Assessing an ITC Investigation:
The Case of Large Residential Washing Machines from China

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Introduction

In 2015, when the Whirlpool Corporation (Petitioner) filed a complaint with the International Trade Commission (ITC) against LG Electronics Inc. and Samsung Electronics Co. (Respondents), it was not the first time. Two years prior, in 2013, Whirlpool petitioned the ITC for anti-dumping and countervailing duties on Respondents’ imports of Large Residential Washers (LRWs) from South Korea and Mexico.\(^1\) In 2015, Petitioner secured anti-dumping and countervailing duty orders on what were found to be injurious imports selling at artificially deflated prices. Anticipating increased domestic market share as a result of these protections, Whirlpool, alongside fellow domestic manufacturer General Electric (GE), invested “hundreds of millions of dollars” in R&D and facilities and “were therefore poised to deliver washers with outstanding quality…because raw material inputs—the most significant component of manufacturing costs—were declining” (ITC, 2016, p.14). When LG and Samsung moved LRW manufacturing to the People’s Republic of China (China) in order to circumvent American tariffs, Petitioner saw low to no return on investment, forcing the cancellation of at least one new LRW project and the forfeiture of 600 jobs at the Whirlpool manufacturing hub in Clyde, Ohio.

Can Petitioner’s operating losses be attributed to dumping activity by Samsung and LG, or are there confounding factors that obscure the effects of Respondents’ activity in the domestic market? This paper investigates the validity of the ITC’s decision to impose anti-dumping duties on imports of LRWs from China. Firstly, using the Ricardian, Heckscher-Ohlin and Economies of Scale models, we identify Chinese comparative advantage in the production of LRWs. We next outline American economic and socioeconomic conditions that may have contributed to Petitioner’s loss of domestic market share. Such conditions include the ongoing consolidation of

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\(^1\) For the purposes of our analysis, LRWs can be understood as LRW parts and finished washers. More details of Commerce’s scope can be found on pages three through seven of *ITC* (2017).
the American manufacturing belt, changing consumer preferences, and the unique demands of American environmental legislation. Given these findings, we cannot accept, without qualification, the ITC’s decision to impose duties on Chinese imports of LRWs.

**Case Summary**

The longevity of the American LRW manufacturing industry should have been a source of pride and business advantage for Whirlpool. Certainly, “Clyde Pride” is palpable in both the testimony of Whirlpool executives at the ITC hearing and the promotional videos on Whirlpool’s website (Chamber of Commerce of Sandusky County Facebook, 2020). A pop-up entitled “Down but never out” recounts the damaging effects of the Great Depression (1929-1939): just 30% of washing machine manufacturers survived the downturn, often by operating at reduced capacity, but by 1941 Whirlpool had made a comeback as the world’s largest manufacturer of washers (Whirlpool Corp., 2023). Just three years earlier, however, Lee Byung-chul founded Samsung, a small food exporter, in Daegu, South Korea. LG Electronics was founded as GoldStar in Seoul in 1958. Washing machines were among both companies’ first manufactured products, but their offerings did not enter the U.S. market until 2003.

In the interim, Whirlpool maintained 64% of domestic market revenue, largely unthreatened by competition, whether domestic (e.g. GE) or foreign (e.g. Bosch models from Germany) (Whirlpool, 2003). According to survey data, as of May 2017 Whirlpool maintains 29% of market share among washing machine brands in the U.S., followed by Maytag and GE, with 16% and 14% of domestic market share respectively. LG and Samsung shared a combined 18% of the market (Statista, 2017). Presumably, these proportions reflect, at least in part, the extended presence of the Whirlpool washers in the domestic market. With this in mind, an explanation of Whirlpool’s operating losses becomes particularly urgent post-2003.
In Whirlpool’s view, this case is dominated by a single factor: pricing. Mr. Levy, for the Petitioner, laments that “Samsung and LG go on and on about the importance of brand, product features and innovation” when in reality, “these things are table stakes” (ITC, 2016, p.17). All LRWs in the market, he argues, are comparable. Thus, manufacturers compete for flooring space in retailers based on price, rather than quality, technological features, or design. In such a market, “it follows that these dumped prices would result in Samsung and LG capturing market share, and that is exactly what happened at the expense of Domestic Producers” (ITC, 2016, p.18).

Whirlpool attributes lost sales and lost revenues to these adverse price and volume effects, citing emails from Sales Managers at Lowe’s and Home Depot that threaten to discontinue Whirlpool’s contracts if they cannot match Samsung and LG’s pricing (ITC, 2016).

Michael T. Shor, counsel for Samsung, does not accept Petitioner’s emphasis on pricing. “Ask yourself,” he begs, “when you last bought a washer, if you considered brand, if you considered a consumer rating, style, color, technology and features for an appliance that you were going to look at and use for the next ten years or more or did you select the model you bought based on price” (ITC, 2016, p.21). According to Respondents, retailers stock all of the major brands. Therefore, sales are determined at the consumer level. In summary, whether or not Respondents’ prices were lower than Petitioner’s does not necessarily account for sales data. To determine the relative importance of prices as an explanatory factor of Petitioner’s disappointing performance in the Period of Interest (POI), we will first need to analyze the significance of the dumping margin, as determined by the Department of Commerce (DOC) We will then consider other potential confounders in Whirlpool’s market performance, including but not limited to consumer preferences.
**Ricardian Explanation**

In its final analysis, the DOC found that all surveyed producers sold LRWs at less than fair value (LTFV) in the American market. According to the report, dumping margins for imports from China were between 32.12% and 52.51% (DOC, 2016). An analysis of relative productivity and relative wages calls into question the deliberateness of this price differential. A simple Ricardian analysis reveals a Chinese comparative advantage in the production of LRWs, with some caveats related to manufacturing data.

According to the multiple-good Ricardian model, we expect low relative productivity to be offset by low wages, while high relative productivity should be accompanied by high wages. To determine relative productivity, we divide total output of household washing machines in either country by their respective total employment in household appliance manufacturing. This yields a marginal product of labor (MPL). Inverting MPL yields the unit labor requirement (ULR), the number of hours of labor required to produce one unit of output (one LRW). Relevant data is assembled in Table 1.

**Table 1**  
*Calculated MPL and ULR for China and the U.S.*

<table>
<thead>
<tr>
<th>Country</th>
<th>Output</th>
<th>Labor</th>
<th>MPL</th>
<th>ULR</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>71,507</td>
<td>315,570</td>
<td>0.227</td>
<td>4.405</td>
</tr>
<tr>
<td>U.S.</td>
<td>14,000</td>
<td>32,970</td>
<td>0.425</td>
<td>2.355</td>
</tr>
</tbody>
</table>

*Note:* MPL is equal to labor divided by output. ULR is equal to output divided by labor.

Given that the U.S. exhibits a lower ULR than China, industry productivity in the U.S. is relatively greater than productivity in China. This is the first necessary consideration for a Ricardian analysis, but to determine which country has a comparative advantage, we must next calculate a relative wage.
Table 2 assembles wage data in Electrical Equipment Manufacturing (EEM) in China and the U.S. Dividing U.S. hourly wage by Chinese hourly wage gives the U.S. relative wage in EEM. The inverse calculation gives the Chinese relative wage in EEM. U.S. relative wage greatly exceeds the Chinese calculation. Even deflating the 2023 data for U.S. earnings to 2014 levels, the year from which Chinese earnings are taken, relative wage differentials are large enough to be interchangeable throughout the calculation, which is continued below.

**Table 2**

*Relative Wages*

<table>
<thead>
<tr>
<th>Country</th>
<th>Hourly wage in EEM</th>
<th>Yearly earnings in EEM</th>
<th>Relative wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>20.77 USD</td>
<td>43,320 USD</td>
<td>12.363 USD</td>
</tr>
<tr>
<td>China</td>
<td>1.68 USD</td>
<td>3,500 USD</td>
<td>0.081 USD</td>
</tr>
</tbody>
</table>

*Note:* Calculation of Chinese hourly wage in EEM assumes a comparable working schedule between U.S. and Chinese workers.

*Note:* Calculation of Chinese yearly earnings in USD uses 2014 wages with a 2023 exchange rate of RMB to USD. Since 2017, both the volatility and value of RMB has increased, further complicating the calculation.

Finally, multiplying ULR by relative wage for each country yields the respective estimated costs of production. Because the calculated cost of LRW production in the U.S. exceeds that in China, despite higher U.S. relative wages, we conclude that China has the comparative advantage. In this case, low relative productivity in China is compensated by low Chinese wages, or U.S. relative productivity is not great enough to offset high U.S. wages.

Hourly wage data in Chinese appliance manufacturing proved difficult to find. Table 2’s data was originally expressed with several qualifications in RMB in the 2006-2015 Labour Statistical Yearbook. Namely, average wages were derived from population surveys and census data and include urban enterprises only. Acknowledging the data set’s limitations, we conclude that, according to a Ricardian analysis, China has a comparative advantage in LRW production. Further analysis using the Heckscher-Ohlin and Economies of Scale models affirms this finding.
This could suggest that China is suited to export LRWs and may be able to offer them at lower price, undermining the suggestion that the only reason for low pricing would be dumping.

**Heckscher-Ohlin Explanation**

The Heckscher-Ohlin model may suggest that China is better suited to export LRWs than the U.S. (and therefore offer lower prices) if China’s relative factor endowment aligns with the factor-intensity of the production of LRWs. To examine this, two questions must be addressed: in what particular factor is the production of LRWs intensive, and what are the relative factor endowments of China and the U.S.? This model is based on strong assumptions. These include (1) that the production function for LRWs exhibits constant returns to scale and diminishing marginal returns, and (2) that China and the U.S. have identical production technologies in the subject good. In this discussion, we presuppose these assumptions to be true.

It is useful to define factor-intensity in the context of LRWs. Labor intensive production of LRWs means more labor is used relative to other factors, such as capital. Another way to characterize production is to determine whether it requires a relatively high skill level. This requires understanding the LRW production process; Petitioner states that all producers of LRWs use the “same manufacturing technology and processes” (ITC, 2017, p. 71). Our analysis accepts Petitioner’s claim that LRW production is localized despite requiring many intermediate parts. Inputs include raw materials (e.g. steel) and purchased components (e.g. pre-stamped metal blanks, injection molded parts, electrical subassemblies, and packaging materials) (ITC, 2017, p. 71). Supply depends on availability of these goods from third-party vendors (ITC, 2017a, p.85).

Research suggests that U.S. appliance manufacturing is somewhat labor intensive. Figure 1 displays the ratio of capital intensity in the electrical equipment, appliance, and components industry from 2012 to 2017 (the ratio of capital to hours worked in the production process).
As shown in the figure, the historical capital intensity ratio for this industry is low, even negative at points, indicating that this industry is labor intensive (Board of Governors of the Federal Reserve System, 2023). Further, appliance manufacturing is generally accepted to be somewhat labor intensive by academics studying trade patterns (Liu and Yang, 2013). We attribute this difference to the many intermediate parts in LRW production. In terms of LRWs’ labor intensity, electronic and machinery manufacturing is broadly considered to be low-skilled labor intensive (Chongvilavan et al., 2009). We assume that relatively more low-skilled workers are involved in LRW production than in design, which is dominated by high-skilled workers.

Attainment of a bachelor’s degree will be used as a proxy for “skill” in the labor market. According to an employment listing for Whirlpool in Clyde, an assembly line hire only needs a high school education and some manufacturing experience (Geebo.com, 2020). Based on this limited analysis, we assume LRWs to be somewhat labor and low-skilled labor intensive.

With respect to factor endowments, China is considered to be labor abundant relative to the U.S.. This is attributed to China’s massive population of workers and the relatively low stock
of physical capital (Marshall, 2011). Table 3 illustrates this by comparing total labor force with gross capital formation in a simple ratio (World Bank Open Data, 2023). 2015 is used as an example year in the POI.

Table 3
Capital and Labor Abundance for U.S. and China for 2015

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP (USD)</th>
<th>Labor force (people)</th>
<th>Gross Capital formation (in % of GDP) x GDP</th>
<th>K/L</th>
<th>Capital Abundant</th>
<th>Labor Abundant</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>11.06 trillion</td>
<td>780,709,784 million</td>
<td>43% x 11.06 trillion: 4.756 trillion</td>
<td>6091.89</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>USA</td>
<td>18.21 trillion</td>
<td>160,644,681 million</td>
<td>21% x 18.21 trillion: 3.284 trillion</td>
<td>20442.63</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

As Chen and Hou (2022) highlight, China’s relative labor input in industry remains high, despite modernization. Relative to the high capital stock of the U.S., China is labor-abundant. China is also considered to be abundant in low-skilled labor relative to the U.S., as shown by comparing levels of education in the two countries. In 2010, the percentage of the Chinese population, 25 or older, that attained at least a bachelor’s or equivalent was 3.6% (World Bank Open Data, 2023). UNESCO data compiled from the World Bank in 2023 suggests the percentage of the American population, 25 or older, that attained at least a bachelor’s or equivalent ranges from a low of 31.7% in 2013 to a high of 35% in 2018. This range, which covers the POI, is approximately ten times higher than the statistic from China. Even allowing for significant variation, this could indicate the U.S. population has relatively higher levels of education. Therefore, the U.S. can be considered relatively skilled-labor abundant. This fact is also generally accepted in trade literature, as can be seen in Autor, Dorn, and Hanson (2016). Based on this limited analysis, the U.S. is abundant in high-skilled labor.
The above factor intensities and factor endowments inform the Hecksher-Ohlin model’s prediction about which country has the comparative advantage in exporting LRWs. When considering labor and capital as the two factors of production, this model predicts that China would export LRWs because the goods are labor-intensive. This implies that the Chinese economy has the comparative advantage in producing LRWs. When considering skilled labor and unskilled labor as the two factors of production, this model predicts that China, abundant in low-skilled labor, would export LRWs, whose production is low-skilled labor intensive. Therefore, the Hecksher-Ohlin model would suggest that Chinese producers have the comparative advantage in LRWs and could offer a lower price than their U.S. counterparts.

**Economies of Scale**

To assess whether economies of scale play a role in the LRW trade dispute, it is necessary to assess whether economies of scale are more present in the Chinese or American industry. To this end, we examined geographic concentration, industry size, number of firms in industry, and industry history. For this analysis, two types of economies of scale will be used: (1) external, suggesting that as industry output increases then average cost goes down, and (2) internal, suggesting that as firm output increases, average cost goes down. The causes of this cost decrease include labor market pooling, specialized suppliers, and knowledge spillovers.

**Figure 2**

*Geographic Concentration of US LRW producers (Left) and of Chinese LRW Producers (Right)*
Figure 2 gives a visual demonstration of production clustering for the main petitioners and respondents. The two Chinese production plants are 225 km apart (Nanjing LG Panda Appliances Co., Ltd. Company Profile | Nanjing, Jiangsu, China | Competitors, Financials & Contacts - Dun & Bradstreet, 2023) (Chinese Chamber of Commerce, 2023). The U.S. plants are 181 km apart (Whirlpool and Staber), 722 km (Whirlpool and Alliance), and 492 km apart (ITC, Large Residential Washers from China, 104). Whirlpool is used as a reference as they are the most vocal petitioner in this dispute. Another necessary consideration for economies of scale is examining both firm number and output, and industry output.

The U.S. may have more firms, but the Chinese appliance manufacturing industry is much bigger (approximately triple the size of the U.S. manufacturing industry) (Statista, 2023). Also, it is notable that Samsung and LG, as massive multinational corporations, have a more vertically disintegrated supply chain compared to Whirlpool and the other petitioners, who specialize mainly in appliances. As Samsung and LG are so large, they may have cost advantages due to their ability to produce intermediate parts themselves or in foreign locales with cheap labor, rather than having to buy specialized parts from suppliers as the American firms must. Williamson (2015) discusses how strategies for innovation, international value chain configuration, and foreign mergers and acquisitions contributed to the competitive advantages of multinationals emerging from China and other BRICS countries. In 2015, LG and Samasung had revenues of 56.8 billion USD and 187.8 billion USD respectively, compared to Whirlpool's revenue of 19.9 billion USD in the same year (Forbes, 2023). It could be argued that LG and Samsung, as massive conglomerates, reap greater internal economies of scale.

One final consideration in economies of scale is the age of the industry, or experience, that each country has in producing the goods in question. In the U.S., the first electric washing
machine was invented in 1932, but the Whirlpool Corporation predates this by 20 years. This puts the approximate age of the U.S. household appliance industry at about 100 years (Cabral, 2021). Various sources disagree on exactly when the Chinese appliance industry began, but an estimate is 1950, putting its approximate age at 73 years. The U.S. may benefit from more experience in the industry, which potentially improves productivity and drives down costs.

The analysis suggests that, with the exception of industry experience, China is more likely to benefit from both internal and external economies of scale. For this reason, Chinese producers are able to offer lower prices than their U.S. competitors.

**Material Injury**

After the DOC determined that LRWs from China were being sold at LTFV in the domestic market, the ITC found that this dumping practice caused material injury to U.S. industry. It was incumbent upon the ITC to “consider all relevant economic factors that bear on the state of the industry in the U.S.” in order not to attribute a causal effect of subject imports on domestic industry performance when the effect is only tangential or minimal (ITC, 2017, p.10).

To this end, the Commission evaluated the effects of factors including changes in consumer tastes and technology, and competition among domestic producers. It found many factors relevant to an explanation of domestic industry performance. Still, subject imports are “not negligible.” Our research suggests that the ITC’s examination falls short on two points: (1) comparative environmental legislative analysis and (2) neglect of the influence of consumer preferences on retailers’ buying habits. Greater consideration of these arguments obscures the origin of material injury.

**Demand and supply considerations**

Both the Commission’s report (2017) and counsel for Whirlpool determined that
demand was expected to be high for the Period of Investigation, citing heightened activity in the housing market and pent-up replacement demand post-2007-2009 recession. By the investigation’s conclusion in 2016, both GE and Whirlpool had repatriated LRW production to the U.S. and invested heavily in domestic production facilities. Whirlpool invested over 400 million USD in their Clyde factory between the 2015 Korea-Mexico orders and the start of the 2016 investigation. Petitioner anticipated high demand, demand that was not borne out.

**Substitutability**

The foreign washing machine industry has exerted much influence on consumer expectations, especially with Samsung and LG offering innovative features such as AI smart talk. Consumers report their inclination to pay extra for new appliance facets absent in Whirlpool appliances (Forbes, 2017). Consumers opting for LG and Samsung LRWs may be causing the aforementioned injury to the U.S. market. While U.S. manufacturers did see less sales, it may be because they offered an inferior product that no longer impressed domestic consumers.

**Efficiency Standards**

Changes in legislation have also played a role in domestic industry performance. In March 2015, the Department of Energy (DOE) proposed a set of energy efficiency standards for LRWs, which called for a decreased volume of water used in wash and rinse cycles by the end of 2027. The newly introduced regulations greatly increased the minimum efficiency standards for LRWs and the efficiency standards required for EnergyStar certification (ITC, 2017). Additional R&D expenditure and facilities expansion needed to meet the new regulations further strained Whirlpool (ITC, 2016). Nonetheless, Whirlpool has reportedly re-engineered its outdated 2012-2013 CTL-LRWs models to meet the mandates (ITC, 2016). HE agitators, a new feature of Whirlpool’s products, is a shallow fill technology requiring the use of a specific HE detergent.
As the DOE’s mandate confronts the global climate crisis, LRWs and complementary appliances become more expensive, laundry cycles will take longer, detergent would be more costly, and clothes may be less clean if these “regulations risk trading-off stain removal and other performance standards” (Anderson, 2023). If not the only explanation, these numbers are further perpetuated by Respondents’ low prices, which pressurizes Whirlpool’s situation.

**Shortcomings**

In 2003, the Energy Analysis Department of the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory (LBNL) and the China National Institute of Standardization (CNIS) set minimum efficiency standards on clothes washers in China that focused on energy and water consumption (Biermayer and Jin, 2004). Meanwhile, Samsung LRWs have become leaders in energy efficiency. In 2009, Samsung released the New Wave Series LRW (equipped with a 1-watt standby power) and today makes the most efficient 11kg washer on the market. The AI Washing Machine earned an A energy rating in 2023. It saves consumers thousands on reduced energy bills over its lifespan (Express, 2023). While it is argued that environmental legislation contributes to higher-priced U.S. LRWs, Asian manufacturers have been innovating in energy efficiency since the early aughts.

The ITC investigation also overemphasizes sales at the retailer level. Whirlpool argues that prices are the most important factor in sales, and that retailers are the most influential party in determining sales. According to Petitioner, if consumers are not presented with X brand’s product on the retail floor, the product will not sell (ITC, 2016). The ITC, “consistent with [their] practice of examining prices for the first arm’s-length transactions in the U.S. market,” also analyzes competition at the retailer/distributor level. Assuming consumer preferences play a role in determining the stock retailers carry, the ITC’s analysis is limited, if not flawed.
Having outlined the conditions of competition relevant to the domestic industry, we accept that Whirlpool and other domestic producers faced certain challenges in the POI. That said, the Commission’s analysis is imperfect, casting doubt on the cause and effect relationship between cheap LRWs from China and operating losses at the plant in Clyde.

**Conclusion**

During the ITC’s 2016 investigation, LG and Samsung moved washing machine manufacturing overseas to Thailand and Vietnam, prompting Whirlpool to petition the ITC for a safeguard tariff, which was granted in 2018. In March of the same year, the Trump administration introduced a 25% tariff on steel, a critical input to LRWs. The former President boasted the fruits of his protectionism for American industry:

> As we celebrate Whirlpool’s 109-year legacy of American manufacturing excellence, today I want to lay out my vision to bring millions and millions more jobs and thousands more factories back to American shores where they belong. We’ve been doing it long and hard. One of the reasons you’re successful today happens to be a meeting I had probably four years ago with a very good representative of your company, saying what they were doing to you and how badly you were being treated by other countries. And you know what I did. And here we are today, the most successful plant. (Applause.) And we’ve done this in a lot of places (Trump White House Archives, 2020).

Under Trump’s agenda, a “successful” plant is one that maintains the operating capacity and employment that it hosted in the early part of the 20th century.

Our paper evaluates to what extent Whirlpool Corporation’s “accumulated operating losses” can be attributed to unfair pricing and market saturation by Respondents LG and Samsung (ITC 2016). We find that several confounding factors obscure the validity of the anti-dumping orders issued by the ITC in 2017. For one, comparative advantage—determined by low relative Chinese wages, high relative U.S. productivity, Chinese low-skilled labor abundance, U.S. capital abundance, and Respondents’ relative economies of scale—lies with China. Moreover, certain conditions of competition limited domestic producers’ performance in
the POI. These include new environmental legislation, consumer attentiveness to innovation by foreign brands, and the ongoing consolidation of the American manufacturing belt, which limits production capacity in the region. What is missing from the scope of our analysis is an investigation of the nationalist protectionism which in several cases has disadvantaged American manufacturers by levying tariffs on steel and other inputs. “Everyone will pay more, with fewer choices,” Samsung predicted in an official statement (Reuters, 2018).

After the conclusion of the ITC’s 2016 investigation, Respondents moved operations once more from Vietnam and Thailand to the U.S. to subvert the 2018 safeguard tariff; the landscape of the domestic industry was changed. LG and Samsung brought their innovation and designs to Tennessee and Kentucky factories. Petitioner and Respondents now compete—with comparable wages and productivity rates—for flooring. This market saturation will likely heighten competition and reveal which firms deserve the bulk of domestic market share. Despite the Trump administration’s calls to celebration, it is doubtful that this is the outcome Whirlpool sought in its decade-long appeal to the ITC.
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