%**		**Simple Avg**	**53.66%**
China				
LG	32.12%	0.240		
Samsung	52.51%	0.727		
Others	44.28%	0.033		
Weighted Avg	**47.35%**			

Notes: The antidumping rates come from the USITC, and the firm-specific shares are calculated from the PIERS bill of lading data. See Section C.14 for further details on PIERS data. The period over which the firm-specific quantity shares are taken is July-December 2011 for Korea, and July-December 2015 for China. Note that there is no PIERS data for Mexico as the data only covers bills of lading from U.S. sea ports.
Source: United States International Trade Commission (2010-2019) and PIERS (2012-2019) bill of lading data.

Table B4: Extensive Detail on Antidumping Duties Calculations

	Korea	**Mexico**	**China**
(1) Avg AD Tariff Change	11.11%	53.66%	47.35%
(2) Country Import Share	0.45	0.40	0.80
Washers Only			
(3a) Import Share of Consumption	0.36		0.43
Avg Tariff Change ((1) × (2) × (3a))	**9.57%**		**16.32%**
Washers and Dryers			
(3b) Import Share of Consumption	0.34		0.40
(4) Washer Share of Washer/Dryer Imports	0.59		0.60
Avg Tariff Change ((1) × (2) × (3b) × (4))	**5.27%**		**9.15%**

Notes: The calculations of average AD tariff change come from Table B3 above. The time periods over which calculations are made are July-December 2011 for the Korea/Mexico antidumping duties, and July-December 2015 for the China antidumping duties.
[a] Country import shares are quantity shares taken from the USITC for the periods specified above.
[b] Import Share of Consumption is calculated using both import quantities from USITC and shipments data from AHAM.
Source: United States International Trade Commission (2010-2019) and Association of Home Appliance Manufacturers (2013-2019).

Table B5: Extensive Detail on Countervailing Duties against Korea

	Rates	Effective date	Period of review	Notes
Daewoo	70.58	06/05/2012	01/01/2011 to 12/31/2011	Preliminary determination
	72.3	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	81.91	09/16/2015	08/03/2012 to 01/31/2014	Deposit rate change
Samsung	1.2	06/05/2012	01/01/2011 to 12/31/2011	Preliminary determination
	1.85	02/14/2013	10/01/2010 to 09/30/2011	Order issurance
	34.77	09/16/2015	08/03/2012 to 01/31/2014	Deposit rate change
All others	1.2	06/05/2012	01/01/2011 to 12/31/2011	Preliminary determination
	1.85	02/14/2013	10/01/2010 to 09/30/2011	Order issuance

Table B6: Extensive Detail on Global Safeguard Tariffs

	Year 1	Year 2	Year 3
First 1.2 million units of imported finished washers	20%	18%	16%
All subsequent imports of finished washers	50%	45%	40%
Tariff of covered parts	50%	45%	40%
Covered parts excluded from tariff	50,000 units	70,000 units	90,000 units

C Additional Results

C.1 Intra-Firm vs Arms-length Imports

Firms are required to report whether a particular import transaction is at arms-length or between related parties. An import transaction is defined as between related parties if "any person, directly or indirectly owns, controls, or holds power to vote 5 percent or more of the outstanding voting stock or shares" of the other party. See Section 402(e) of the Tariff Act of 1930. This distinction matters for our calculations of tariff pass-through, as the decision to adjust prices in response to tariffs may involve how the firm decides to change the allocation of profits across subsidiaries. The U.S. Census Bureau publishes aggregates of trade according to this split; the most disaggregated data available for our purposes is NAICS 335224: "all household laundry equipment."

As shown in Table C1, a very large share of U.S. imports of this category occurs between related parties. Figure C1 shows these related-party shares by country and year; the patterns evident in this figure align with the shifts in production by these major firms shown in other figures.

Table C1: Related-Party Share of 2016 U.S. Imports by Country, NAICS 335224: Household Laundry Equipment

Country	Related Party Share	Import Share
Mexico	0.99	0.37
China	0.76	0.36
South Korea	0.90	0.07
Thailand	0.79	0.06
Vietnam	0.99	0.06
World	0.85	1.00

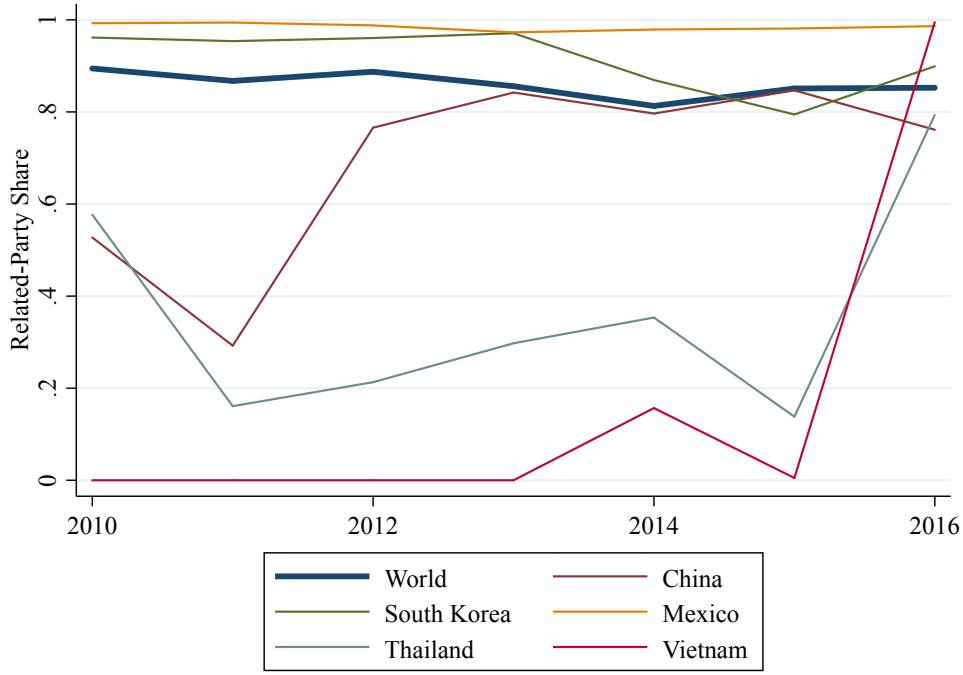
Notes: Imports are defined as related-party if "any person, directly or indirectly owns, controls, or holds power to vote 5 percent or more of the outstanding voting stock or shares" of the other party. See Section 402(e) of the Tariff Act of 1930. The most disaggregated data available split out by related-party includes all household laundry equipment; thus, the import shares are not directly comparable to other tables/figures in this paper.
Source: United States Census Bureau (2000-2019).

C.2 Application of Section 201 Tariffs

As shown in Figure C2, the calculated duties before the global safeguard tariffs in 2018 were negligible. Interestingly, the figure shows that duties didn't jump until roughly May of 2018, despite the fact that announcements indicated duties would be collected beginning in February.

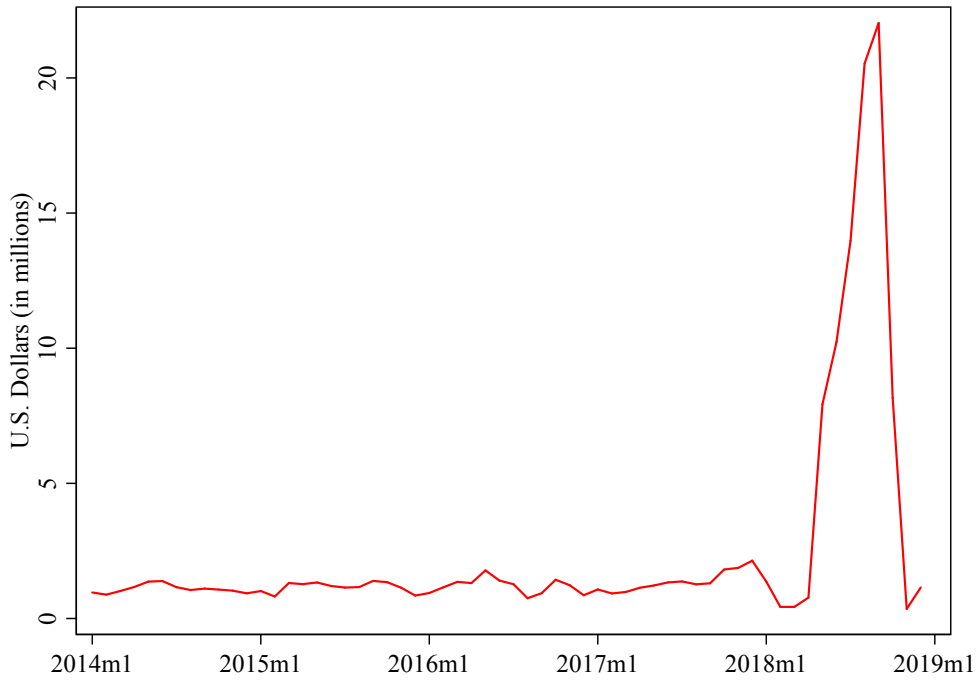
The Section 201 Import Safeguard tariff included a number of exclusions, such that not all imports of the relevant HS product codes were subject to new tariffs in early 2018. In addition to excluding washing machine imports from Canada and a number of developing countries, the initial petition identified a number of products to be out of the scope of

Figure C1: Related Party Share of Household Laundry Equipment Imports to U.S., Selected Countries 2010-2016



Notes: Imports are defined as related-party if "any person, directly or indirectly owns, controls, or holds power to vote 5 percent or more of the outstanding voting stock or shares" of the other party. See Section 402(e) of the Tariff Act of 1930. The most disaggregated data available split out by related-party includes all household laundry equipment; thus, the import shares are not directly comparable to other tables/figures in this paper.
Source: United States Census Bureau (2000-2019).

Figure C2: Calculated Duties on U.S. Imports of Washing Machines 2010-2018



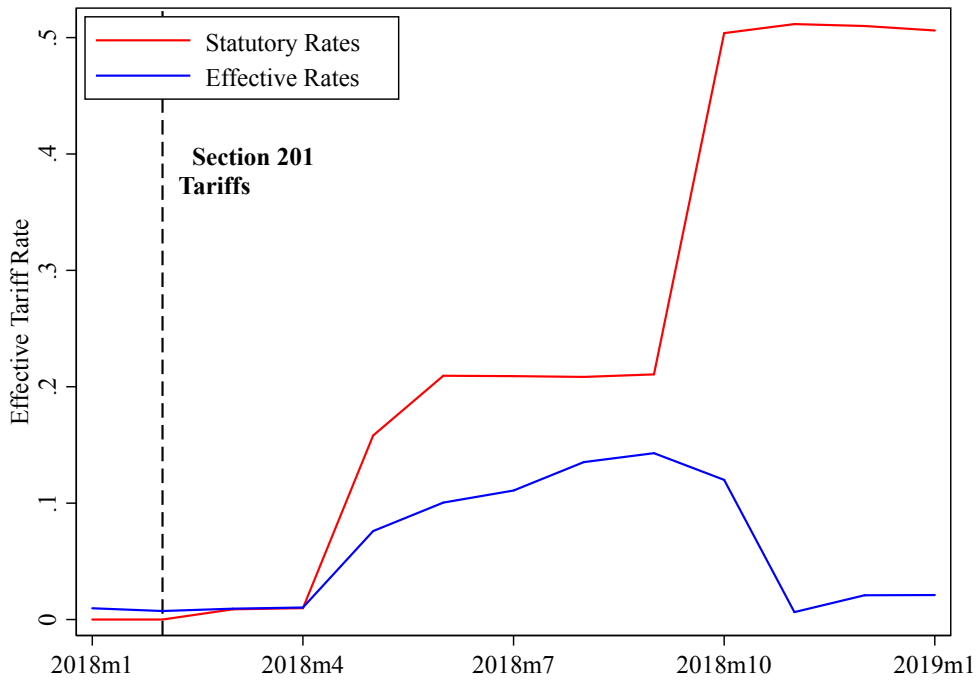
Notes: Includes HS8450110040, HS8450110080, HS8450200040, HS8450200080, and HS8450200090.
Source: United States International Trade Commission (2010-2019).

the investigation. Among these excluded products were stacked washer-dryers, commercial washers, and the following presumably specialty washers:

- Front loading washers with a permanent split capacitor and belt drive train;
- Top loading washers with a controlled induction motor and belt drive train;
- Front loading washers with a cabinet width greater than 28.5 inches.

It is unclear why these specialty washers were excluded from the scope. From the investigation documents, we learn that the respondents (LG and Samsung) requested these excluded articles be included within the scope of the investigation, whereas Whirlpool and G.E. urged against amending the scope (see USITC 2017, page 9). We can see the effects of these exclusions by splitting the publicly available import quantities by the applicable rate provision code. Section 201 rates are classified under "69 –Chapter 99" of the Harmonized Tariff Schedule of the United States; other rate provisions include "61 – Dutiable HS Chapters 1-87" (MFN rates) and others associated with preferential trade agreements. Figure C3 illustrates the differences between the statutory tariff rates and the average effective tariff rate – defined as the actual tariffs applied to the relevant HS codes divided by overall value.

Figure C3: Effective Tariff Rates of Washing Machines: by Rate Provision Code

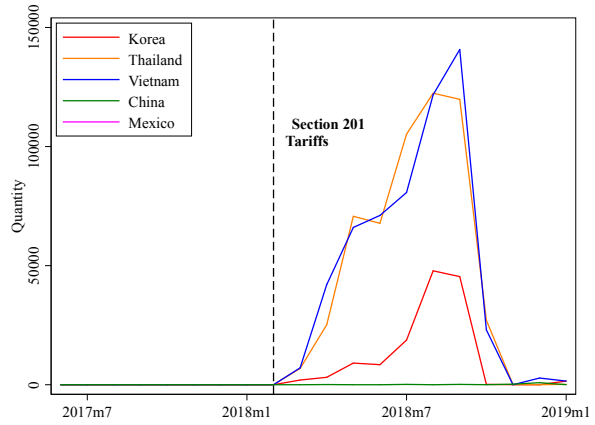


Notes: Includes residential washing machines classified under HS8450110040, HS8450110080, HS8450200040, HS8450200080, and HS8450200090. Section 201 safeguard tariffs are classified under rate provision code "69 – Dutiable HS chapter 99." The average effective tariff rate is defined as the actual tariffs applied to these imports divided by the tariff-exclusive import value.
Source: United States International Trade Commission (2010-2019).

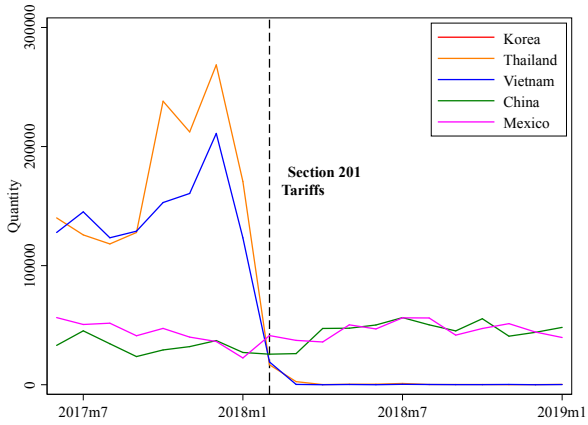
Further detail on the timing and shifts of imports can be seen by also splitting out country-level detail of the rate provision codes. Figure C4 illustrates a number of other patterns in the data.

Figure C4: Imports and Responses to Section 201 Tariffs, Washing Machines

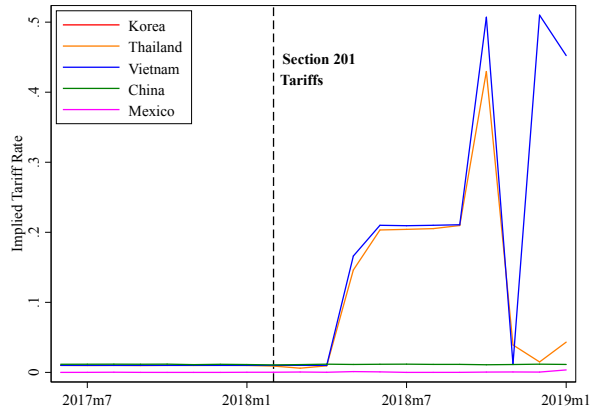
(a) Quantity Washer Imports Subject to Section 201



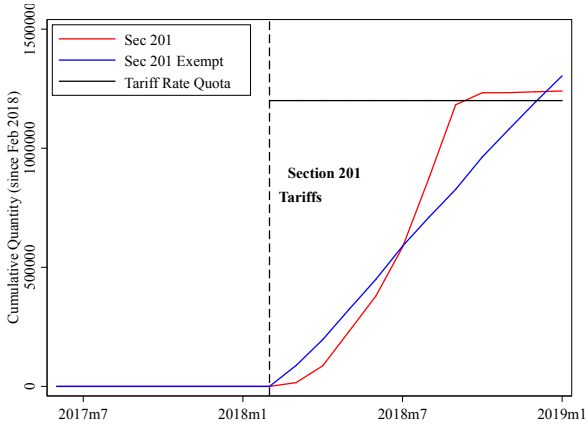
(b) Quantity Washer Imports Excluded from Section 201



(c) Effective Tariff Rate by Country



(d) Cumulative Import Quantities since Feb 2018



Notes: Includes HS8450110040, HS8450110080, HS8450200040, HS8450200080, and HS8450200090. Section 201 tariffs are classified under rate provision code "69 – Dutiable HS chapter 99."
Source: United States International Trade Commission (2010-2019).

Figures C4b and C4a split the quantity of imported washers by whether or not Section 201 duties applied. The figures demonstrate that the Section 201 tariffs were not applied uniformly across origin countries. Nearly all imports from Vietnam and Thailand were subject to these duties, whereas imports from Korea were only partially affected. In contrast, as shown in Figure C4b, washers from China and Mexico were unaffected. Given that the section 201 ruling did not provide for country-level exclusions for these cases, the most likely explanation is that the composition of products imported from these countries (entirely) fell under the set of excluded products identified above.

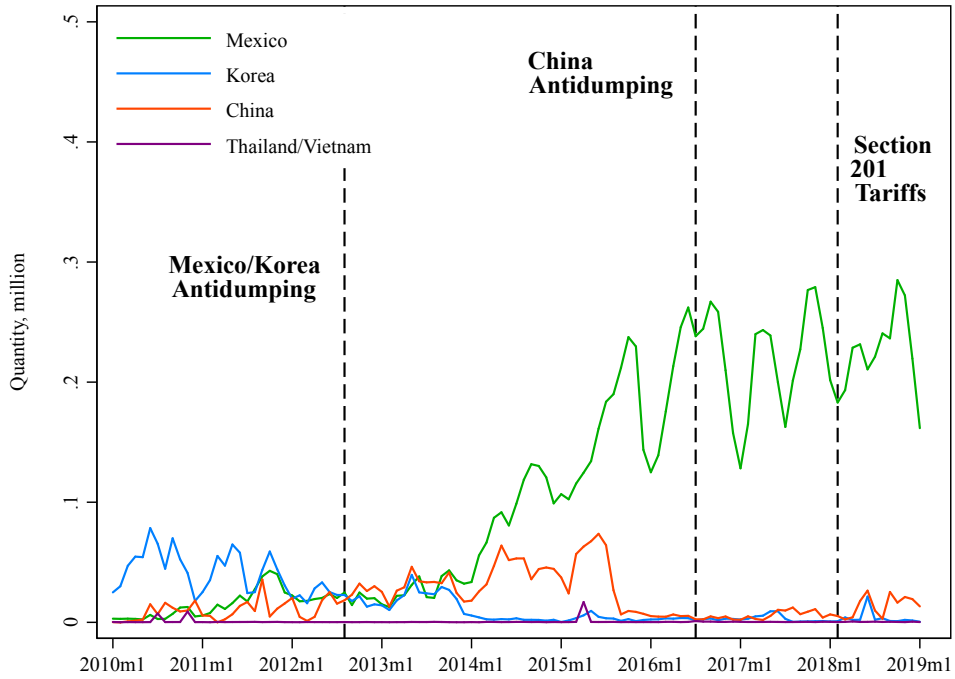
Another way of seeing the differential application of the tariffs across countries is to calculate the average effective tariff rate paid on imported washers. Figure C4c does this by dividing the calculated duties of these imports by the value of imports. Consistent with the fact that all imports from Thailand and Vietnam were subject to the safeguard duties, the average effective rate for these countries aligns with the statutory rates announced by the U.S. Department of Commerce (20 percent, increasing to 50 percent). The average effective rate paid by Korean imports reflects the fact that only some portion were subject to the new

duties. The timing of the rate jump to 50 percent for Thailand/Vietnam in October 2018 is consistent with that shown in Figure C4d showing the cumulative amounts of imports for the period subject to Section 201 duties. While Figure C4d confirms that Section 201 imports reached the 1.2 million-unit quota in October of 2018, it also demonstrates that the quantity of imports excluded from the scope is still substantial.

C.3 Source Locations of Dryer Imports

One might wonder whether the production relocations documented above for washing machines would be similar for dryers, given the fact that the washer-dryer are often matched with similar aesthetics and outward appearance. In Figure C5 we show the major source countries for clothes dryers do not, in fact, match the patterns for clothes washers documented in Panel A of Figure 1. Mexico is the major source location for dryers destined for the U.S. market.

Figure C5: Major Import Source Countries for Dryers



Notes: Includes clothes dryers classified under HS8451210090 and HS8451290010.
Source: United States International Trade Commission (2010-2019).

C.4 Third-Country Effects of U.S. Trade Policy

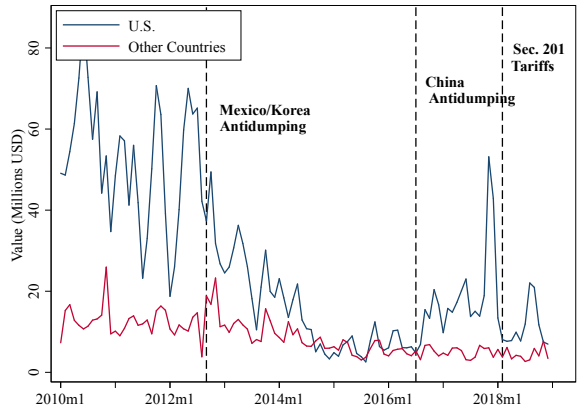
The production relocations that followed U.S. trade policy impacted trade patterns of other countries as well. When production shifted location to avoid country-specific tariffs by the United States, firms then exported their products to other countries in addition to the U.S. These patterns are shown most visibly in Panel C and Panel D of Figure 1 in the main text. Interestingly, we do not see these visible third-country effects for countries in the European Union, or Japan. Figure C6 below shows the broader pattern across the

main foreign countries of production for large residential washers. We plot the U.S and other countries with monthly trade data for comparison. Following the 2012 Korea/Mexico antidumping duties, Korean exports to other countries slow – with a lag – similar to exports to the U.S. (Figure C6a). In Figure C6b Chinese exports to other countries rises and falls (again, with a lag) with exports to the U.S. Finally, in Figure C6c shows third-country exports from Thailand and Vietnam also rise when production shifts from China to these countries.

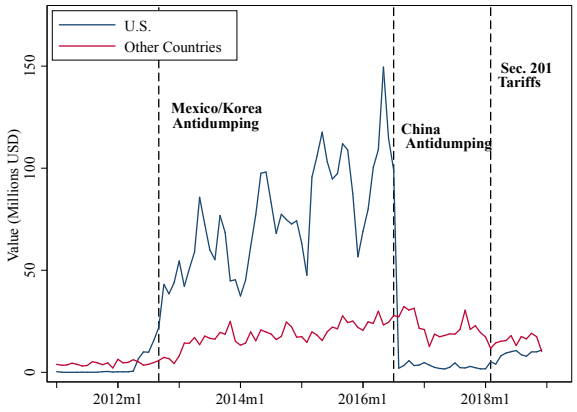
As a whole, this evidence demonstrates sizable effects of U.S. trade policies on third-countries— those not directly impacted by the policies themselves.

Figure C6: Exports of Large Washing Machines to U.S. and Other Countries

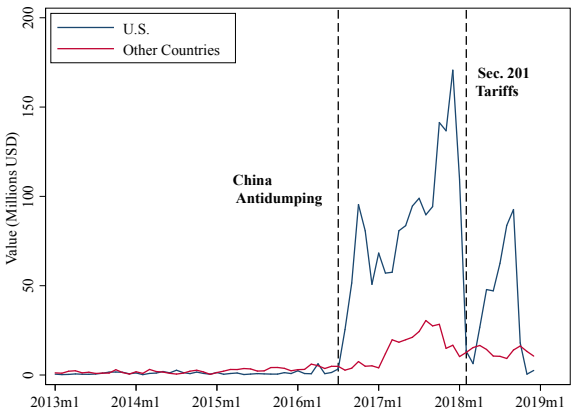
(a) Korea Exports



(b) China Exports



(c) Thailand/Vietnam Exports



Notes: Includes codes under HS845020. Other countries includes those major trading partners that report monthly trade statistics. These include: Australia, Canada, EU-28, Korea, Japan and Mexico.
Source: United Nations (2010-2019).

C.5 Other Relevant Features of Appliances

The inclusion of other appliances in our analysis of price changes following the Section 201 Safeguard tariffs serves to account for any price changes attributed to higher input costs coming from the Section 232 "national security" tariffs on steel and aluminum. Although we do not have a detailed breakdown of the various cost components of appliance production,

Table C2 summarizes the average steel content (in pounds) in individual appliances, according to a recent study performed by the Steel Recycling Institute and the Association of Home Appliance Manufacturers. As is clear in the table, the steel content of washing machines is indeed quite close to the appliance used as our control: electric/gas ranges (average of 90 lbs vs 127.5 lbs). The other appliances—refrigerators and dishwashers—have steel content that is slightly higher and lower, respectively.

Similar steel content would not adequately control for the increased costs associated with higher steel prices if the appliances had vastly different shares of domestic production. If all electric/gas ranges were imported, then they would not be subject to any of the higher costs from higher steel prices in the United States. To check on whether the import shares are similar across appliance categories, we combine import quantities for each appliance to the proprietary data on shipments (imports plus domestic production less exports) available from the Association of Home Appliance Manufacturers (AHAM). Indeed, electric/gas ranges has the closest import share to washing machines – within 15 percentage points – among the appliance categories we considered (dishwashers and refrigerators). See Table C3.

Another concern with our interpretation of evidence using other appliances in the context of washing machines is that subsequent tariffs on Chinese imports—part of the Section 301 provision of enforcing U.S. trade agreements—affected a range of other appliances. Among the set of products included under the third round of Section 301 tariffs against Chinese goods put into place in September 2018 were household refrigerators and gas/electric stoves and ranges. Household dishwashers, the other major appliance in our data, were not subject to additional tariffs during the period we study. The additional rates applied to these goods during this time was substantially smaller (only 10 percent) than other trade provisions put into place in 2018. Apart from differences in the rate and timing of these tariffs, the other obvious difference with the Section 201 tariffs was that these tariffs were targeted at China alone. Prior to the Section 301 tariffs, the Chinese share of total imports for refrigerators, ranges, and dishwashers was 18, 10, and 30 percent, respectively.

As shown in Figure C7 the average effective tariff rate against all imported refrigerators and ranges (the blue lines) moved up only slightly beginning in October of 2018. Dishwashers were unaffected by any new tariffs.

Table C2: Steel Content of Appliance Production

Appliance Description	Steel Weight
Side by side refrigerator	152.5 lb
Ranges (gas)	149.4 lb
Ranges (electric)	106.8 lb
Clothes dryers (gas)	100.4 lb
Clothes dryers (electric)	107 lb
Clothes washers, top load	94.5 lb
Clothes washers, front load	84.2 lb
Top/bottom refrigerator	79.0 lb
Room air conditioners	35.6 lb
Microwave ovens	28.8 lb
Dishwashers (steel interior)	26.7 lb
Dishwashers (plastic interior)	27.6 lb

Source: Steel Recycling Institute and Association of Home Appliance Manufacturers (2013-2019).

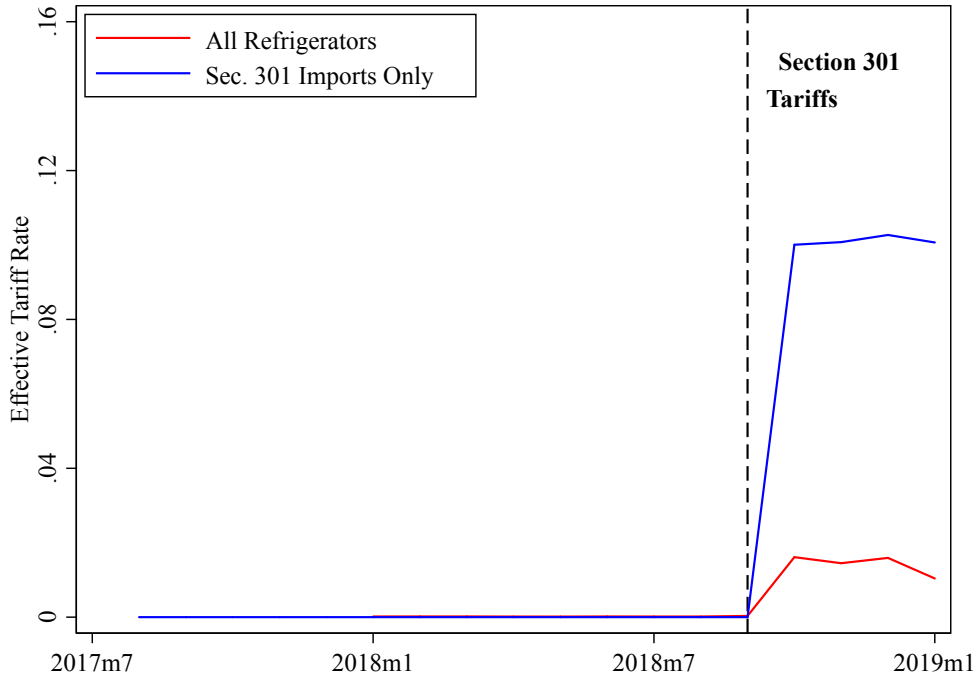
Table C3: Import Share of Consumption: Major Appliances

Imports (USITC) divided by Shipments (AHAM)				
Washers	Dryers	Dishwashers	Ranges	Refrigerators
49.53%	36.67%	16.80%	61.15%	89.62%

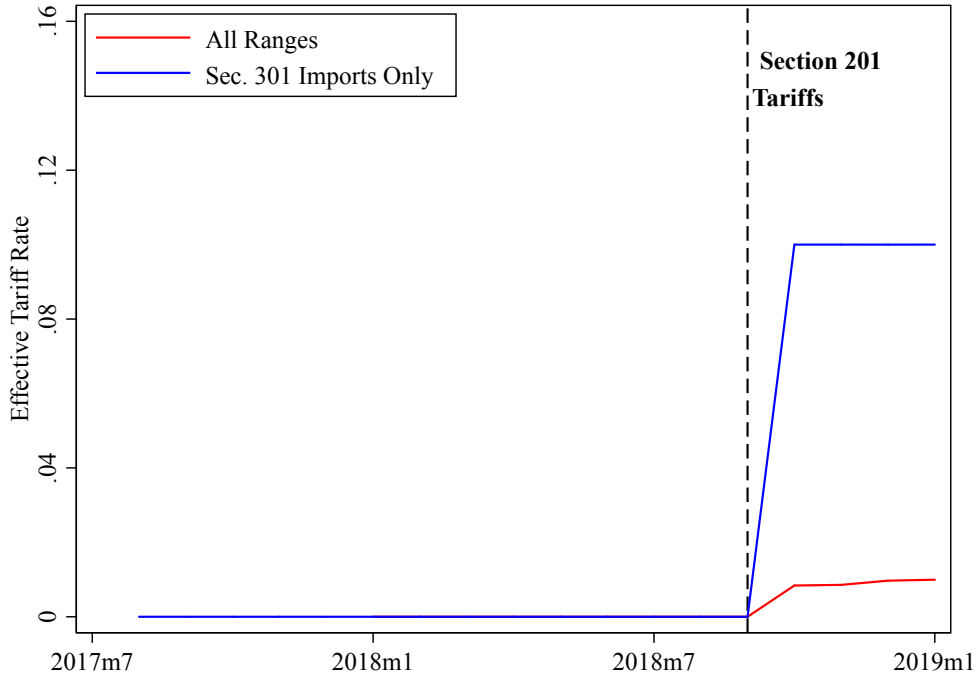
Notes: See Figure C7 for a list of HS codes associated with other appliances.
Source: United States International Trade Commission (2010-2019) and Association of Home Appliance Manufacturers (2013-2019) for 2017.

Figure C7: Effective Tariff Rate of Refrigerators and Ranges: All Imports vs Section 301 Imports

(a) Refrigerators



(b) Ranges



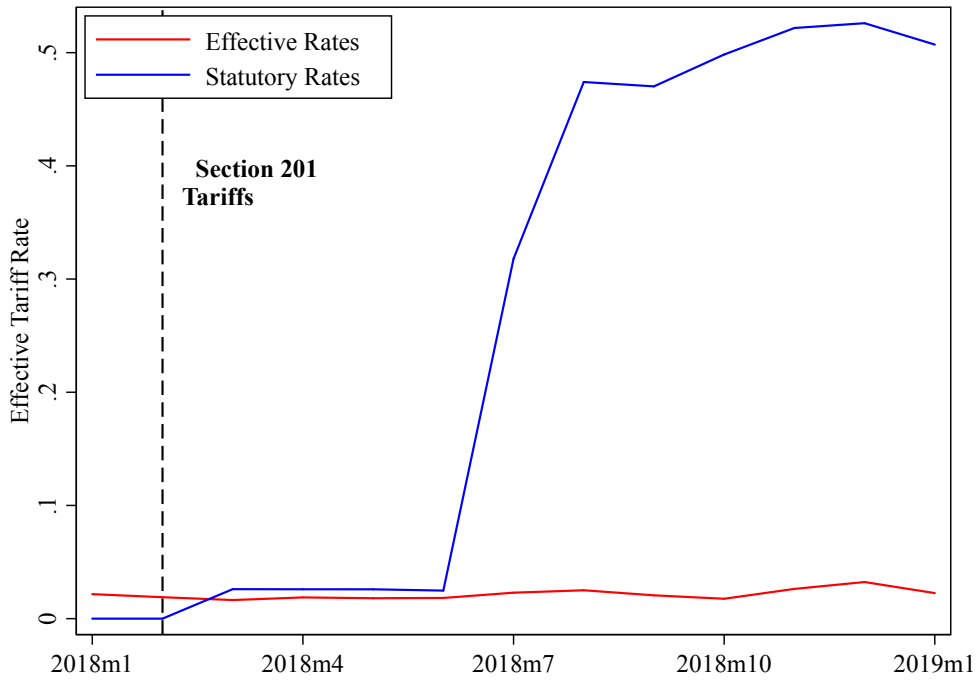
Notes: Refrigerators include products listed in HS8418100020, HS8418100030, HS8418100040, HS8418100045, HS8418100055, HS8418100065, HS8418100075, HS8418100090, HS8418210020, HS8418210030, HS8418210090, HS8418220000, HS8418290000, HS8418291000, HS8418292000, HS8418300000, HS8418400000. Ranges include products listed in HS7321113000, HS7321113010, HS7321113020, HS7321113050, HS8516604074, HS8516604078, HS8516604080, HS8516604082, HS8516604086.
Source: United States International Trade Commission (2010-2019).

C.6 Tariffs on Washing Machine Parts

In addition to large residential washers, the Section 201 Safeguard investigation included certain washer parts, including "(i) all cabinets, or portions thereof, designed for use in washers; (ii) all assembled tubs designed for use in washers which incorporate, at a minimum, a tub and a seal; (iii) all assembled baskets designed for use in washers which incorporate, at a minimum, a side wrapper, a base, and a drive hub; and (iv) any combination of the foregoing parts or subassemblies." (USITC 2017) This description makes clear that these additional inclusions are better described as sub-assemblies of washers than indivisible parts.

To determine whether these additional tariffs could have played a role in the price changes of washers—particularly those domestic brands—we split the publicly available trade data for the relevant product groups (HS84509020 and HS84509060) based on the assigned rate provision code of imports. The evidence, shown in Figure C8 demonstrates that although the tariff rate of washer parts imports subject to Section 201 tariffs (the blue line) did indeed jump in mid-2018, the average tariff rate across all washer parts (shown in the red line) was essentially unchanged. Hence, the share of washer parts affected by these Section 201 tariffs was trivial—less than 1 percent of the total—and therefore this provision of the section 201 investigation was more likely put into place as a preventative measure to guard against the avoidance of the washer tariffs themselves.

Figure C8: Effective Tariff Rate of Washer Parts: Statutory vs Effective Rates



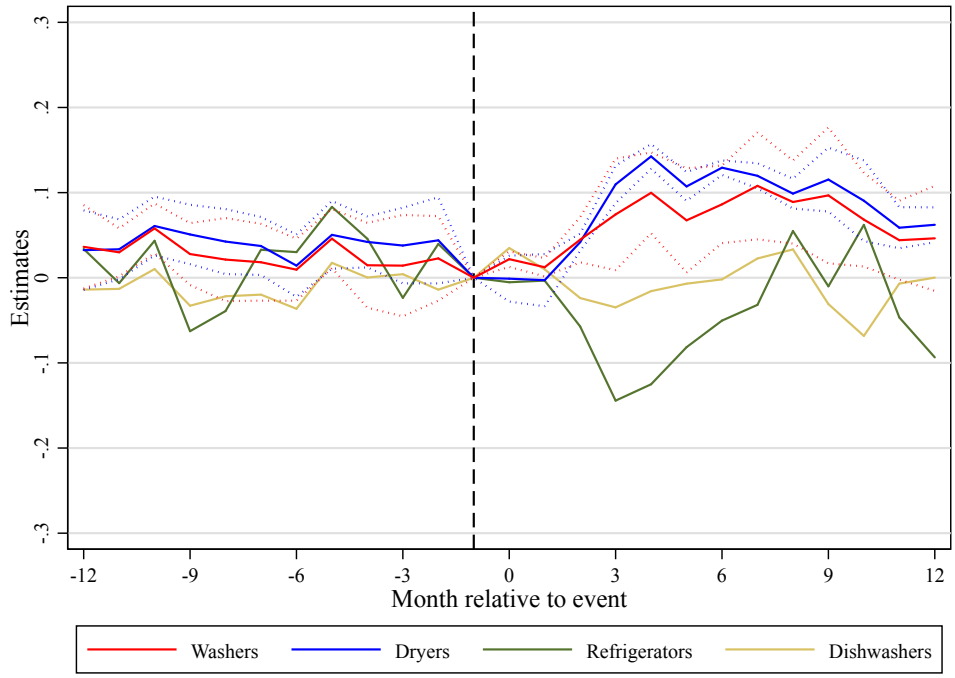
Notes: Includes HS codes listed under HS8450902000 and HS8450906000. Section 201 tariffs are classified under rate provision code "69 – Dutiable HS chapter 99."
Source: United States International Trade Commission (2010-2019).

C.7 Evidence using Wholesale Prices

We use data from the Association of Home Appliance Manufacturers – the main industry organization for appliance manufacturers in the United States – to assess the stage of the supply chain where prices increased following the section 201 safeguard tariffs. AHAM collects the dollar value and quantity for 13 appliance categories from its members at a monthly frequency. The universe of this data corresponds to U.S. industry "shipments", defined to include domestic production plus imports less exports. Hence, this provides a clean mapping to the set of products that are included in our main data from Gap Intelligence.

We apply the same procedure as in section C to estimate the price effects for washers and dryers relative to ranges (gas and electric). The results are in Figure C9. As shown in the Figure, the prices of both washers and dryers rise by amounts similar to Panel B of Figure 5. These results rule out that the price increases were a result of retailer decisions, rather than further up the supply chain.

Figure C9: Price Effects of Safeguard Tariffs: Wholesale Prices



Notes: Excluded category is ranges (gas and electric).
Source: Authors calculations based on Association of Home Appliance Manufacturers (2013-2019).

C.8 Pass-Through Regressions Using Import Prices

A systematic approach for estimating the price effects from tariff changes in prior papers (dating back to at least Feenstra 1989) is to follow the literature examining the effects of exchange rate changes and utilize a regression of changes in import prices (from trade data) on changes in tariff rates. Specifically, the typical estimated regression is given by:

$$\Delta \ln p_{igt}^{border} = \alpha_0 + \alpha_1 \Delta(1 + \tau_{igt}) + \gamma_i + \omega_g + \beta_t + \varepsilon_{igt}, \tag{C1}$$

where g indicates an HS-10 level product code, i indicates an export country, and t indicates month. As the left-hand side variable p_{igt}^{border} is usually measured exclusive of tariffs, an estimate of α_1 close to zero indicates that tariff-inclusive import prices rise by as much as the tariff – hence a 100 percent pass-through to import prices.

Below we estimate equation (C1) separately for each of the tariff changes affecting washing machines. We first construct a dataset for all relevant HS-codes from the appliance categories in section B (washing machines, dryers, ranges, refrigerators, and dishwashers). Then, following Amiti, Redding and Weinstein (2019), we use 12-month log changes and sample periods that include the 12 months before and 12 months after each tariff episode.[28] We also follow the convention of Amiti, Redding and Weinstein (2019) and drop observations with a ratio of unit values in t relative to t-12 of greater than 3 or less than 1/3. Table C4 summarizes the results, where we also include country fixed effects, hs-product fixed effects, and month fixed effects. The implied elasticities are always around 1 and stand in stark contrast to the results we obtain using our data on retail prices that cover both imported and domestically-produced products.

Table C4: Country-Product Level Tariff Pass-Through Regressions on Import Prices (Exclusive of Tariffs)

	Kor/Mex AD	China AD	Sec. 201 Safeguard	
			20% rate	50% rate
	$\Delta \log p_{igt}$	$\Delta \log p_{igt}$	$\Delta \log p_{igt}$	$\Delta \log p_{igt}$
Variables	(1)	(2)	(3)	(4)
$\Delta(1+\tilde{\tau}_{igt})$	-0.00	0.35	-0.02	-0.04
	(0.10)	(0.60)	(0.29)	(0.07)
Constant	0.04	-0.03	0.03	0.03
	(0.02)	(0.04)	(0.05)	(0.05)
Implied Elasticity	1.00	1.35	0.98	0.96
Observations	2762	3918	4403	4403
Adjusted R-squared	0.05	0.04	0.03	0.03
Country F.E.	Yes	Yes	Yes	Yes
Product F.E.	Yes	Yes	Yes	Yes
Month F.E.	Yes	Yes	Yes	Yes
Weighted	Yes	Yes	Yes	Yes

Notes: The table reports country-product level tariff pass-through to import prices (see equation (C1)). Standard errors are clustered by product codes. Each regression is weighted by the total HS-level quantity in the 12-months preceding tariff changes. *Source:* United States International Trade Commission (2010-2019) and authors' calculations.

For another perspective that more closely mirrors our analysis in section E and therefore may better capture the price changes due to indirect effects coming from production relocation, we conduct the regressions at the product-level. To create product-level import prices, we first incorporate tariffs paid at the country-level before aggregating values and quantities; hence, the resulting product-level prices are therefore inclusive of tariffs. Thus

[28] We use the simple average of the firm-level antidumping duty rates outlined in Table B2, resulting in an average tariff rate of 28.3 percent in Korea in 2012, 54.4 percent in Mexico in 2012, and 43.0 percent in China in 2016.

$p_{gt} = \frac{\sum_i p_{igt} q_{igt}(1+\tau_{igt})}{\sum_i q_{igt}}$. For the product-level change average tariff rate we mirror the calculation used in equation (5) by calculating $\Delta\tilde{\tau}_{gt} = \sum_i s_{ig,t-12}\Delta\tau_{igt}$ where $s_{igt-12} = \frac{q_{ig,t-12}}{Q_{g,t-12}}$ are the lagged (12-month) weights. Note that the tariff-inclusive import prices imply that a coefficient of 1 is consistent with complete pass-through. Table C5 summarizes the results. While this product-level specification reduces the pass-through estimates relative to Table C4, the magnitude and variation in the elasticities do not align well with our estimates in section E. While the graphical evidence from Figure 3 might suggest a negative product-level elasticity for the period of Korea/Mexico antidumping duties, the results in column (1) show a positive coefficient. This is due, at least in part, to the high (likely, prohibitive) duties on Mexican imports, as well as the Korean imports of Daewoo; a specification that abstracts from these duties (i.e. sets them to zero) does indeed yield a negative elasticity of -0.51 (not shown in table).

Table C5: Product Level Tariff Pass-Through Regressions on Import Prices (Inclusive of Tariffs)

	Kor/Mex AD	China AD	Sec. 201 Safeguard	
			20% rate	50% rate
	$\Delta \log p_{gt}$	$\Delta \log p_{gt}$	$\Delta \log p_{gt}$	$\Delta \log p_{gt}$
Variables	(1)	(2)	(3)	(4)
$\Delta(1+\tilde{\tau}_{gt})$	0.37	0.24	0.32	0.88
	(0.25)	(0.15)	(0.09)	(0.07)
Constant	0.02	-0.03	-0.04	-0.09
	(0.07)	(0.06)	(0.04)	(0.05)
Implied Elasticity	0.37	0.24	0.32	0.88
Observations	500	713	725	725
Adjusted R-squared	0.22	0.10	0.22	0.42
Product F.E.	Yes	Yes	Yes	Yes
Month F.E.	Yes	Yes	Yes	Yes
Weighted	Yes	Yes	Yes	Yes

Notes: The table reports product-level tariff pass-through to import prices (here, inclusive of tariffs). The $\Delta(1+\tilde{\tau}_{gt})$ is defined mirroring equation (5) in the main text: $\Delta\tilde{\tau}_{gt} = \sum_i s_{ig,t-12}\Delta\tau_{igt}$, where $s_{ig,t-12} = \frac{q_{ig,t-12}}{Q_{g,t-12}}$. The term $\Delta \ln p_{gt}$ is defined as $\Delta \ln p_{gt} = \Delta \ln \frac{\sum_i p_{igt} q_{igt}(1+\tau_{igt})}{\sum_i q_{igt}}$. Each regression is weighted by the total HS-level quantity in the 12-months preceding tariff changes. Robust standard errors are in parentheses.
Source: United States International Trade Commission (2010-2019) and authors' calculations.

C.9 Matched Washers and Dryers

Many washers are produced and sold with matching dryers. In this section, we match the washers with the dryers of the same brand in the Gap Intelligence data with the following procedure

1. For each brand, observe the pattern of model part numbers. In general, the same product family has the same numerical part of the part number.

2. Match washers by the numerical part, debut date, and base color.

3. For the rest unmatched washers, match again by the numerical part and base color. We allow for matched models to have different debut date.

We find that among the washers of the five major brands (LG, Samsung, Whirlpool, Maytag, G.E.), 75.3 percent of the 571 models have matching dryers. In general, within the matched group, one washer can be matched with two dryers: one gas dryer and one electric dryer. Gas dryers are usually priced higher than the electric dryers. After excluding the gas dryers and comparing only the electric washers and electric dryers within the matched group, we find the price correlation between washers and dryers is 0.967. In addition, for 86.3 percent of the matched observations, the washer has exactly the same price as the matching dryer.

C.10 Correlations of Sales Ranks

We scrape three retailer websites for appliances (Home Depot, JC Penny and Best Buy), obtaining a February 2019 snapshot of the sales rank of each model for every product (washers, dryers, dishwashers, refrigerators and ranges) based on the "Best Selling" indicator on the site. We also collect the model number and name. The data is then cleaned to extract the names of our five major brands (Whirlpool, Maytag, LG, Samsung and GE) from the product name. In a next step we create ranks within each brand (brand ranks) to match appliances based on brand name and brand rank.

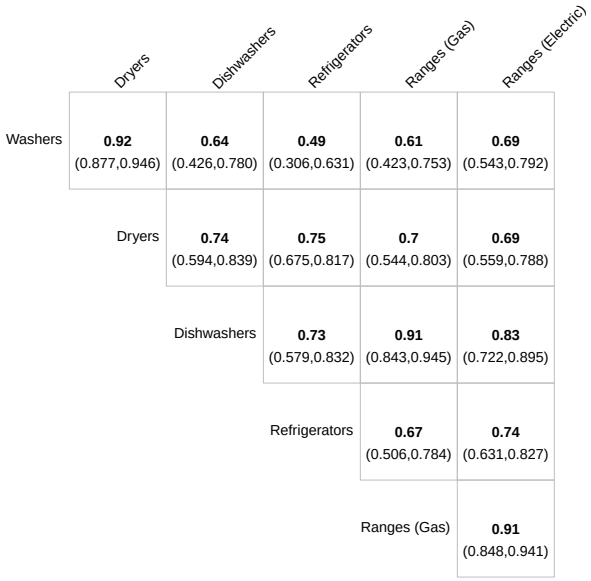
For instance, for a specific retailer the highest ranked Whirlpool washer is given a brand rank of one, the highest ranked LG washer for this retailer is also given a brand rank of one, the second highest ranked Whirlpool washer for this retailer is given a brand rank of two, and so on for each product and each retailer. We pair the highest ranked Whirlpool washer with the highest ranked Whirlpool dryer, refrigerator, dishwasher, and range. The second highest ranked product is matched with other second highest ranked products. If there is no 10th LG dryer to match with the 10th LG washer, we simply assign a missing value to the LG dryer.

Using this data, we compute the Pearson correlation coefficient between the sales ranks of every pair of products based on all pairwise non-missing observations in each retailer.

The results are shown in Figure C10. As is clear in the matrix of correlations, there is an especially tight connection between washers and dryers among the set of appliances for these retailers.

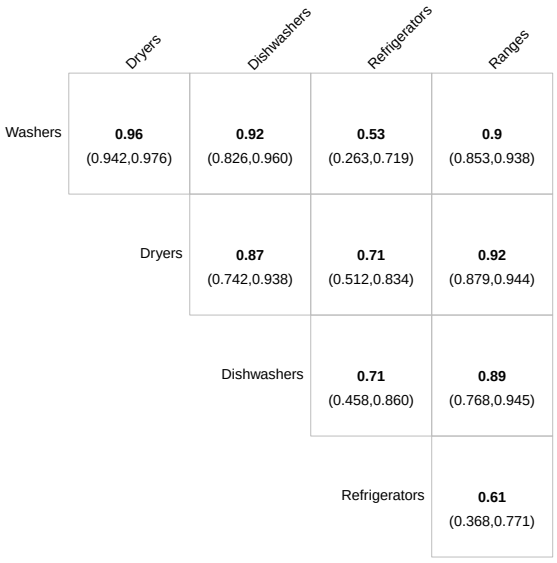
Figure C10: Sales Rank Correlations across Retailers

(a) Home Depot Appliance Sales Rank Correlation



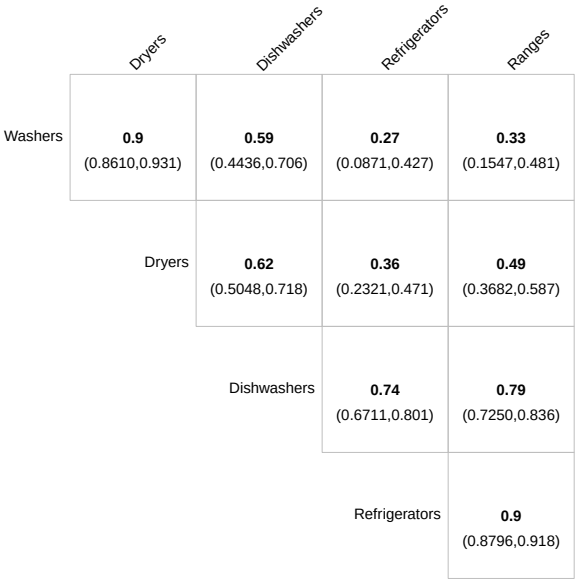
	Dryers	Dishwashers	Refrigerators	Ranges (Gas)	Ranges (Electric)
Washers	**0.92** (0.877,0.946)	**0.64** (0.426,0.780)	**0.49** (0.306,0.631)	**0.61** (0.423,0.753)	**0.69** (0.543,0.792)
Dryers		**0.74** (0.594,0.839)	**0.75** (0.675,0.817)	**0.7** (0.544,0.803)	**0.69** (0.559,0.788)
Dishwashers			**0.73** (0.579,0.832)	**0.91** (0.843,0.945)	**0.83** (0.722,0.895)
Refrigerators				**0.67** (0.506,0.784)	**0.74** (0.631,0.827)
Ranges (Gas)					**0.91** (0.848,0.941)

(b) JC Penny Appliance Sales Rank Correlation



	Dryers	Dishwashers	Refrigerators	Ranges
Washers	**0.96** (0.942,0.976)	**0.92** (0.826,0.960)	**0.53** (0.263,0.719)	**0.9** (0.853,0.938)
Dryers		**0.87** (0.742,0.938)	**0.71** (0.512,0.834)	**0.92** (0.879,0.944)
Dishwashers			**0.71** (0.458,0.860)	**0.89** (0.768,0.945)
Refrigerators				**0.61** (0.368,0.771)

(c) Best Buy Appliance Sales Rank Correlation



	Dryers	Dishwashers	Refrigerators	Ranges
Washers	**0.9** (0.8610,0.931)	**0.59** (0.4436,0.706)	**0.27** (0.0871,0.427)	**0.33** (0.1547,0.481)
Dryers		**0.62** (0.5048,0.718)	**0.36** (0.2321,0.471)	**0.49** (0.3682,0.587)
Dishwashers			**0.74** (0.6711,0.801)	**0.79** (0.7250,0.836)
Refrigerators				**0.9** (0.8796,0.918)

Notes: Correlations are Pearson's R. Confidence intervals in parentheses.
Source: Sales Rank Dataset (2019).

C.11 Foreign Trade Zone Production

One important feature of U.S. imports of washing machines is the use of foreign trade zone (FTZ) production in the United States. Created at the request of a U.S. firm to the U.S. Department of Commerce, a manufacturing facility in an FTZ operates outside of the customs border of the United States.[29] The intent, as the case in many developing countries, is to allow for processing production for re-export without incurring tariffs on the imported components. Hence, for the case of washing machines, an FTZ would allow a U.S. manufacturer to import the components of washing machines with little or no associated tariffs.

Typically, an imported good will be recorded twice: first as a "general import" when it arrives at the border, and then again as an "import for consumption" after it passes through customs. Most of the time differences in the recorded values between these two definitions are small and reflect idiosyncratic timing in customs clearance as well as time spent in temporary storage in bonded warehouses. FTZ production introduces another potential discrepancy between these two definitions, as FTZ production exists outside the customs border of the United States. Specifically, in FTZ production the imported component parts will enter the country recorded as "general imports," but will not be recorded as an "import for consumption" because they are processed inside the FTZ and therefore never cross the U.S. customs border.[30]

Another discrepancy can occur if the final good produced by the FTZ is not re-exported but rather ends up entering the U.S. market. This can be the case due to another motivation for FTZ production apart from removing traiffs on imported components of production for re-export: exploiting differences in the tariff rates between imported components and the final product. If the finished product of an FTZ enters the United States for domestic consumption, then the firm must then pay duties on the value of the imported parts. However, the FTZ firm is allowed to choose whether they pay the tariff rate of the finished product (washing machine) or the imported components (various washing machine parts). As the tariff rate on the finished product is lower, the firm records the import for consumption under the final product code classification (as a washing machine), but only on the foreign value-added component of production.

The increasing importance of FTZs for washing machine production destined for the U.S. market is evident in Figure C11. As shown in Figure C11a, a large gap emerges between imports for consumption and general imports in 2014; Figure C11b demonstrates that roughly all of this discrepancy owes to a jump in the Cleveland Customs District.

This feature of reporting by FTZ production provides valuable information for the calculation of the foreign import share of domestic value-added. Since the reported import values of washing machines in FTZs actually reflect the foreign value-added component (from parts) on the quantity of finished products, the unit values of the FTZ-based imports capture the per-unit value of foreign components used in production. We take these FTZ unit values and compare them to the average wholesale unit value of these washing machines from AHAM data to arrive at an estimate of the import share in value-added. The result is somewhere in

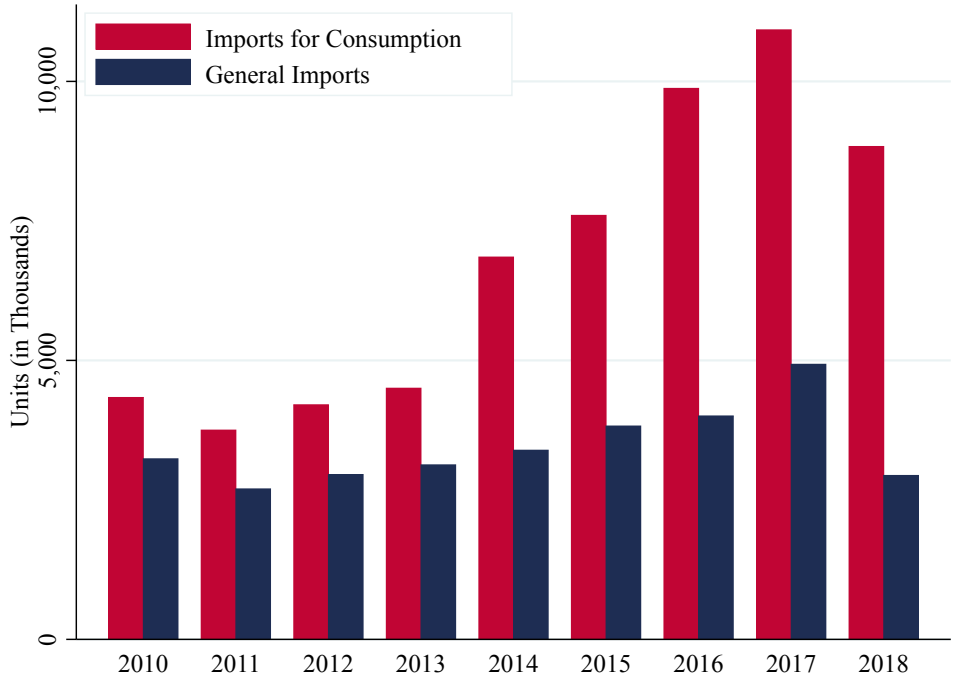
[29] Foreign trade zones exert a large influence on economic activity more generally. According to research by Grant (2017), foreign trade zones account for roughly one-sixth of U.S. manufacturing value-added, and one-eighth of the value of U.S. imports.

[30] Or, in the language of U.S. Customs Bureau, they remain as "Foreign Status" goods.

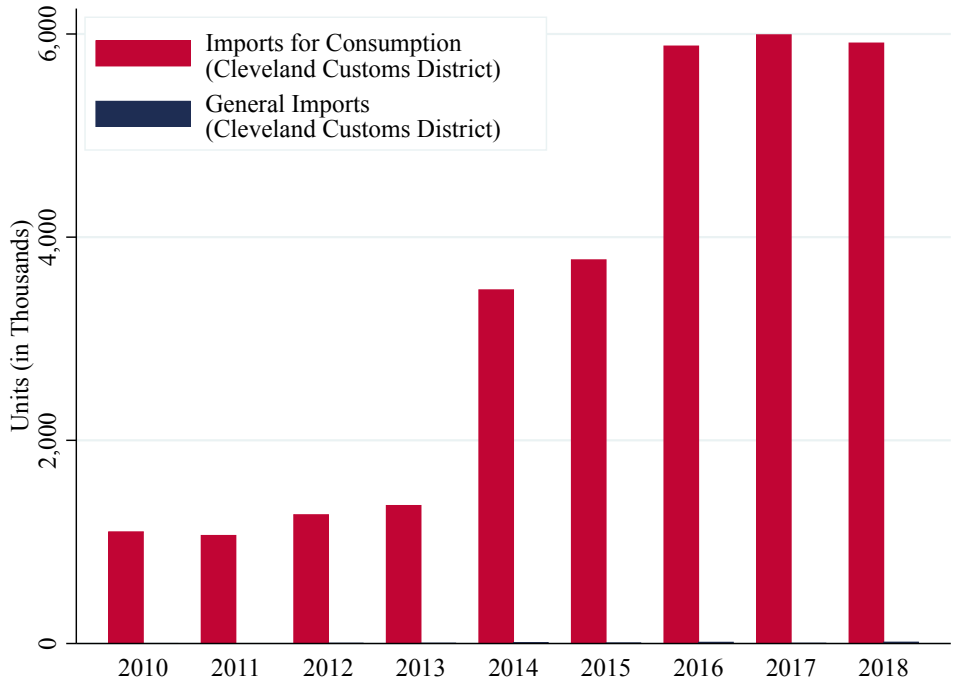
the vicinity of 5 and 11 percent of the average wholesale unit value from the AHAM data.

Figure C11: Annual 2010-2017 Quantity of Washing Machine Imports: Total and Cleveland Customs District

(a) Total



(b) Cleveland Customs District



Notes: Includes HS8450110040, HS8450110080, HS8450200040, HS8450200080, and HS8450200090.
Source: United States International Trade Commission (2010-2019).

C.12 Further Production Relocation Details

The details regarding how foreign firms relocated production are difficult to ascertain as they involve proprietary knowledge that is often not documented in public sources. Nevertheless, some useful pieces of information can be inferred from news reports and various documents prepared as part of the USITC investigation.[31] In 2017, LG had manufacturing operations for large residential washers in Korea, China, Thailand, and Vietnam, while Samsung had manufacturing operations in Mexico, Korea, China, Vietnam, and Thailand. Both of these firms did not begin producing these large washers in Vietnam until 2016, while production in Thailand increased sharply in 2016. Both expected production to decline from 2017 to 2018.

In both Vietnam and Thailand, these firms reported producing other products on the same equipment and machinery used to produce large residential washers. Thailand was a significant exporter of small residential washing machines (HS 845011) prior to the U.S. antidumping duties on China, and so its possible that some capacity was re-routed from small washers to large washers in Thailand.

These patterns are also confirmed by the firm-level import data described below in Section C.14.

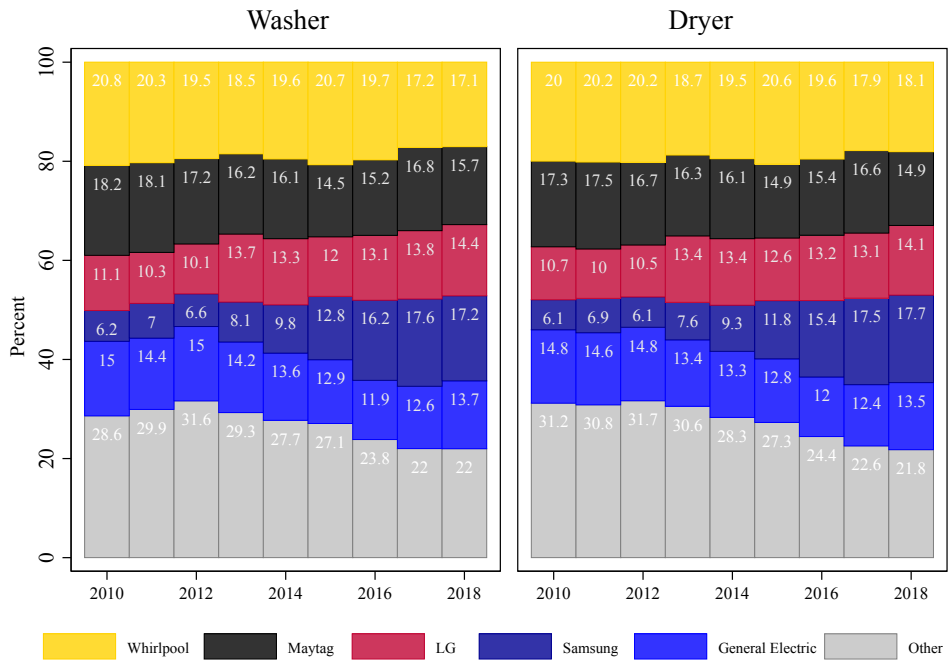
In the United States, both firms engaged in extensive construction of facilities. In early 2017, LG announced plans to build a new facility for washing machine production outside Clarksville, TN, with investments totally 360 million USD. Production did not begin in earnest until May 2019. Samsung also announced in mid-2017 the purchase of the site of a former Caterpillar factory in Newberry, SC, citing investments of 380 million USD. Production of washers began a short time later, in early 2018. [https://news.samsung.com/us/samsung-kicks-off-us-home-appliances-production/] The shorter time required for Samsung could have been due to their strategy to retrofit an existing facility, rather than engage in a greenfield investment.

C.13 Market Shares

To calculate brand-level market shares, we utilize consumer purchase data recorded by a market research firm, Traqline (Stevenson Company). They use internet surveys to track the brand-level information of washer and dryer purchases (and purchases of several other consumer goods). The market shares below are based on 14,500 to 22,500 washer purchases per year (12,500 to 19,000 dryer purchases per year).

[31] A useful news report on production relocations can be found here, with the following relevant section: "In 2012, a previous probe by the U.S. Commerce Department found that Samsung and LG washers made in South Korea and Mexico were sold below production costs in the United States or benefited from unfair subsidies. The South Korean companies subsequently shifted production for the U.S. market to China. In Dec. 7 testimony before the trade commission, lawyers for LG and Samsung said that the companies were now producing washers for the U.S. market in Thailand and Vietnam. In the case of Samsung, that production began in June 2016, about a month before the Commerce Department issued preliminary antidumping duties against Chinese-made LG and Samsung washers." For sources pertaining to the USITC investigations, see United States International Trade Commission 2017*b*.

Figure C12: Market Shares



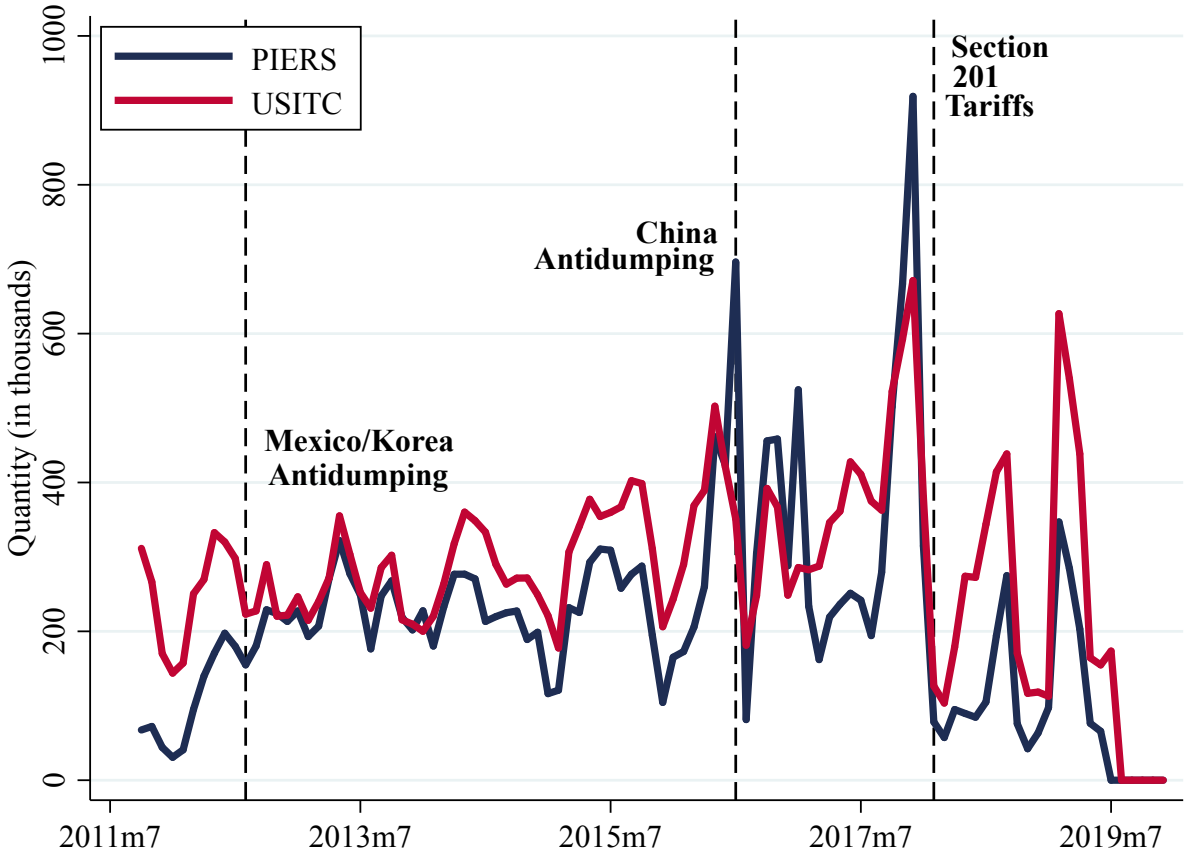
Source: Traqline Market Research (2010-2018).

C.14 Firm-Level Imports

Identifying the firms involved in import transactions is helpful for a variety of purposes, such as the aggregation of the antidumping duties and the further confirmation of production relocation occurring for the firms we study. We utilize the PIERS dataset, which is derived from bill of lading documents pertaining to U.S. ports. This data is shipment level data with variables that align with the relevant producing firm, such as the "shipper", "consignee" and "notify". There are quantities but only a rough estimate of shipment value, and as such we do not attempt to utilize this data for the construction of unit values. An additional concern is the potential for product mis-classification if shippers combine different products in a single shipment. Finally, as this data only captures U.S. imports by sea ports, it will miss imports from Mexico and Canada.

As shown in Figure C13, the alignment between the quantities of imports between PIERS and USITC (suitably adjusted for non-Mexican and non-Canadian source locations) is reasonably good. As can be seen in the figure, the PIERS data looks to exhibit greater lumpiness in monthly quantities, a fact which could be explained by the differences in the timing between when the bill of ladings are submitted and the imports are processed by U.S. Customs. Indeed, this lumpiness (and subsequent degree of mis-alignment) appears to be greatest when an uncharacteristically large mass of U.S. imports occurs directly before the application of the China antidumping and Section 201 tariffs.

Figure C13: U.S. Imports of Washing Machines: PIERS vs USITC



Notes: U.S. imports of washing machines from all source countries excluding Canada and Mexico.
Source: United States International Trade Commission (2010-2019) and PIERS (2012-2019) bill of lading data.

C.15 Price Effects Using Alternative Products as Control Group

Table C6: Difference-in-Difference Estimates: Using Refrigerators as Control Group

	Antidumping against China				**Safeguard tariffs 2018**			
	4-month	8-month	4-month	8-month	4-month	8-month	4-month	8-month
Washers	0.001	0.026	0.008	0.031	0.108	0.150	0.113	0.137
	(0.015)	(0.017)	(0.012)	(0.013)	(0.012)	(0.015)	(0.011)	(0.011)
Dryers	-0.008	0.015	-0.005	0.019	0.110	0.149	0.114	0.137
	(0.012)	(0.014)	(0.009)	(0.010)	(0.011)	(0.013)	(0.008)	(0.008)
Dishwashers	-0.013	-0.014	-0.004	-0.003	-0.011	0.014	-0.010	0.001
	(0.013)	(0.014)	(0.007)	(0.008)	(0.010)	(0.015)	(0.007)	(0.007)
Ranges	-0.025	-0.008	-0.039	-0.028	-0.001	0.035	0.002	0.018
	(0.010)	(0.013)	(0.007)	(0.007)	(0.010)	(0.015)	(0.006)	(0.007)
Model characteristics	✓	✓			✓	✓		
Model fixed effects			✓	✓			✓	✓
N	1,637,298		1,637,298		1,637,298		1,637,298	

Table C7: Difference-in-Difference Estimates: Using Dishwashers as Control Group

	Antidumping against China				**Safeguard tariffs 2018**			
	4-month	8-month	4-month	8-month	4-month	8-month	4-month	8-month
Washers	0.014	0.040	0.011	0.034	0.119	0.136	0.123	0.136
	(0.017)	(0.018)	(0.012)	(0.013)	(0.014)	(0.018)	(0.011)	(0.012)
Dryers	0.004	0.029	-0.002	0.023	0.121	0.135	0.124	0.136
	(0.014)	(0.015)	(0.009)	(0.010)	(0.012)	(0.016)	(0.009)	(0.010)
Refrigerators	0.013	0.014	0.004	0.003	0.011	-0.014	0.010	-0.001
	(0.013)	(0.014)	(0.007)	(0.008)	(0.010)	(0.015)	(0.007)	(0.007)
Ranges	-0.012	0.006	-0.035	-0.024	0.010	0.021	0.012	0.017
	(0.013)	(0.014)	(0.008)	(0.008)	(0.012)	(0.018)	(0.007)	(0.009)
Model characteristics	✓	✓			✓	✓		
Model fixed effects			✓	✓			✓	✓
N	1,637,298		1,637,298		1,637,298		1,637,298	

C.16 List of Product Characteristics

Table C8 describes the additional product characteristic variables included in the Gap Intelligence data.

Table C8: List of Product Characteristics

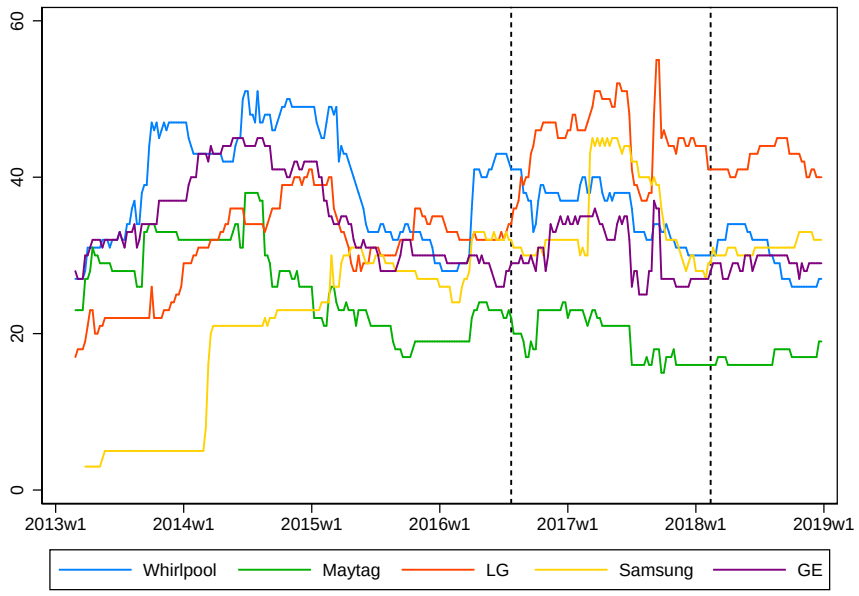
Washers	
Total capacity	Dummies for less than 3.0, 3.0-4.0, 4.0-5.0, more than 5.0 cu. ft.
Steam	Dummy for steam
Energy star	Dummy for energy star
Smart appliance	Dummy for smart appliance
Load type	Dummy for top load
Color	Dummy for white
Digital display	Dummy for digital display
Chrome trim	Dummy for chrome trim
Cycles	Dummies for less than 7 cycles, each of 8-14 cycles, 15 cycles or more
Washing mechanism	Dummy for agitator
Dryers	
Total capacity	Dummies for less than 4.0, 4.0-5.1, 5.9-6.8, 7.0-7.8, no less than 8.0 cu. ft.
Steam	Dummy for steam
Energy star	Dummy for energy star
Smart appliance	Dummy for smart appliance
Electric/gas	Dummy for gas
Color	Dummy for white
Digital display	Dummy for digital display
Chrome trim	Dummy for chrome trim
Cycles	Dummies for less than 7 cycles, each of 8-14 cycles, 15 cycles or more
Dishwashers	
Width	Dummy for 23 inches or more
Place setting capacity	Dummies for less than 10, 12-13, 14, 15, 16 or more, cu. ft.
Energy star	Dummy for energy star
Cycles	Dummies for 1-4 cycles, 5 cycles, 6 cycles, 7 or more cycles
Color	Dummies for black, white, stainless steel
Tub material	Dummy for stainless
Refrigerators	
Width	Dummies for less than 30, 30-35, 35-36, 36 or more inches
Total capacity	Dummies for less than 18, 18-20, 20-23, 23-27, 27 or more cu. ft.
Freezer capacity	Dummies for less than 5, 5-7, 7-9, 9 or more cu. ft.
Exterior dispenser	Dummy for exterior water and ice dispenser
Color	Dummies for white, black, and stainless steel
Product type	Dummies for top freezer, bottom freezer, side by side, and french door
Number of doors	Dummy for 3 or more doors
Ranges	
Cooktop elements	Dummies for 4 or less, 5, 6 or more
Oven capacity	Dummies for no more than 3.4, 3.5-4.45, 4.5-5.5, 5.6-6.5, no less than 6.6 cu. ft.
Cleaning type	Dummy for self-cleaning
Fuel type	Dummies for gas, electric, dual, and induction
Griddle	Dummy for griddle
Double ovens	Dummy for double ovens
Convection	Dummy for convection
Fan	Dummy for fan convection type
Color	Dummies for stainless, white, black
Range type	Dummy for freestanding

C.17 Total Number of Available Models

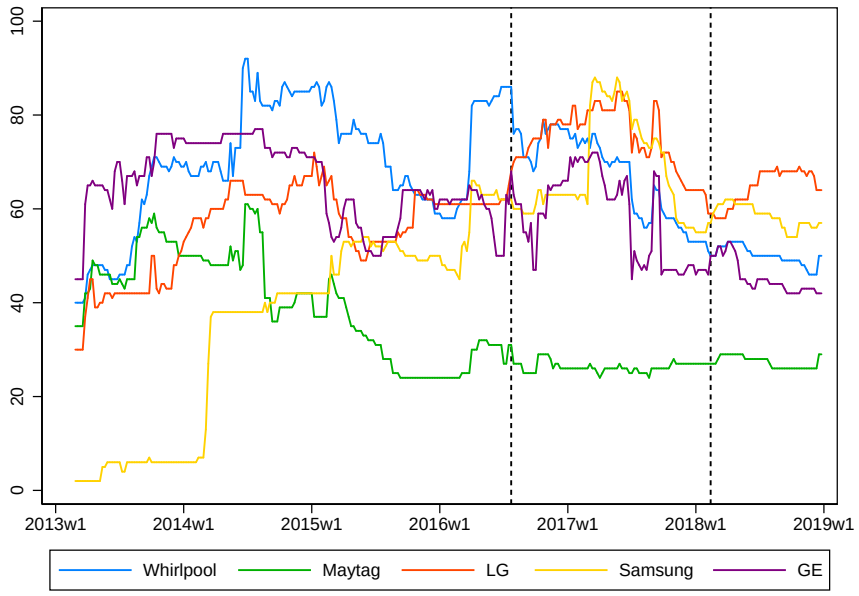
Figure C14 displays the number of available models by brand across the periods we study.

Figure C14: Total Number of Available Models by Brand

(a) Washers



(b) Dryers

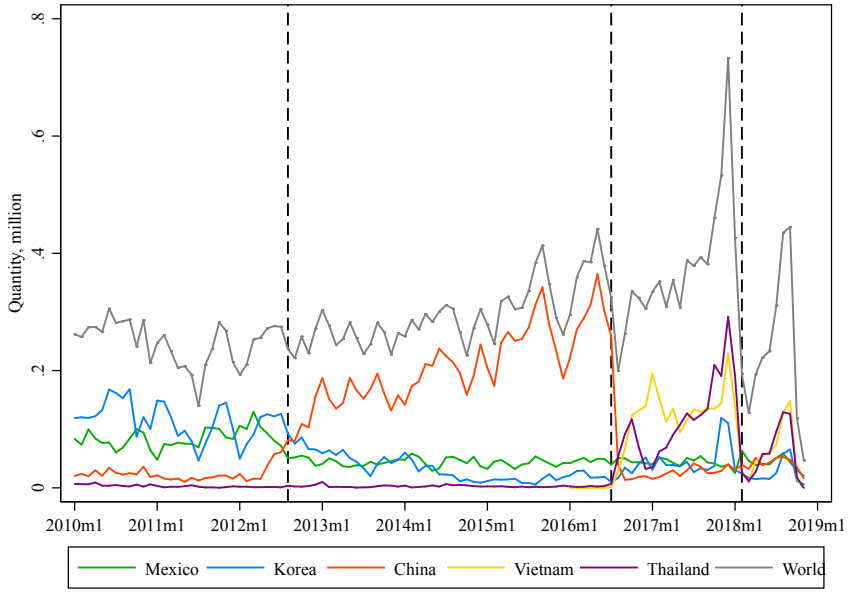


Notes: We count the number of unique models that appeared in a given week. Only 5 major retailers are included in the count. Two vertical date lines are July 26, 2016 and February 6, 2018, which are discussed in the text.

D Robustness Figures and Tables

In this section, we include the results from a variety of robustness checks on our analysis on washing machine price changes following recent trade policy actions.

Figure D1: Monthly U.S. Imports of Washing Machines by Country (Quantity), Seasonally Adjusted



Notes: Residential washing machines are classified under HS8450110040, HS8450110080, HS8450200040, HS8450200080, and HS8450200090.
Source: United States International Trade Commission (2010-2019).

Figure D2: Time Fixed Effects from Log Price Regression (All 5 Appliances), CPI for Laundry Equipment

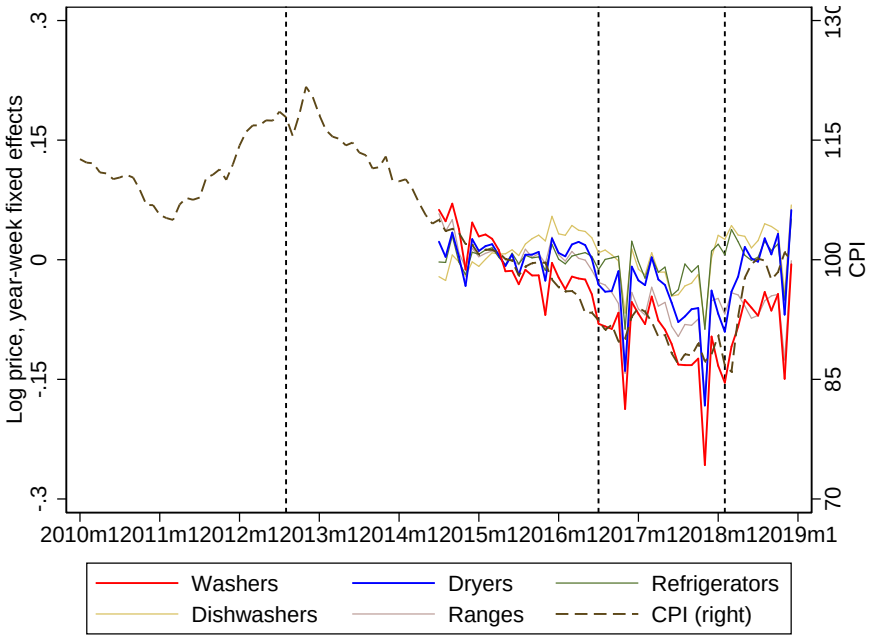
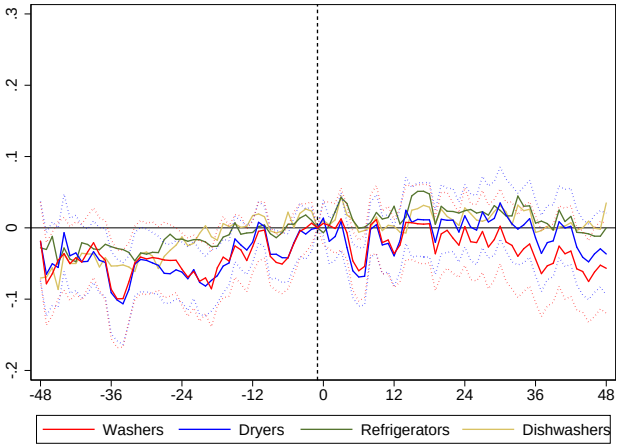
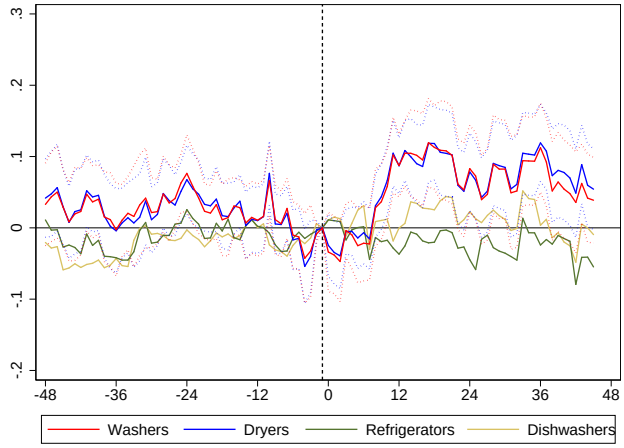


Figure D3: Price Effects of Safeguard Tariffs and Antidumping Duties against China: by Brand, with Model Characteristics as Controls

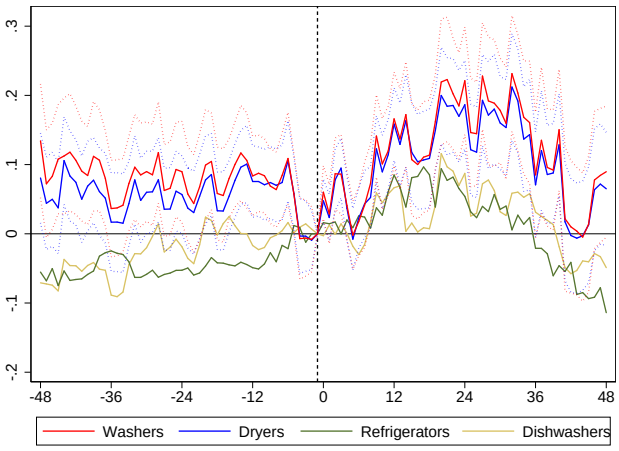
(a) Antidumping against China - Whirlpool



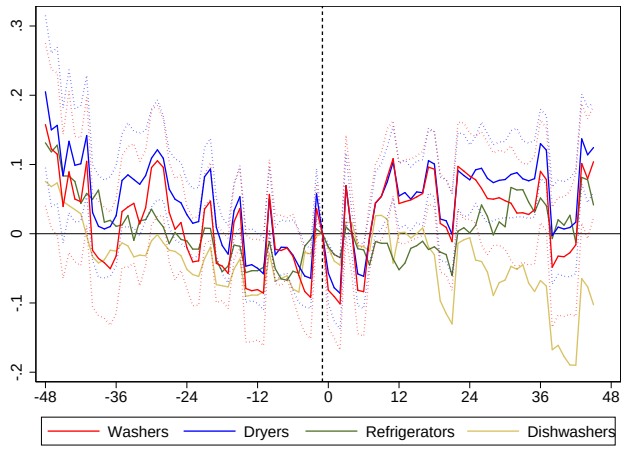
(b) Safeguard Tariffs 2018 - Whirlpool



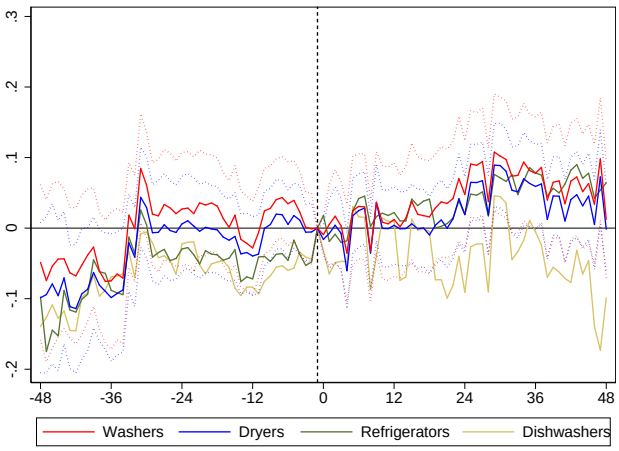
(c) Antidumping against China - Maytag



(d) Safeguard Tariffs 2018 - Maytag



(e) Antidumping against China - LG



(f) Safeguard Tariffs 2018 - LG

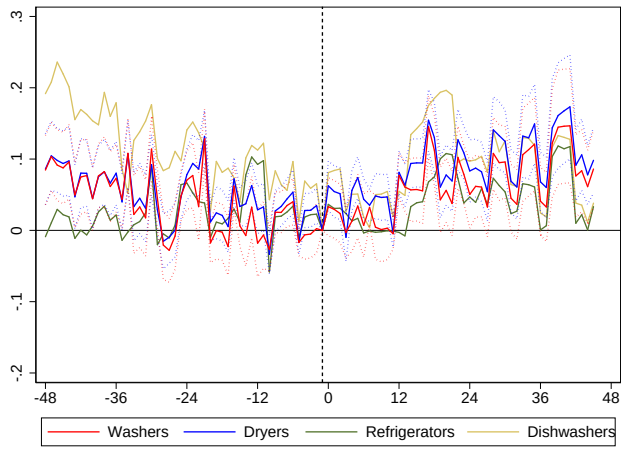
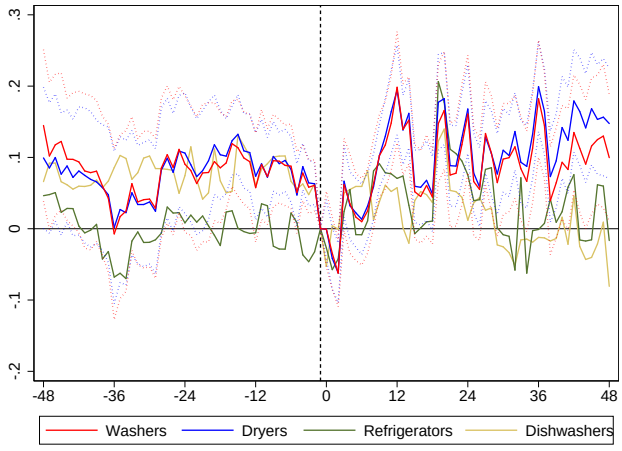
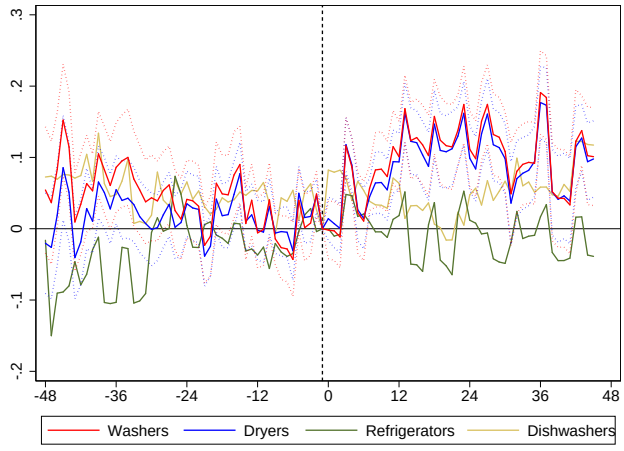


Figure D3: Price Effects of Safeguard Tariffs and Antidumping Duties against China: by Brand, with Model Characteristics as Controls (Continued)

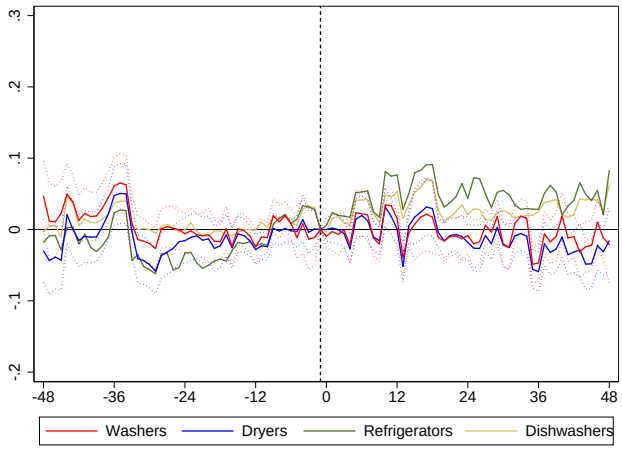
(g) Antidumping against China - Samsung



(h) Safeguard Tariffs 2018 - Samsung



(i) Antidumping against China - G.E.



(j) Safeguard Tariffs 2018 - G.E.

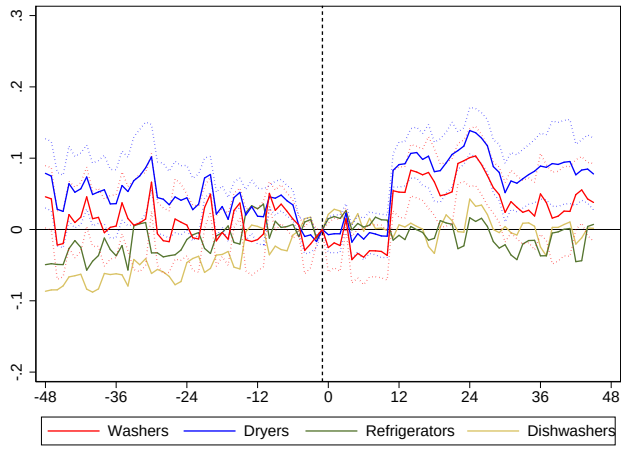


Table D1: Difference-in-Difference Estimates: Brand-Specific Price Effects of Washing Machine Tariffs, Alternative Specification with Model Fixed Effects as Controls

	Washers		Dryers		Refrigerators		Dishwashers	
	4-month	8-month	4-month	8-month	4-month	8-month	4-month	8-month
Antidumping against China								
Whirlpool	0.038	0.046	0.035	0.051	0.026	0.022	0.017	0.011
	(0.023)	(0.027)	(0.017)	(0.020)	(0.011)	(0.011)	(0.014)	(0.015)
Maytag	0.063	0.086	0.069	0.081	0.065	0.065	-0.001	-0.012
	(0.031)	(0.034)	(0.025)	(0.029)	(0.023)	(0.026)	(0.028)	(0.025)
LG	0.018	0.046	-0.002	0.030	0.019	0.045	0.040	0.066
	(0.027)	(0.026)	(0.021)	(0.022)	(0.018)	(0.020)	(0.027)	(0.028)
Samsung	0.067	0.051	0.060	0.033	0.118	0.041	0.078	0.027
	(0.030)	(0.035)	(0.023)	(0.026)	(0.020)	(0.022)	(0.029)	(0.036)
G.E.	0.025	0.023	0.010	0.011	0.015	0.015	0.029	0.022
	(0.015)	(0.018)	(0.011)	(0.014)	(0.007)	(0.009)	(0.008)	(0.010)
Safeguard tariffs 2018								
Whirlpool	0.180	0.146	0.168	0.139	0.008	-0.010	0.030	0.025
	(0.024)	(0.027)	(0.019)	(0.020)	(0.015)	(0.016)	(0.017)	(0.019)
Maytag	0.143	0.091	0.163	0.152	0.033	0.065	0.017	0.067
	(0.030)	(0.040)	(0.027)	(0.036)	(0.022)	(0.026)	(0.023)	(0.033)
LG	0.054	0.081	0.053	0.067	-0.001	-0.015	0.046	-0.007
	(0.016)	(0.017)	(0.014)	(0.013)	(0.016)	(0.012)	(0.016)	(0.018)
Samsung	0.142	0.154	0.112	0.125	-0.025	-0.077	-0.043	-0.027
	(0.026)	(0.029)	(0.020)	(0.023)	(0.015)	(0.019)	(0.016)	(0.024)
G.E.	0.089	0.086	0.116	0.111	-0.011	-0.008	-0.029	-0.015
	(0.018)	(0.018)	(0.014)	(0.014)	(0.009)	(0.009)	(0.011)	(0.011)

Notes: The table reports results analogous to Table 1—based on separate estimates for each brand. Specifically, first equation (4) is estimated (with model fixed effect as controls) and then a linear combination of these estimates is used to compute the left hand side of equation (3)—separately for each brand and product category. Standard errors in parentheses.

Table D2 displays the difference-in-difference estimates for washers and dryers under various robustness specifications.

Table D2: Summary of Robustness Results for Difference-in-Difference Estimates

		(1) Main	(2) All brands, offline stores	(3) All brands, offline stores (weighted)	(4) All brands, all stores (unweighted)	(5) Without age controls	(6) Long sample with alternative age controls
Antidumping against China							
Washers	4-month	0.026	0.031	0.036	0.023	0.021	0.025
		(0.015)	(0.015)	(0.018)	(0.013)	(0.016)	(0.015)
	8-month	0.034	0.034	0.044	0.041	0.027	0.033
		(0.017)	(0.018)	(0.020)	(0.015)	(0.017)	(0.017)
Dryers	4-month	0.016	0.020	0.031	0.014	0.015	0.017
		(0.012)	(0.013)	(0.015)	(0.010)	(0.011)	(0.012)
	8-month	0.023	0.017	0.047	0.023	0.022	0.021
		(0.014)	(0.015)	(0.017)	(0.011)	(0.013)	(0.014)
Safeguard tariffs 2018							
Washers	4-month	0.109	0.087	0.089	0.069	0.112	0.109
		(0.014)	(0.014)	(0.016)	(0.011)	(0.014)	(0.014)
	8-month	0.115	0.091	0.137	0.081	0.126	0.120
		(0.018)	(0.018)	(0.022)	(0.014)	(0.018)	(0.018)
Dryers	4-month	0.111	0.097	0.099	0.074	0.114	0.109
		(0.013)	(0.013)	(0.015)	(0.010)	(0.013)	(0.013)
	8-month	0.114	0.082	0.131	0.077	0.122	0.116
		(0.017)	(0.018)	(0.019)	(0.013)	(0.016)	(0.017)
N		1,637,298	1,288,919	1,193,439	3,955,956	1,637,298	1,950,470

Notes: Column 1 represents the baseline estimates with model characteristics as controls. Column 2 keeps a sample of only offline stores for all retailers and includes all brands. Column 3 weights observations by the number of brick-and-mortar stores for each retailer (i.e., giving more weights to observations at retailers with more stores). The estimates in column 4 are based on a regression that includes all brands and all retailers (both online and offline stores, unweighted). The estimates in column 5 are based on a regression that uses the baseline sample of brands and retailers and excludes product age dummies. The estimates in column 6 are based on the baseline sample of brands and retailers, utilizing all observations starting from March 3, 2013. In addition, all age dummies for initial models are assigned zeros, and one separate dummy for initial models is added.