Trade Flow of U.S. Recalled Consumer Products: A Gravity Model Analysis

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Dedication

This thesis is dedicated to my wife, Andrea K. S. Lindgren, whose patience allowed me the time to work on the thesis and for helping me to keep pushing forward towards its completion.

Abstract

This paper examines the hypothesis that the trade flow of recalled products and harm caused by recalled products will conform to economic theory in a similar way as the flow of goods in general. A Bergstrand-based gravity model is used in the analysis. My application uses a novel data set that includes measures of U.S. consumer product recalls from 2006 and 2007. The results of the analysis show that the flow of recalled goods corresponds to theory. The type of consumer products imported into the U.S., as well as those later recalled, are found to tend to be labor intensive. Better exporting country institutions corresponded to a relatively greater amount of goods later recalled.

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1. Introduction

For consumer product safety, the year 2007 was an important one. It marked the start of a period of increased public, legislative and academic attention to consumer product safety. This was due to high profile recalls of products manufactured in China. Large numbers of children's toys were recalled due to above limit lead content. The largest such case involved multiple types of toys manufactured for Mattel. The Mattel case culminated in the CEO of the Chinese manufacturing firm committing suicide and high profile apologies being made by Mattel to the Chinese government over its statements regarding the case. In the U.S., laws and regulations were changed as a result of the increased number of recalls. Calls were made by legislators to restrict trade until the issues regarding the recalls could be solved. The issue of product safety is clearly important from the standpoint of the consumer, but it is also important in regards to international trade. Restrictions placed on trade need to be made from an informed point of view to create appropriate public policy.

This paper examines the hypothesis that the trade flow of recalled products and harm caused by recalled product will conform to economic theory in a similar way as the flow of goods in general. The gravity model can be used to estimate the flow of imports of consumer goods into the U.S. and allows a comparison to the value and harm caused by products that are subsequently recalled due to safety concerns. A better understanding the flow of unsafe products is important in crafting trade policy, managing consumer product safety regulations, choices where a firm sources products, and the country of origin a consumer chooses to purchase a product from. The types of consumer goods

analyzed in this paper are ones that were overseen by the U.S. Consumer Product Safety Commission (CPSC) during 2006 and 2007. The CPSC manages all consumer product safety recalls except for those involving food, drugs, highway automobiles, boats, aircraft, or firearms which are managed by other U.S. agencies.

This paper makes several novel contributions. The consumer product recall data set constructed is at a much greater detail than currently available and for the first time relates product recalls to the price information and country of manufacturing data available in the recall notices. This type of data should help aid in the tracking and regulation of consumer safety beyond looking at just specific product category safety trends over time. An import data set was created from U.S. Census Bureau data that focuses on U.S. imports regulated by the CPSC. In the economics literature, product quality is difficult to measure directly. This paper provides an empirical measurement of one aspect of product quality, which is product safety. Using this measurement, product safety is modeled for the first time using the gravity model, which allows various policy variables to be analyzed within a theory-based economic framework.

2. Literature Review

This paper contributes to two areas of literature and helps to inform a third. The **first** area is on the effect of product recalls on: shareholder wealth, imports to the U.S., and firm sales. This wide-ranging area of literature does not include the use of trade models but does represent the prior work that has been done examining the impacts of product recalls. This paper contributes to this area of literature by examining what

factors may play a role in the flow of unsafe products and lays the ground work for being able to predict the relative likelihood of recalls occurring by country of manufacturing. Being able to better predict this risk would be a benefit to both firms and investors.

The literature on shareholder wealth begins with an examination of automotive and drug recalls on shareholder wealth by Jarrell and Peltzman (1985) which shows that shareholder wealth is negatively affected by recall announcements. A similar conclusion is reached by Pruitt and Peterson (1986) on the examination on the effect of drug and other consumer product recalls on shareholder value. Hoffer, Pruitt and Reilly (1988) make corrections to the methodology of Jarrel and Peltzman and find that after these corrections that no significant impact of recalls on shareholder wealth can be found. Davidson and Worrell (1992) examine automotive recalls and find that when recalls are divided into repairable and replaceable categories that recalls which required replacement had significant greater effects on shareholder wealth. Dranove and Olsen (1994) examine drug recalls and their effect on shareholder value and spillover to other pharmaceutical firms. They find that individual firms suffered a loss in shareholder value from recalls and that spillover effects occurred when it was expected that the cost of similar safety compliance would be borne by competing firms. Barber and Darrough (1996) expand on the work by Pruitt and Peterson by increasing the number of years in the data set and including Japanese automotive manufacturing firm in addition to U.S. firms. They find that shareholder wealth for individual firms is negatively affected by recalls but find no evidence of a spillover effect to competing firms. Chu, Lin and Prather (2005) examine non-automotive consumer product recalls from 1983 to 2005 and the effects on

shareholder wealth and find that for responsible firms markets react negatively and quickly to the release of product recall announcements. For most of these papers the recall announcements in the Wall Street Journal was the main source of data on U.S. product recalls. The types of product recalls analyzed were limited by the nature of research to only include publicly traded firms.

One paper was found that examines the effect of recalls on imports to the U.S. Candelaria and Hale (2008) examine the impact of consumer product recalls on the subsequent volume of U.S. imports originating from China. In their paper they divide consumer products that were imported into the U.S. into two groups, a recall and non-recall group. Inclusion in the recall group was based on a product having a recall occurring in the third quarter of 2007. They then forecast the value U.S. imports for the second half of 2007 for the two groups using lagged monthly data from 2000 through the first half of 2007. This data is adjusted for seasonality and holidays. They find that imports for recalled group were 5.1% lower than would be predicted. The authors state they have no reason to believe that the difference between the predicted and actual results is due to anything other than the impact of the recalls themselves.

A wide-ranging working paper by Freedman, Kearney, Lederman (2009) examines recall effects on firms' sales and shareholder wealth. The impetus for their paper was the major jump in the number of toy and children's products recalled in 2007 and their investigation follows along that line. They find that the grouping of similar toys recalled in 2007 had lowered sales in Christmas of 2007 and that there was a spillover effect to manufactures of infant/preschool toys that were not involved in a recall. They

also found that the recall of one type of toy did not affect the sales in other similar toy groupings by that same manufacture. In examining the effect of a recall on a toy's brand, they found that there were negative spillovers to the competitors' sales if the branded items were in a similar toy grouping, but the effect was positive if the branded items were in different toy groupings. A plausible explanation for this is that consumers associate the brand and toy type to an associated recall, but since they still want to purchase a toy with the desired brand, they will choose to purchase a branded toy that they believe to be safe since it is dissimilar from the recalled toys grouping. Finally, they examine the stock market performance of publically traded toy firms and find that the recalling firms are negatively impacted and that there are spillover effects to non-recalling toy firms.

The **second** area of literature is related to product complexity and product quality. Product quality and product safety would seemingly share much in common as product safety would be a natural inclusion as an aspect of product quality. Other aspects of product quality would include: complexity, durability, and a wide variety of features that are specific to consumer preferences. Much of the difficulty in this literature is in trying to estimate values for product quality. Faruq (2010) states that indication of product quality does not exist in trade data and the common method to identify quality is by using a price index as a proxy. This assumes that a similar-type motorcycle produced in one country that is twice as expensive as one produced in another must solely be due to quality. This approach has been refined and improved over the years, recently by Hallak (2006). Hallak and Schott (2011) state that some of the problems of using a price

equation to determine quality are due to currency misalignment or comparative advantage between countries. They devise a method that allows for other factors besides quality to account for a price difference in a differentiated product. They identify a product's brand as being one such aspect of price that is not necessary related to quality. Since it is assumed that some measure of quality is contained within a price differential, any methods that control for other aspects of the price differential help to make the price differential closer to an isolated measure of quality.

Reitzes (1992) put forth a theory that firms will only use a "quality commitment" to secure pricing power. As a result, the difference in price between two similar goods will not be proportional to the difference in quality between those goods. The pricing power can be used to increase the price of the good beyond its increase in quality. Chu and Chu (1994) argue for a theory in which a manufacturer of high quality products with no brand recognition for quality can signal quality by selling through a retailer with a strong reputation. They find that doing so allows for equilibrium profits above zero. This further supports the argument that price differences in similar goods are due to more than just quality differences.

In the present paper, the focus is on an aspect of product quality which is product safety. Prior literature has found difficulty in trying to obtain an isolated measure of product quality. Since data are available on product safety in the form of product recall data, no estimation or derivation of safety is needed. The present paper contributes to this area of literature by examining and providing empirical measurements of product safety, an aspect of product quality.

The **third** area of literature this paper helps to inform is product safety law, regulation, and supply chain management. The present paper does not purpose new law or regulation but a review of the literature in this area finds that there is a lack of a good analytical basis for comparing and explaining the relative level of product safety between countries of manufacturing. A review of this literature is given in Appendix A.

3. Model and Specifications

The gravity model of economics was introduced by Tinbergen in 1962. It was based on an analogy to the concept of gravitational force. In its simplest form, the model relates the flow of trade between two countries as the economic mass of the two countries divided by the distance between the two countries. The gravity model has found much empirical success, but did not have a theoretical underpinning until Anderson (1979). Other literature addressing the theoretical roots of the gravity model followed such as: Bergstrand (1985); Bergstrand (1989); Feenstra, Markusen, and Rose (2001); and Haveman and Hummels (2004). Each work sets up a different set of assumptions that give rise to the gravity model in full or partial form.

A commonly used gravity model with solid theoretical underpinnings is described by Bergstrand (1989) and is summarized as follows:

$$PX_{ij} = \beta_0(GDP_i)^{\beta 1}(GDP_i/POP_i)^{\beta 2}(GDP_j)^{\beta 3}(GDP_j/POP_j)^{\beta 4}(D_{ij})^{\beta 5}(A_{ij})^{\beta 6}\, e_{ij} \qquad (1)$$

where PX_{ij} is the U.S. dollar value for the flow from country i to country j, GDP_i and GDP_j is GDP in nominal U.S. dollars for country i and j respectively, POP_i and POP_j is population for country i and j respectively, D_{ij} is the distance from the economic center of country i to country j, A_{ij} is the distortionary term that represents any factor that distorts trade flows from country i to country j by aiding or restricting it, and e_{ij} is the error term for the flow of trade from country i to country j. The log form of equation (1) is typically used in regression analysis.

Bergstrand goes on to show the theoretic framework that can explain this model. A 2-firm, 2-good, N-country monopolistic competition model is created to show how the gravity model relates to the Heckscher-Ohlin model of inter-industry trade and the Helpman-Krugman-Markusen models of inter-industry trade. The firms produce uniquely differentiated goods which is the same type of goods of interest in the present paper.

The flow of goods later subject to recall would not be expected to differ markedly from that of the general flow of goods for most of the terms in the model. In this regard, Equation (1) is used to explain both the flow of recalled goods as well as the total flow of goods. The harm caused by recalled products is also of interest. In this paper, Equation (1) is also adapted by substituting for the flow of recalled goods with the flow of harm caused by recalled goods. This substitution allows for the flow of harm caused by recalled product to be quantified and compared to the flow of total goods and recalled

goods. The construction of the harm measurement is based on a count of deaths and injuries listed in product recall notices. This measure of harm is not monetary so the price of a product is not considered in this flow measurement. Additionally, since the monetary cost of the harm caused to consumers is not measured, everything from minor injuries to deaths was given equal weight in construction of the flow measurement. This is a limitation to the usefulness of the measurement.

Since only consumer product recall data within the U.S. is available, only the one-way flow of consumer goods into the U.S. is analyzed for comparison. Since there is only a single country j, all of the j terms become part of the constant β_0. This gives the following equation:

$$PX_{ij} = \beta_0(GDP_i)^{\beta 1}(GDP_i/POP_i)^{\beta 2}\,(D_{ij})^{\beta 5}(A_{ij})^{\beta 6}\,e_{ij} \qquad (2)$$

The expected signs of the coefficients are explained by Bergstrand (1989). β_1 is expected to be positive since GDP serves as a proxy for country i's national output. A higher national output should tend to produce higher levels of exports. The expected sign of β_2 is more ambiguous since GDP per capita tends to serve as a proxy for exporting country i's labor to capital endowment ratio. As a result the expected sign of β_2 would be tend to be dependent on the type of goods in question. With an elasticity of substitution in consumption greater than one, β_2 would tend to be positive if the flow of goods are capital intensive and negative if labor intensive. Since the flow is of general consumer products towards the U.S., the expectation is that the elasticity of substitution in

consumption will be greater than one and the flow of goods will tend to be labor intensive. As a result, the expected sign for this case is negative. β_5 is expected to be negative as distance serves as a proxy for shipping related costs between country i and country j. Higher cost due to increased trading partner distance should tend to reduce the relative amount of trade between countries.

Taking the natural log of Equation (2) and then substituting the variables $Contig_{ij}$, $Institutions_i$, and $Links_{ij}$ for distortionary term $\ln A_{ij}$ gives the following equation:

$$\ln PX_{ij} = \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_i/POP_i) + \beta_5 \ln D_{ij}$$
$$+ \beta_{6C}\, Contig_{ij} + \beta_{6I}\, Institutions_i + \beta_{6L}\, Links_{ij} + e_{ij} \qquad (3)$$

where $Contig_{ij}$ is a binary variable equal to one if the exporting country i shares a border with the importing country (i.e., the U.S.). In general a shared border should reduce barriers to trade with an effect that is similar but distinct from trading partner distance. As a result, the expected sign β_{6C} of would be positive.

$Institutions_i$ represents the quality of the exporting country i's institutions. β_{6I} is expected to be positive since higher quality institutions in the exporting country are expected to reduce transaction costs due to the reduction in the exporter's incentive to breach contracts as argued by Berkowitz, Moenius, and Pistor (2006). They investigated the effects of an importer's quality of institutions on trade of complex and simple

products, which are typically called differentiated and homogenous goods in related literature. Drawing on the theory of incomplete contracts, they argue that good legal institutions in the country of export increase trade in complex products since they reduce the exporter's incentive to breach contracts. They find empirical evidence that increased quality of the exporter's institutions results in the export of more complex products and import of more simple products. Complex products are the type of products regulated by the CPSC, so the use of qualities of institutions should similarly be an important factor in explaining a manufacturer's incentive to produce safe products.

$Links_i$ is a binary variable that represents the cultural and linguistic ties between exporting country i and the importing country (i.e., the U.S.). β_{6L} is expected to be positive since common language and cultural ties should increase the flow of trade as shown by Rauch (1999) and Frankel et al. (1993).

4. Method and Data

Using equation (3), the following flows are estimated: (a) Value of Consumer Products Imported by the U.S.; (b) Value of Recalled Consumer Products Imported by the U.S.; and (c) Harm Caused by Recalled Consumer Products Imported by the U.S.

Table 1 lists the expected signs for each of the three estimated flows. The reasoning behind these expectations is given in the previous section. The expected values are the same for all the estimated flows. A description of the variables used to estimate

Equation (3) is listed in Table 2. Details on the data used are given in the following subsections.

4.1. Recall Data

There are many U.S. agencies that regulate products consumers use: Food and Drug Administration, the U.S. Department of Agriculture's Food Safety and Inspection Service, National Highway Traffic Safety Administration, Environmental Protection Agency, U.S. Coast Guard, Bureau of Alcohol, Tobacco, Firearms, and Explosives and the Consumer Product Safety Commission (CPSC). Each of these agencies is responsible for issuing recalls within its area of jurisdiction. Consumer products that the CPSC regulates were chosen for use in this paper since they account for the widest class of consumer product of any of the agencies and the CPSC regulates many of the products involved in high profile cases that grab the public's attention (often cases involving children).

The Consumer Product Safety Improvement Act of 2008 mandates that the CPSC create a searchable public database. This new database allows the user to search for product recall notices by means of a variety of criteria, but does not present the notices together in an analyzable format. Further, the database does not report the full amount of information reported in an individual notice. The CPSC was contacted by way of the Freedom of Information Act to determine if they had created an analyzable dataset based on their recall notices. They replied that they did not have recall information in an analyzable format. As a result, individual recall notices were analyzed one-by-one in

order to create the novel data set used in this paper. Appendix B shows a typical recall notice issued by the CPSC.

The public notices the CPSC issues in the event of a recall carry information on: product name, recalling party (manufacturer, importer, distributor and/or retailer), number of units recalled, description of hazard, number of injuries/incidents, description of the product, where it was sold, how long it was sold, where it was manufactured, and the remedy purposed to resolve the hazard.

Data covering 2006 and 2007 was chosen for inclusion and pooled to create a larger data set than just one year would provide. This represented 757 recall notices from 43 countries of manufacturing. For each year covered, the number of recalls was 310 and 447 for 2006 and 2007, respectively. There was also one public safety notice and one voluntary replacement notice. Information from these two cases was not included in the analyzed data set.

A statistical characterization of the data is given in Appendix C. The data from 2006 and 2007 was pooled and divided by two in order to annualize the data. The data shown includes the U.S. as country of manufacturing. Of note in this data is the mean time between when a product is first for sale and when a recall notice was issued. At close to 20 months this represents a significant time lag. One potential source of error in the data is that time at which a product is recalled does not match the time at when it was imported. Product recalls in the data set are from 2006 and 2007, but some of these products could have been on sale for 10 years or 10 weeks. As a result a flow that is assumed to be just for 2006 and 2007 is actually for a period that starts 20 months earlier

on average. The corresponding right hand side variables in equation (3) are for the 2006/2007 time-frame. However, many products are likely to be continually imported in batches at dates after the initial import date. For example a recalled product may have had a first shipment of 10,000 units to the U.S. in 2005 and a second shipment of the same amount in 2006. This should help to mitigate any error effect of the mean 20 month time lag by putting more of the product flow closer to the intended 2006/2007 timeframe.

Using the information on the recall notices, the value of the products being recalled by country of manufacturing could be determined, as shown in Appendix D. For cases where multiple countries were listed as manufactures, the value of the recall was divided equally among the countries of manufacturing. This assumption was made to allow for analytic feasibility, but could lead to error in the results.

Incidents and injuries could be broken down into: general reports, injuries, permanent injuries, deaths, minor damage, and major damage to property. A value for harm to consumers was created by adding up the incidents of all injuries and damage to property. For cases where multiple countries were listed as manufactures, the value of the harm caused was divided equally among the countries of manufacturing. Zero data was treated by assigning an arbitrarily small positive number in place of a value of zero; this method has been used in previous literature (Linder and de Groot, 2006). To handle zero-data, a Tobit regression would be a more solid statistical technique to use compared to the OLS regression. OLS was chosen for simplicity and ease of obtaining coefficient results that are elasticities.

Using the information in the individual product recall notices, additional descriptive data was added to the novel dataset. While not directly used in the analysis of this paper they did inform the discussion in this paper and the direction of analysis. The following description of the recall data in Appendices E, F and G is based on all countries of manufacturing listed in the recall notices, including the U.S. The U.S. values were not excluded in these appendices since they are an important part of the overall nature of U.S. consumer product recalls.

The product recall notices indicate firms responsible for the recall by name and if they are a Manufacturer, Importer/Distributor, or Retailer. In some cases multiple types of firms are listed. Appendix E shows the occurrence of the type of firm listed in a product recall notice. As indicated in the table, retailers are rarely the responsible party listed in a recall notice.

Product recall notices list a resolution to the recall: refund, replacement, free repair, free hardware (for the consumer to make the repair), a voucher for use towards the purchase of a different product sold by the recalling firm, modification of the recalled product by the consumer, direction to discard the recalled product, extra instruction on the use of the product, or some other remedy. Appendix F shows the occurrence of each type of recall remedy. At an occurrence of nearly 40%, a refund is the most frequent remedy method employed.

It was possible to further categorize the recalled products as: dangers to children, dangers due to lead, dangers due to magnets, power tools, sports and recreation, electronics, appliances, and counterfeits. Appendix G shows the occurrence of recalls by

these general categories. For some recalls, inclusion in these categories can be overlapping, such as in the case of a children's' toy that is recalled to the use of leaded paint. This categorization allows the nature of products recalls to be seen more clearly. Recalls due to a product posing a danger to children accounted for 37% of the cases, and recalls due to lead in products accounted for 17% of cases. As a product category, recalls of sports and recreation products accounted for nearly 17% of all recalls issued. This was followed by appliances, electronics, and power tools at 11%, 7%, and 6%, respectively.

4.2. U.S. Import Data

Since the recall data being used was only from the CPSC, is was desirable to use only the value of imports that had the potential of being recalled by the CPSC. Product codes are available for imports into the U.S. such that it was possible to attempt to select only the imports that fell under the purview of the CPSC. For example, Food Manufacturing was an easy choice of an import type to exclude since it would fall under the U.S. Department of Agriculture's Food Safety and Inspection Service purview. The import data used for this paper was from the U.S. Census Bureau. The product codes used were classified under North American Industry Classification System (NAICS).

Data for imports into the U.S. for 2006 and 2007 were available from the U.S. Census Bureau at http://censtats.census.gov/naic3_6/naics3_6.shtml. The data are available on a country basis down to the 6 digit NAICS product code level. Appendix H lists manufacturing product codes included in the import data and codes not included in the data. Codes for data not included are listed at the highest level possible for

conciseness. Product codes that are handled by another U.S. government agency besides the CPSC were not included, nor were product codes that do not typically include finished consumer products. The table indicates the reason for inclusion or exclusion by listing the responsible recalling agency other than the CPSC. Product codes that are not primarily consumer products are indicated as "non-consumer". Product codes that need further explanation for inclusion as a consumer product indicate examples of consumer products that are included under the code. Many product codes are not composed strictly of consumer products. This is a potential source of error in the later analysis.

It was not immediately clear how many countries to include in the analysis. There were 43 countries of manufacturing listed on recall notices during 2006 and 2007, but there were many countries that were not listed on recall notices during that time period. When listed by imports into the U.S. the 43rd recalling county of manufacturing would rank 73rd, so clearly the countries without recalls needed to be included in the analysis. Ninety-five countries were chosen for inclusion by using a cut-off of 5 million U.S. dollars for country-level imports into the U.S. Appendix D shows the imports and recalls by country of manufacturing in more detail.

4.3. Data for Explanatory Variables

The data sources for the remaining explanatory variables are summarized below.

GDP data for 2006 and 2007 in 2012 U.S. dollars was available from the World Bank.

GDP per Capita data for 2006 and 2007 in 2012 U.S. dollars was available from the World Bank.

Distance data are from CEPII's GeoDist No. 2011-25 database and the weighted distance measure *distwces* is used. This value is the distance between countries' largest cities weighted by geographic population distribution within each country.

The binary variable *contig* was created to indicate whether the exporting and importing country (i.e., U.S.) shared a border. The value of one was assigned in the case of a shared border and the value of zero was assigned if there was no shared border. This value was simple to assign as the U.S. is the only importing country. As such only the exporting countries, Canada and Mexico were assigned a value of one. This corresponds to the contiguity data listed in the CEPII's GeoDist No. 2011-25 database.

Following the methodology of Berkowitz, Moenius, and Pistor (2006) the following data from 2010 from the International Country Risk Guide are averaged to create an index for the Quality of Exporter Institutions: Law and Order, Contract Viability, Corruption, and Bureaucratic Quality. The index rating is from one to five, with five indicating a higher quality of institutions. This index value is used for part of the distortionary term, A_{ij}, first introduced in equation (1).

Following Rauch (1999) and Frankel et al. (1993) a variable called *Link* can be created that has the value of one if the U.S. and the country of manufacturing share a language. Rauch and Frankel also use colonial ties to assign a value of one. For the U.S. this would only include the Philippines, which already has a relatively high degree of English speakers. A country was deemed to share a language with the U.S. if English was an official language or half of the population was estimated to be able to have a simple conversation in English. The language survey from TNS Opinion & Social (2006) was used for most of the determinations. This binary variable is used for part of the distortionary term, A_{ij}, first introduced in equation (1). The following countries were assigned a value of one in the data: Australia, Austria, Bahamas, Belgium, Canada, Denmark, Finland, Germany, Hong Kong, India, Ireland, Israel, Luxembourg, Netherlands, Netherlands Antilles, New Zealand, Nigeria, Norway, Pakistan, Philippines, Singapore, Slovenia, South Africa, Sweden, Switzerland, Trinidad and Tobago, and United Kingdom.

5. Results

The estimations of Equation (3) for the natural log flow into the U.S. of: consumer goods, recalled consumer goods and harm caused by recalled consumer goods are respectively shown in Table 3 as: Imports to the U.S., Value of Recalled Products, and Number of Cases of Harm. The independent variables used in each case are: *lnGDP*, *lnGDPperCapita*, *lnDistance*, *Contig*, *Institutions*, and *Links*. Heteroscedastic consistent standard errors are shown in all cases.

The flow of recalled consumer goods generally corresponds to the flow of total consumer goods into the U.S. The flow of harm caused by recalled products is more complicated in that it weakly corresponds with the exception of the variables *lnDistance* and *contig*. For consumer goods imports, the model explains almost half of the variation. For recalled goods and harm caused, the model explains about one quarter and one fifth of the variation, respectively. High adjusted R^2 values typically found in multi-country trade studies are not to be expected here since the GDP and GDP per capita values for the importing country are part of the constant.

The coefficient on the natural log of exporter GDP is positive as expected and significant at the 1% level across all estimations. A one percent increase in exporter's GDP corresponds to a 1.15, 8.38, and 3.74 percent increase in U.S. imports, recalled value, and harm respectively. This difference in coefficients across estimations may be due to countries with larger national outputs manufacturing different types of goods compared to countries with smaller national outputs. Additionally, the units across the three estimations are not the same, so the magnitude of the coefficients should not be expected to be the same.

The coefficient on the natural log of exporter GDP per capita is negative for all estimations and significant at the 1% level for the flow of consumer goods and the flow of recalled goods. A one percent increase in exporter's GDP per capita corresponds to a 1.69 and 10.2 percent decrease in U.S. imports and recalled value respectively. The positive coefficient for exporter GDP implies the elasticity of substitution exceeds one. When this is the case, the sign on exporter GDP per capita is would tend to be positive if

the flow of goods is capital intensive and negative if labor intensive. It can therefore be inferred that, on average, the consumer goods analyzed tend to be labor intensive.

The coefficient on the natural log of Distance is, as expected, negative for the estimation of the flow of consumer goods and recalled goods, but only for the flow of consumer goods is significant at the 5% level. A one percent increase in distance corresponds to a 1.71 percent decrease in U.S. imports.

The coefficient on the trade border contiguity is positive and significant at the 1% level for only the flow of harm. Being contiguous trading partners corresponds to a 30.4 percent increase in harm from recalled products. While this is the expected sign, the coefficient is much larger compared to the standard error range on the coefficient when the flow of imports is estimated. This may be due to difference in product mix from bordering countries that could lead to more dangerous products such as heavier motorized products that could have great potential for harm to consumers. The *contig* variable also acts as a proxy for North American Free Trade Agreement (NAFTA) membership. The expected effect of trading block membership would be positive as participation in free trading blocs would be expected to increase the flow of trade as shown by Bergstrand (1989) as well as Feenstra, Markusen, and Rose (2001). It would be expected for imports to the U.S. and recalled products imported to the U.S. that the contiguous border as well as inclusion in the trade bloc would lead to an increase in trade flow, but the data here does support that relationship. This unexpected result would appear to highlight the importance that the product mix being exported can have on the results.

The coefficient on quality of institutions is positive for all estimations as expected and significant at the 5% level for the flow of consumer goods and the flow of recalled goods. A one point increase in quality of institutions index corresponds to a 2.76 and 13.6 percent increase in U.S. imports and recalled value, respectively. This indicates that all other things being equal, countries with better institutions export a relatively greater amount of goods later recalled. This could also reflect that strong institutions result in greater accountability. This is compatible with the findings of Berkowitz et al. (2006) that increased quality of the exporter's institutions result in the export of more complex products.

The coefficient on *Links* was negative across all estimations, but was not found to be significant at the 5% level in any estimation. The inclusion of the variable did not affect other results with the exception of the case of the coefficient of quality of institution for the flow of harm caused by recalled goods. Without including the *Link* variable, the coefficient for *Institutions* is significant at the 5% level with a one point index increase corresponding to a 6.07 percent increase in the flow of harm caused.

The hypothesis that the flow of recalled goods would conform to economic theory as laid out in the Bergstrand-based gravity model is confirmed for the core variables of exporter GDP and exporter GDP per capita. The results for the flow of recalled consumer products match the predicted economic theory for the flow of consumer products. However, this cannot be said for the variable of distance between trading partners. The expected sign was negative, but the results do not support this with a

significance level of 5%. The number of observations is consistent across the analysis presented; however, the ability to achieve statistically significant results is likely impacted by the robustness of each independent variable. *Imports* has a much larger degree of information contained in its construction compared to the *RecalledValue* variable; *Numberof Harm* has even less. The less robust variables are likely susceptible to potentially isolated events far more so than the level of consumer product imports into the U.S. It may also be that some of the dependent variables have an ambiguous relationship with the independent variables. The data only includes a one-way flow into the U.S. In a typical gravity model based analysis the bi-directional flow of many countries is included which greatly adds to the robustness of the results.

The flow of harm cannot be said to strongly conform to economic theory as laid out in the Bergstrand-based gravity model. On a theoretical basis, the case was already tenuous since the flow being measured was not monetary.

6. Concluding Remarks

The results show that both the flow of consumer goods and consumer goods later recalled, a measure of product safety, can be successfully modeled using a Bergstand-based gravity model. The measure for the flow of goods later recalled was determined through the construction of a novel dataset of U.S. consumer product recalls. A measure for the flow of harm caused by these recalls was also determined, but this flow could not be shown to conform to the gravity model.

The type of consumer products imported into the U.S., as well as those later recalled, were found to be labor intensive. Better exporting country institutions corresponded to a relatively greater amount of goods later recalled. Language similarity between exporters and the U.S. was not statistically significant for any of the estimations.

Since it can now be demonstrated that the flow of recalled consumer goods conforms to a standard gravity model, various policy variables related to product recalls can now be analyzed within a theory-based economic framework. The debate surrounding specific countries potentially exporting a disproportionate amount of unsafe products can now be better evaluated in reference to the expected values of a theory-based trade model. Specifically, looking at the estimation residuals for individual exporting countries and comparing those to the estimation mean may be a good indicator of whether an exporting country is exporting an alarming level of unsafe products compared to what would be expected.

Further refinement to the model may help investors and firms determine which countries may be more likely to produce goods that result in future product recalls. A more refined model could be as a tool in risk management, which would be a benefit to both investors and firms.

There are several areas of future research that could extend the research of this paper. The results showed the need for a variable to better control for the effects of product mix. This needs to be done without significantly reducing the model's degrees of

freedom. Using a few well-chosen product-type dummy variables or making separate model estimations of the recall dataset disaggregated by similar product type may be beneficial.

Construction of harm values would be improved by using monetary values such as from liability court cases. If this type of data is unavailable, assigning a typical monetary reward to the categories of injuries, permanent injuries, and deaths, may be an improvement over treating them equally. The benefit of the liability court case results would be that a specific level of damage is assigned based on the details of the case.

The addition of more years to the dataset should be beneficial. Potentially increasing the number of years for the data pooling would increase the model's predictive ability. Additionally, comparing these results to the time frame after the Consumer Product Safety Act of 2008 would be of interest in evaluating the impact of the changes in consumer product regulation.

The same approached used in this paper could be extended to other product areas. Pharmaceutical and food safety based recalls datasets may be available or readily constructed. They would likely not suffer from the product mix problem that is faced when using a category as broad as consumer products.

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Table 1. – Expected Signs of Coefficient Estimates for Equation (3) for the Trade Flows to the U.S. of Imports, Recalled Value, and Number of Cases of Harm.

Variables	Abbreviation	Coefficient	lnImports	lnRecalled Value	lnNumber ofHarm
ln(GDP)	lnGDP	β_1	+	+	+
ln(GDP/POP)	lnGDPperCapita	β_2	-	-	-
ln(D)	lnDistance	β_5	-	-	-
Contiguous Borders	Contig	β_{6C}	+	+	+
Quality of Institutions	Institutions	β_{6I}	+	+	+
Cultural and Linguistic Links	Links	β_{6L}	+	+	+

Table 2. – Description of the Variables Used to Estimate Equation (3)

Variable	N	Mean	StdDev	Median	Min	Max
lnGDP	92	25.5	1.66	25.6	22.4	29.1
lnGDPperCapita	92	9.01	1.37	9.02	6.12	11.5
lnDistance	95	8.97	0.531	9.06	7.05	9.65
Contig	95	0.0211	0.144	0	0	1
Institutions	89	3.10	0.923	3	0.875	5
Links	95	0.284	0.453	0	0	1

NOTES:
GDP: Units are 2012 USD, data from the World Bank
GDPperCapita: Units are 2012 USD, data from the World Bank
Distance: Units are kilometers, data from CEPII's GeoDist No. 2011-25 database and the weighted distance measure *distwces* is used. The *distwces* value is the distance between countries' largest cities weighted by geographic population distribution within each country.
Contig: Units are binary with one indicating a shared border between two trading partners and zero indicating no shared border. The data used corresponds to the contiguity data listed in the CEPII's GeoDist No. 2011-25 database.
Institutions: Units are a one to five index rating, with five indicating higher quality institutions. The data is from the 2010 International Country Risk Guide and was compiled using the methodology of Berkowitz, Moenius, and Pistor (2006).
Links: Units are binary with one indicating a shared language or colonial tie and zero indicating the absence. The data was from the 2006 TNS Opinion & Social survey and a 50% threshold for shared simple conversational language was used to indicate a linkage between two countries.

Table 3. – Estimates of Equation (3) for the Trade Flows to the U.S. of Imports, Recalled Value, and Number of Cases of Harm.

Variables	lnImports	lnRecalledValue	lnNumberofHarm
lnGDP	1.15 **	8.38 **	3.74 **
	(0.19)	(1.77)	(1.36)
lnGDPperCapita	-1.69 **	-10.2 **	-3.10
	(0.34)	(2.8)	(2.01)
lnDistance	-1.71 *	-4.55	2.61
	(0.72)	(6.59)	(3.19)
Contig	-0.40	12.3	30.4 **
	(3.13)	(17.3)	(8.7)
Institutions	2.76 **	13.6 *	7.03
	(0.66)	(5.4)	(3.59)
Links	-1.00	-0.98	-2.64
	(0.80)	(7.59)	(5.47)
Intercept	12.4	-139	-144
	(7.2)	(68)	(33)
R2	0.48	0.31	0.28
Adjusted R2	0.44	0.26	0.22
N	88	88	88

NOTES:
Heteroscedastic consistent standard errors are in parentheses.
** Significant at the 1% level * Significant at the 5% level

Appendix A. – Literature Review of Product Safety Law, Regulation, and Supply Chain Management.

Often China is cited as being a problem just by the sheer number of recalls of products manufactured there; a policy analysis of recalls by country of manufacturing that takes into account the relative economic size of each country will help improve this area of literature.

Cortez (2007) makes the case that a temporary ban on toy imports from China would be permissible under international trade rules. It is argued that the temporary ban would give the Chinese government the appropriate motivation to enter into strong bilateral safety agreements with the U.S. and to set up credible enforcement mechanisms.

Huang (2008) gives a strong overview of Chinese product safety regulatory systems, Chinese exporter behavior, the mechanics of the legal process involved in settling disputes between Chinese exporters and U.S. importers, and the problems a firm faces in winning and enforcing legal claims. Huang advocates both increased rewards for meeting product specifications as well as increased penalties for failure to meet specifications. One method of rewards that is suggested is in the form of increased payment for meeting product specifications. Increased help from U.S. importers on translation and explanation of applicable U.S. safety standards is also recommended. The use of penalties would require increased government to government cooperation on regulation and enforcement of claims. Short of this Huang advises U.S. importers to require Chinese firms to obtain sufficient and reputable liability insurance.

Bamberger and Guzman (2008) review various methods of achieving product safety. They argue that since it is difficult for U.S. regulators to monitor the production processes of firms abroad and for a plaintiff in the U.S. to seek appropriate recourse, laws should be enacted that would hold U.S. importing firms responsible for the actions of the foreign firms. This is argued to be a better method of achieving product safety than laboring to get governments to create good regulatory systems or through product certification by third-party organizations. Under their proposal, U.S. importing firms should face stronger penalties for safety violations compared to firms that produce domestically. Bamberger and Guzman note that while the Food and Drug Administration (FDA) conducts production level inspections abroad, the FDA is hindered by lack of funds and the requirement that they must notify foreign producers before an inspection. The Consumer Product Safety Commission (CPSC) lacks the authority to test products, foreign or domestic, before they reach market. Self-regulation and third party regulation as well as foreign government regulation were argued by Bamberger and Guzman to not be the best way to obtain a situation where U.S. firms internalize the cost of unsafe products produced abroad. They argue that while their plan sets up a discriminatory regulation scheme, it is the current system that subjects firms manufacturing in the U.S. to a higher regulatory standard that is really discriminatory. While a strong argument is made that their proposal would be legal under international trade rules, it is unclear how that would be viewed by the U.S. trading partners and what their response would be.

Echazu (2010) purposed a new method of writing contracts to ensure a firm's suppliers are accountable for supplying unsafe products. The contracts would specify that the supplier would accept less money if a recall occurred due to the supplied product. Also, the supplier would be required to hold risk insurance in the event of a future recall. Since the supplier is liable they would have incentive to supply the product that is agreed upon by the manufacturer. Insurance firms would be required to determine the risk for these contracts.

Literature on food safety is comparatively well developed compared to that for general consumer products. Specifically the in areas of trade, food safety regulation has a special place in being used as a non-tariff barrier to trade. Kinsey (1993) provided an overview of the economics of food safety in relation to international trade agreements. Relative to food, consumer products do not have as many stringent regulations; although recent strengthening of lead content in children's products and the positioning of CPSC personnel to U.S. ports of entry as front line inspectors may indicate that some consumer products may be inching towards comparatively stringent regulation. In regards to the various legal proposals to address unsafe food imports to the U.S., Mitchell (2003) provides an overview of the economic consequences of trade conflict. While these are in the area of food safety, they inform the discussion on potential new regulations affecting the trade of consumer products. A major difference between food products and products reviewed by the CPSC is that many food products are homogenous goods, while products reviewed by the CPSC are generally all differentiated goods.

Appendix B. – Example of U.S. Consumer Product Safety Commission Recall Notice

U.S. Consumer Product Safety Commission

Office of Information and Public Affairs Washington, DC 20207

FOR IMMEDIATE RELEASE
January 25, 2007
Release #07-090

Firm's Recall Hotline: (866) 723-0925
CPSC Recall Hotline: (800) 638-2772
CPSC Media Contact: (301) 504-7908

Sally Foster Inc. Recalls Tea Lights Candles for Fire Hazard

WASHINGTON, D.C. - The U.S. Consumer Product Safety Commission, in cooperation with the firm named below, today announced a voluntary recall of the following consumer product. Consumers should stop using recalled products immediately unless otherwise instructed. It is illegal to resell or attempt to resell a recalled consumer product.

Name of product: Tea Lights Sold with Votive Candle Holders
Units: About 46,800 sets
Retailer: Sally Foster, Inc., of Troy, Mich.
Importer: Innovage Distribution, Inc., of Los Angeles, Calif.
Hazard: The tea light candles have a clear, plastic shell that can melt or ignite, posing a fire or burn hazard to consumers.
Incidents/Injuries: Sally Foster has received two reports of the plastic shells of these tea light candles igniting, causing minor property damage. No injuries have been reported.
Description: The recalled tea lights were sold as part of the three-piece Glass Candle Holders with Tea Lights Set, item number S106 in the Sally Foster catalog and Web site. The product's packaging was marked "Votive Holders with Tealights-Set of 3" and "Item Number 2006 157." Only the white tea light candles with clear plastic shells are affected. Products delivered after December 8, 2006 included tea lights with metal shells and are not included in this recall. The glass candle holders sold with these tea lights are not subject to the recall and consumers may continue to use them.
Sold through: Sally Foster's Web site from July 2006 through December 2006 and in Sally Foster catalogs from August 2006 through December 2006 for about $15.
Manufactured in: China
Remedy: Consumers should immediately stop using the tea light candles and contact Sally Foster for a set of six free replacement tea light candles with metal shells. Consumers who purchased the item online will be directly notified by Sally Foster and will receive the free set of six replacement tea light candles.
Consumer Contact: Call Sally Foster toll-free at (866) 723-0925 between 8 a.m. and 11 p.m. ET Monday through Friday, and between 9 a.m. and 6 p.m. Saturday through Sunday, or visit the firm's Web site at www.sallyfoster.com
Media Contact at Sally Foster: Tamara Oliverio, (248) 404-2142

NOTES:
Source: U.S. Consumer Product Safety, Release #07-090, http://www.cpsc.gov.

Appendix C. – Recall Data Set Select Statistics (2006 and 2007)

Descriptive Data	Mean	Missing Values
Months Sold Before Recall	19.8	1
Number of Units Recalled	149352	0
Number of Reports per Recall	24.5	-
Number of Foreign Reports per Recall	0.39	-
Number of Injuries per Recall	1.65	-
Number of Permanent Injuries per Recall	0.0528	-
Number of Deaths per Recall	0.0159	-
Number of Cases of Minor Damage per Recall	0.814	-
Number of Cases of Major Damage per Recall	0.0436	-
Cases of Harm per Recall	2.58	-
Recalled Unit Price (Mean)	$607	27
Total Value of Recalled Products Per Recall	$22,400,000	27

NOTES:
Source: Novel recall dataset constructed from U.S. Consumer Product Safety Recall Notices from 2006 to 2007, http://www.cpsc.gov.

Appendix D. – Mean 2006 and 2007 U.S. Import and Recalled Value by Country of Manufacturing

	Country	Imports into the U.S. ($)	Recalled Value ($)	Recalled Value Fraction
1	China	206,787,959,000	1,307,469,761	0.00632
2	Mexico	61,399,025,500	621,478,650	0.01012
3	Japan	27,030,013,500	1,006,512,708	0.03724
4	Malaysia	19,826,790,000	9,055,000	0.00046
5	Canada	17,514,557,000	291,631,025	0.01665
6	Taiwan	14,581,633,000	66,267,146	0.00454
7	South Korea	14,077,450,500	151,633,000	0.01077
8	Thailand	12,094,623,000	380,195,000	0.03144
9	Germany	9,616,127,000	42,000	0.0000
10	India	9,613,088,500	4,358,435	0.00045
11	Vietnam	8,714,375,500	1,354,760	0.00016
12	Italy	8,587,479,000	6,434,225	0.00075
13	Singapore	7,019,653,000	0	0
14	Indonesia	6,647,929,500	13,041,750	0.00196
15	Hong Kong	4,843,521,500	10,460,575	0.00216
16	United Kingdom	4,652,532,000	0	0
17	Philippines	3,975,476,000	1,402,500	0.00035
18	France	3,884,027,500	2,643,150	0.00068
19	Switzerland	3,718,444,000	14,815,000	0.00398
20	Pakistan	3,326,428,500	1,117,360	0.00034
21	Bangladesh	3,129,539,500	3,484,000	0.00111
22	Brazil	3,071,675,500	0	0
23	Honduras	2,605,665,000	969,000	0.00037
24	Cambodia	2,296,421,500	0	0
25	Israel	2,274,193,000	0	0
26	Dominican Republic	2,144,429,000	9,939,500	0.00464
27	Turkey	1,793,802,500	30,875	0.00002
28	Sri Lanka	1,724,494,000	0	0
29	Ireland	1,685,256,000	0	0
30	Sweden	1,651,113,000	225,001,850	0.13627
31	Guatemala	1,642,800,000	3,097,500	0.00189
32	El Salvador	1,488,915,500	0	0
33	Hungary	1,383,841,000	0	0
34	Spain	1,376,099,000	3,509,583	0.00255
35	Jordan	1,312,511,000	0	0
36	Macau	1,128,562,500	614,000	0.00054
37	Austria	995,075,000	67,201,500	0.06753
38	Netherlands	975,815,000	0	0
39	Belgium	950,733,500	11,800,000	0.01241
40	Peru	939,878,000	215,250	0.00023
41	Nicaragua	936,961,000	0	0
42	Denmark	855,391,500	1,006,000	0.00118
43	Egypt	839,331,000	28,200	0.00003
44	Colombia	692,911,500	0	0
45	Costa Rica	646,862,500	0	0
46	Czech Republic	576,834,000	0	0
47	Australia	574,422,500	0	0
48	Portugal	565,429,000	1,395,000	0.00247
49	Poland	534,462,000	2,470,000	0.00462
50	Norway	498,082,500	770,000	0.00155

51	Haiti	455,353,000	0	0
52	Finland	424,293,000	2,121,600	0.005
53	Romania	315,917,500	812,500	0.00257
54	SouthAfrica	248,845,500	20,430,000	0.0821
55	New Zealand	230,573,000	1,054,105	0.00457
56	United Arab Emirates	229,994,000	0	0
57	Slovakia	188,606,000	0	0
58	Slovenia	163,578,000	0	0
59	Greece	129,045,500	2,750	0.00002
60	Bulgaria	126,214,500	812,500	0.00644
61	Argentina	123,021,000	0	0
62	Tunisia	121,326,500	0	0
63	Morocco	121,013,500	0	0
64	Bahrain	118,732,500	0	0
65	Brunei	114,573,000	0	0
66	Russia	93,132,500	0	0
67	Oman	84,123,500	0	0
68	Chile	74,661,500	0	0
69	Ukraine	53,282,500	0	0
70	Ecuador	50,650,500	0	0
71	Estonia	50,357,000	266,000	0.00528
72	Jamaica	44,522,000	0	0
73	Venezuela	32,943,000	0	0
74	Lithuania	30,681,000	0	0
75	Saudi Arabia	27,717,500	0	0
76	Luxembourg	25,377,000	0	0
77	Belarus	22,822,000	0	0
78	Uruguay	17,045,000	0	0
79	Netherlands Antilles	10,794,000	0	0
80	Kazakhstan	9,667,000	0	0
81	Trinidad and Tobago	8,328,500	0	0
82	Bahamas	2,527,500	0	0
83	Kuwait	1,739,000	0	0
84	Ivory Coast	1,136,000	0	0
85	Nigeria	862,500	0	0
86	Azerbaijan	466,000	0	0
87	Iraq	429,500	0	0
88	Aruba	367,500	0	0
89	Gabon	270,500	0	0
90	Angola	268,000	0	0
91	Equatorial Guinea	194,000	0	0
92	Algeria	81,500	0	0
93	Chad	50,000	0	0
94	Congo	49,500	0	0
95	Libya	5,500	0	0

NOTES:
Source 1: Novel recall dataset constructed from 2006 and 2007 U.S. Consumer Product Safety Recall Notices, http://www.cpsc.gov.
Source 2: Novel U.S. import dataset constructed from 2006 and 2007 U.S. Census Bureau data, http://censtats.census.gov/naic3_6/naics3_6.shtml.

Appendix E. – Occurrence of Responsible Party Listing in the CPSC Recall Notices (2006 and 2007)

Responsible Party	Occurrence (%)
Manufacturer	47.8%
Importer/Distributor	62.0%
Retailer	4.6%

NOTES:
Multiple types of responsible parties can be listed in a given recall notice which makes the sum of each type of listing over 100%.
Source: Novel recall dataset constructed from 2006 and 2007 U.S. Consumer Product Safety Recall Notices, http://www.cpsc.gov.

Appendix F. – Occurrence of Recall Resolution in the CPSC Recall Notices (2006 and 2007)

Recall Resolution	Occurrence (%)
Refund	39.8%
Replacement	19.3%
Free Repair	17.7%
Free hardware	13.1%
Voucher	4.6%
Modification by Consumer	1.9%
Discard	1.3%
Extra Instructions	1.2%
Other Remedies	0.5%

NOTES:
Multiple types of recall resolutions can be listed in a given recall notice which makes the sum of each type of listing over 100%.
Source: Novel recall dataset constructed from 2006 and 2007 U.S. Consumer Product Safety Recall Notices, http://www.cpsc.gov.

Appendix G. – General Categories of Recalls in the CPSC Recall Notices From 2006 and 2007

Nature of Recall	Occurrence (%)
Danger to Children	37.0%
Danger due to Lead	17.0%
Danger due to Magnets	1.9%
Power Tool Product	5.9%
Sports and Recreation Product	16.8%
Electronics Product	6.7%
Appliance Product	11.2%
Counterfeit Product	0.8%

NOTES:
Multiple types, or no types, of classification were possible for a given recall notice.
Source: Novel recall dataset constructed from 2006 and 2007 U.S. Consumer Product Safety Recall Notices, http://www.cpsc.gov.

Appendix H. – U.S. Import Dataset Product Code Inclusion Details

NAICS Product code	Meaning of Products and services code	Import Data	Reason
311	Food Manufacturing	no	FDA
312	Beverage and Tobacco Product Manufacturing	no	FDA/ATF
3131	Fiber, Yarn, and Thread Mills	no	Non-Consumer
313210	Broadwoven fabric mills	yes	Blankets and Bedspreads
313221	Narrow fabric mills	no	Non-Consumer
313222	Schiffli machine embroidery	no	Non-Consumer
313230	Nonwoven fabric mills	no	Non-Consumer
313241	Weft knit fabric mills	no**	Non-Consumer
313249	Other knit fabric and lace mills	yes	Bedspreads and Tablecloths
3133	Textile and Fabric Finishing and Fabric Coating Mills	no	Non-Consumer
314110	Carpet and rug mills	yes	
314121	Curtain and drapery mills	yes	
314129	Other household textile product mills	yes	Home
314911	Textile bag mills	yes	Consumer Bags
314912	Canvas and related product mills	yes	Tents and Sails
314991	Rope, cordage, and twine mills	no	Non-Consumer
314992	Tire cord and tire fabric mills	no	Non-Consumer
314999	All other miscellaneous textile product mills	yes	
31511X	Hosiery and Socks	yes *	
315111	Sheer hosiery mills	yes	
315119	Other hosiery and sock mills	yes	
315191	Outerwear knitting mills	no**	
315192	Underwear and nightwear knitting mills	no**	
315211	Men's cut and sew apparel contractors	no**	
315212	Women's cut and sew apparel contractors	no**	
315221	Men's underwear and nightwear manufacturing	yes	
315222	Men's suit, coat, and overcoat manufacturing	yes	
315223	Men's shirt, except work shirt, manufacturing	yes	
315224	Men's pants, except work pants, manufacturing	yes	
315225	Men's work clothing manufacturing	no**	
315228	Other men's outerwear manufacturing	yes	
315229	All other cut and sew apparel manufacturing	no**	
315231	Women's lingerie and nightwear mfg	yes	
315232	Women's blouse and shirt manufacturing	yes	
315233	Women's dress manufacturing	yes	
315234	Women's suit, tailored jacket, and skirt mfg.	yes	
315239	Other women's outerwear manufacturing	yes	
315291	Infants' cut and sew apparel manufacturing	yes	
315292	Fur and leather apparel manufacturing	yes	
315299	All other cut and sew apparel manufacturing	yes	
315991	Hat, cap, and millinery manufacturing	yes	
315992	Glove and mitten manufacturing	yes	
315993	Men's and boys' neckwear manufacturing	yes	
315999	All other accessory and apparel manufacturing	yes	
316110	Leather and hide tanning and finishing	no	Non-Consumer

316211	Rubber and plastics footwear manufacturing	yes	
316212	House slipper manufacturing	yes	
316213	Men's nonathletic footwear manufacturing	yes	
316214	Women's nonathletic footwear manufacturing	yes	
316219	Other footwear manufacturing	yes	
316991	Luggage manufacturing	yes	
316992	Women's handbag and purse manufacturing	yes	
316993	Other personal leather good manufacturing	yes	
316999	All other leather good manufacturing	yes	
321	Wood Product Manufacturing	no	Non-Consumer
322	Paper Manufacturing	no	Non-Consumer
323	Printing and Related Support Activities	no	Non-Consumer
324	Petroleum and Coal Products Manufacturing	no	Non-Consumer
325	Chemical Manufacturing	no	Non-Consumer
326	Plastics and Rubber Products Manufacturing	no	Non-Consumer
327111	Vitreous china plumbing fixture manufacturing	yes	
327112	Vitreous china and earthenware articles mfg.	yes	
327113	Porcelain electrical supply manufacturing	yes	
327121	Brick and structural clay tile manufacturing	no	Non-Consumer
327122	Ceramic wall and floor tile manufacturing	no	Non-Consumer
327123	Other structural clay product manufacturing	no	Non-Consumer
327124	Clay refractory manufacturing	no	Non-Consumer
327125	Nonclay refractory manufacturing	no	Non-Consumer
327211	Flat glass manufacturing	no	Non-Consumer
327212	Other pressed and blown glass and glassware	yes	
327213	Glass container manufacturing	yes	
327215	Glass product mfg. made of purchased glass	yes	
3273	Cement and Concrete Product Manufacturing	no	Non-Consumer
3274	Lime and Gypsum Product Manufacturing	no	Non-Consumer
3279	Other Nonmetallic Mineral Product Manufacturing	no	Non-Consumer
331	Primary Metal Manufacturing	no	Non-Consumer
3321	Forging and Stamping	no	Non-Consumer
332211	Cutlery and flatware, except precious, mfg.	yes	
332212	Hand and edge tool manufacturing	yes	
332213	Saw blade and handsaw manufacturing	yes	
332214	Kitchen utensil, pot, and pan manufacturing	yes	
3323	Architectural and Structural Metals Manufacturing	no	Non-Consumer
332410	Power boiler and heat exchanger manufacturing	yes	
332420	Metal tank, heavy gauge, manufacturing	no	Non-Consumer
332431	Metal can manufacturing	no	Non-Consumer
332439	Other metal container manufacturing	no	Non-Consumer
3325	Hardware Manufacturing	no	Non-Consumer
3326	Spring and Wire Product Manufacturing	no	Non-Consumer
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt	no	Non-Consumer
3328	Coating, Engraving, Heat Treating, and Allied Activities	no	Non-Consumer
332911	Industrial valve manufacturing	no	Non-Consumer
332912	Fluid power valve and hose fitting mfg.	yes	
332913	Plumbing fixture fitting and trim mfg.	yes	
332919	Other metal valve and pipe fitting mfg.	yes	
332991	Ball and roller bearing manufacturing	no	Non-Consumer
332992	Small arms ammunition manufacturing	no	Non-Consumer
332993	Ammunition, except small arms, manufacturing	no	ATF
332994	Small arms manufacturing	no	ATF

332995	Other ordnance and accessories manufacturing	no	ATF
332996	Fabricated pipe and pipe fitting mfg.	no	Non-Consumer
332997	Industrial pattern manufacturing	no	Non-Consumer
332998	Enameled iron and metal sanitary ware mfg.	yes	Bathtubs and
332999	Miscellaneous fabricated metal product mfg.	no	Non-Consumer
333111	Farm machinery and equipment manufacturing	no	Non-Consumer
333112	Lawn and garden equipment manufacturing	no**	
333120	Construction machinery manufacturing	no	Non-Consumer
333131	Mining machinery and equipment manufacturing	no	Non-Consumer
333132	Oil and gas field machinery and equipment	no	Non-Consumer
3332	Industrial Machinery Manufacturing	no	Non-Consumer
3333	Commercial and Service Industry Machinery Manufacturing	no	Non-Consumer
333411	Air purification equipment manufacturing	yes	
333412	Industrial and commercial fan and blower mfg.	no	Non-Consumer
333414	Heating equipment (except warm air furnaces) manufacturing	yes	
333415	AC, refrigeration, and forced air heating	yes	
3335	Metalworking Machinery Manufacturing	no	Non-Consumer
3336	Engine, Turbine, and Power Transmission Equipment	no	Non-Consumer
333911	Pump and pumping equipment manufacturing	yes	
333912	Air and gas compressor manufacturing	yes	
333913	Measuring and dispensing pump manufacturing	no	Non-Consumer
333921	Elevator and moving stairway manufacturing	no	Non-Consumer
333922	Conveyor and conveying equipment mfg.	no	Non-Consumer
333923	Overhead cranes, hoists, and monorail systems	no	Non-Consumer
333924	Industrial truck, trailer, and stacker mfg.	no	Non-Consumer
333991	Power-driven handtool manufacturing	yes	Small Power
333992	Welding and soldering equipment manufacturing	no	Non-Consumer
333993	Packaging machinery manufacturing	no	Non-Consumer
333994	Industrial process furnace and oven mfg.	no	Non-Consumer
333995	Fluid power cylinder and actuator mfg.	no	Non-Consumer
333996	Fluid power pump and motor manufacturing	no	Non-Consumer
333997	Scale and balance, except laboratory, mfg.	no	Non-Consumer
333999	Miscellaneous general purpose machinery mfg.	no	Non-Consumer
334111	Electronic computer manufacturing	yes	
334112	Computer storage device manufacturing	yes	
334113	Computer terminal manufacturing	no**	
334119	Other computer peripheral equipment mfg.	yes	
334210	Telephone apparatus manufacturing	yes	
334220	Broadcast and wireless communications equip.	yes	
334290	Other communications equipment manufacturing	yes	
334310	Audio and video equipment manufacturing	yes	
334411	Electron tube manufacturing	no	Non-Consumer
334412	Bare printed circuit board manufacturing	no	Non-Consumer
334413	Semiconductors and related device mfg.	no	Non-Consumer
334414	Electronic capacitor manufacturing	no	Non-Consumer
334415	Electronic resistor manufacturing	no	Non-Consumer
334416	Electronic coils, transformers, and inductors	no	Non-Consumer
334417	Electronic connector manufacturing	yes	Extension
334418	Printed circuit assembly manufacturing	no	Non-Consumer
334419	Other electronic component manufacturing	no	Non-Consumer
334510	Electromedical apparatus manufacturing	no	Non-Consumer
334511	Search, detection, and navigation instruments	no	Non-Consumer
334512	Automatic environmental control manufacturing	yes	Thermostats

334513	Industrial process variable instruments	no	Non-Consumer
334514	Totalizing fluid meters and counting devices	no	Non-Consumer
334515	Electricity and signal testing instruments	yes	Home and
334516	Analytical laboratory instrument mfg.	no	Non-Consumer
334517	Irradiation apparatus manufacturing	no	Non-Consumer
334518	Watch, clock, and part manufacturing	yes	
334519	Other measuring and controlling device mfg.	yes	
334611	Software reproducing	no**	
334612	Audio and video media reproduction	yes	
334613	Magnetic and optical recording media mfg.	yes	
335110	Electric lamp bulb and part manufacturing	yes	
335121	Residential electric lighting fixture mfg.	yes	
335122	Nonresidential electric lighting fixture mfg.	no	Non-Consumer
335129	Other lighting equipment manufacturing	yes	
335211	Electric housewares and household fan mfg.	yes	
335212	Household vacuum cleaner manufacturing	yes	
335221	Household cooking appliance manufacturing	yes	
335222	Household refrigerator and home freezer mfg.	yes	
335224	Household laundry equipment manufacturing	yes	
335228	Other major household appliance manufacturing	yes	
335311	Electric power and specialty transformer mfg.	yes	
335312	Motor and generator manufacturing	yes	
335313	Switchgear and switchboard apparatus mfg.	yes	
335314	Relay and industrial control manufacturing	no	Non-Consumer
335911	Storage battery manufacturing	yes	
335912	Primary battery manufacturing	yes	
335921	Fiber optic cable manufacturing	no	Non-Consumer
335929	Other communication and energy wire mfg.	no	Non-Consumer
335931	Current-carrying wiring device manufacturing	yes	
335932	Noncurrent-carrying wiring device mfg.	yes	
335991	Carbon and graphite product manufacturing	no	Non-Consumer
335999	Miscellaneous electrical equipment mfg.	yes	
3361	Motor Vehicle Manufacturing	no	NHTSA
3362	Motor Vehicle Body and Trailer Manufacturing	no	NHTSA
3363	Motor Vehicle Parts Manufacturing	no	NHTSA
3364	Aerospace Product and Parts Manufacturing	no	Non-Consumer
3365	Railroad Rolling Stock Manufacturing	no	Non-Consumer
3366	Ship and Boat Building	no	USCG
336991	Motorcycle, bicycle, and parts manufacturing	yes	
336992	Military armored vehicles and tank parts mfg.	no	Non-Consumer
336999	All other transportation equipment mfg.	no**	
337110	Wood kitchen cabinet and countertop mfg.	yes	
337121	Upholstered household furniture manufacturing	yes	
337122	Nonupholstered wood household furniture mfg.	no**	
337124	Metal household furniture manufacturing	yes	
337125	Household furniture, exc. wood or metal, mfg.	no**	
337127	Institutional furniture manufacturing	no	Non-Consumer
337129	Wood TV, radio, and sewing machine housings	yes	
337211	Wood office furniture manufacturing	yes	
337212	Custom architectural woodwork and millwork	no**	
337214	Office furniture, except wood, manufacturing	yes	
337215	Showcases, partitions, shelving, and lockers	yes	
337910	Mattress manufacturing	yes	

337920	Blind and shade manufacturing	yes	
3391	Medical Equipment and Supplies Manufacturing	no	Non-Consumer
339911	Jewelry, except costume, manufacturing	yes	
339912	Silverware and hollowware manufacturing	yes	
339913	Jewelers' material and lapidary work mfg.	no	Non-Consumer
339914	Costume jewelry and novelty manufacturing	yes	
339920	Sporting and athletic goods manufacturing	yes	
339931	Doll and stuffed toy manufacturing	yes	
339932	Game, toy, and children's vehicle mfg.	yes	
339941	Pen and mechanical pencil manufacturing	yes	
339942	Lead pencil and art good manufacturing	yes	
339943	Marking device manufacturing	yes	
339944	Carbon paper and inked ribbon manufacturing	yes	
339950	Sign manufacturing	no	Non-Consumer
339991	Gasket, packing, and sealing device mfg.	no	Non-Consumer
339992	Musical instrument manufacturing	yes	
339993	Fastener, button, needle, and pin mfg.	no	Non-Consumer
339994	Broom, brush, and mop manufacturing	yes	
339995	Burial casket manufacturing	no**	
339999	All other miscellaneous manufacturing	yes	

NOTES:
* 31511X is equal to 315111 and 315119 in the data.
** Product codes that were not included due to lack of availability.
NHTSA = National Highway Traffic Safety Administrations
Food = Food and Drug Administration and Food Safety or Inspection Services of the U.S. Department of Agriculture.
USCG = United States Coast Guard
Source: Novel U.S. import dataset constructed from 2006 and 2007 U.S. Census Bureau data, http://censtats.census.gov/naic3_6/naics3_6.shtml.