Examining Barriers to Trade in Used Vehicles

David Coffin, Jeff Horowitz, Danielle Nesmith, and Mitchell Semanik

Abstract

Used vehicles represent a significant share of global vehicle trade, but many countries have policies in place that specifically limit used vehicle imports. Among five top passenger vehicle exporting countries (Canada, Japan, Korea, Mexico, and the United States), the United States is the largest exporter of used vehicles, with used vehicle exports accounting for an estimated 14 percent of total U.S. vehicle exports in 2014. Developing countries tend to show a preference for used vehicles versus new vehicles due to cost savings and greater product varieties. Top used vehicle markets include the United Arab Emirates, Russia, Nigeria, Mexico, and Burma. This paper uses a gravity model to estimate how policies from 140 countries limited used vehicle exports from five of the top passenger vehicle exporting countries, updating and improving on research published in 2006. Policies that almost entirely ban used vehicle imports are found to reduce used vehicle imports by 76 percent, while other policies limiting used vehicle imports reduce imports of used vehicles by 38 percent.

United States International Trade Commission

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Introduction

Exports of used vehicles play a major role in total passenger vehicle exports, but have received relatively little attention from analysts, despite being a significant part of global trade. According to estimates in this paper, used passenger vehicle exports originating in Japan, Canada, the United States, Korea, and Mexico in 2014 represented 0.5 percent ($13.9 billion) of the value of these countries' total exports and 6 percent of the value of their total passenger vehicle exports that year.[1] Used vehicle exports may also affect prices in these countries' domestic markets for passenger vehicles.

This paper seeks to survey existing research, improve upon existing used vehicle export data, and examine measures that may affect used vehicle trade. The first section looks at global demand for used vehicles, using existing data and literature on how trade in used vehicles affects importer and exporter countries. The second section examines significant markets for used vehicle exports, using existing data. The third section discusses measures limiting used vehicle imports, as well as why these measures may exist. The fourth section introduces the variables used in a gravity estimation of the factors driving the differences in used vehicle imports by country; the variables include several created solely for this study. The gravity estimation uses estimated used vehicle exports from the United States and Canada, combined with data on such exports from Japan, Korea, and Mexico. These countries are five of the six largest global exporters of passenger vehicles (figure 1).[2] The fifth section discusses the results of the gravity estimation. The final section analyzes and explains the results.

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[1] From here on, the phrases "new vehicle" and "used vehicle" will be used in place of "new passenger vehicle" and "used passenger vehicle." Passenger vehicles include cars, sport-utility vehicles, crossovers, minivans, and pickup trucks of less than five tons. Large vans for the transport of more than eight people, or trucks larger than five tons are not included because they tend to be manufactured by a different set of companies. Moreover, their ownership and trade patterns tend to differ from those vehicles included in the passenger vehicle category.

[2] The European Union (EU), the other top-six exporter, was not included because its vehicle export data does not include separate codes for used vehicles. GTIS, Global Trade Atlas database (accessed December 8, 2015).

Figure 1: Share of 2014 global passenger vehicle exports included in model

Source: GTIS, Global Trade Atlas database (accessed December 8, 2015). Corresponds to appendix table B.1.

Global Demand for Used Vehicles

According to existing research on used vehicles and used products in general, trade in used vehicles tends to flow from high-income countries, which produce most vehicles, to low-income countries, which have higher consumer demand for used vehicles. The primary reason for this pattern is likely that differences in income levels lead to differing depreciation costs--i.e., an average car's price depreciates more in a high-income country than in a low-income one.[3] Sellers of used vehicles in a high-income country can thus sell their vehicles in low-income countries for a better price than if they held the cars for sale at home. At the same time, as will be seen below, imports of used vehicles benefit consumers in low-income countries by enabling them to buy higher-quality vehicles at a lower price point and in greater variety than they can new vehicles.

Trade in used vehicles also appears to have variable effects on producers of new vehicles, depending on a country's income level. Producers of lower-quality new vehicles in countries that import used vehicles may be negatively affected by used vehicle imports. For producers in

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[3] Depreciation occurs more rapidly in higher income countries because the cost of repairs is higher in those countries, thus increasing the cost of ownership for owning an older vehicle more rapidly than in countries where labor and repair costs are less expensive. Grubel, "International Trade in Used Cars and Problems of Economic Development," 1980, 782–83.

large high-income countries like the United States, the effect of used vehicle exports on the domestic vehicle market may be negligible.

Why Low-income Countries Import Used Vehicles

Consumers in low-income countries tend to show a preference for used vehicles. This preference is driven by three primary factors: limited new offerings, price differentials, and differing depreciation rates. First, only a limited number of new vehicles, whether domestically produced or imported, are offered for sale in most developing countries, so a consumer in a developing country may find an imported used vehicle of a particular type more easily than a new one. Second, imported used vehicles tend to be less expensive than new vehicle imports. For example, the average cost of a new vehicle exported from the United States in 2014 under export codes specific to new vehicles was nearly $28,000, but the average value of a used vehicle exported from the United States that year was approximately $11,000.[4] These used vehicles may also be of higher quality than new vehicles exported from other markets, like China or India. Third, repairs in low-income countries tend to be less costly because of the lower cost of labor there, holding down maintenance costs overall.[5] Thus, the consumer in a lower-income country may be willing to pay more for a used vehicle than a comparable consumer in a higher-income country, despite used vehicles' tendency to require more repairs.

Additionally, research on the effects of income on consumer preferences has shown that consumers in lower-income countries tend to have a stronger preference for lower-quality goods than consumers in higher-income countries.[6] However, that is not to say that consumers in low-income countries prefer used over new at similar prices, but they are often income-constrained. For example, one study used gravity simulations to verify that increased per capita incomes lessened demand for used vehicles.[7]

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[4] USITC/DOC, DataWeb (accessed May 12, 2016).
[5] Grubel, "International Trade in Used Cars," 1980, 782–83.
[6] Davis and Kahn, "International Trade in Used Vehicles," January 2010, 6.
[7] Pelletiere and Reinert, "World Trade in Used Automobiles," 2006, 161–72.

Effect of Used Vehicle Imports on Low-Income Countries

According to existing research, consumers in low-income countries benefit from access to imported used vehicles, whereas sales of new vehicles in these countries, particularly cheaper new vehicles, may suffer when imported used vehicles are available.[8] An examination of the welfare impact of Cyprus's liberalization of used vehicle imports on consumers, for example, found that its consumers benefited by several hundred dollars per purchaser, but that most of the benefit came from increased variety rather than from a drop in prices for all vehicles.[9] An analysis of the effect of used vehicle import liberalization in Mexico found that greater access to imported used vehicles significantly depressed the sales and prices of new vehicles, Mexican automakers' annual revenue, and Mexican government revenue, and predicted that further liberalization would have a negative impact on the Mexican economy as a whole.[10] This same analysis also revealed a shift in demand from smaller new vehicles to larger used vehicles in Mexico.[11]

An examination of the U.S. passenger vehicle market over a 20-year period likewise revealed that the producer manufacturing the lowest-priced new vehicles seemed to be the manufacturer most affected by the existence of a used vehicle market (likely due to competition between higher-end used vehicles and lower-end new vehicles).[12] Increased availability of used vehicles likely negatively affects new vehicle producers in developing countries in a similar fashion. However, a third paper examining the U.S. and Mexican markets argued that "there is no evidence that the increased availability of used vehicles [from the United States] has decreased sales of new vehicles in Mexico."[13] Further, this paper also used data that appeared to show that the decline seen in new small vehicle purchases in Mexico actually began several years before imports of used vehicles increased.[14]

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[8] Research on this topic comes from single-country case studies, which may have only limited relevance to an analysis of global trade in used vehicles.

[9] Clerides, "Gains from Trade in Used Goods," December 2004, 2–3.

[10] Chu and Delgado, "Used Vehicle Imports Impact," 2009, 360–62.

[11] Chu and Delgado, "Used Vehicle Imports Impact," 2009, 350.

[12] Esteban and Shum, "Durable-good Oligopoly with Secondary Markets," 2007, 17.

[13] Davis and Kahn, "International Trade in Used Vehicles," January 2010, 3.

[14] Davis and Kahn, "International Trade in Used Vehicles," January 2010, 17, 28.

Another question raised about used vehicle imports in low-income countries is their effect on the environment. Emission levels in low-income countries will likely increase as the number of vehicles on the road increases. However, imported newer used vehicles may produce fewer emissions than the older used vehicles already in operation in low-income countries. To the extent that newer imported used vehicles replace older vehicles in low-income countries, imported used vehicles may reduce emissions and pollution overall. One study found, however, that Mexico's imports of used vehicles from Canada and the United States from 2005 to 2008 lowered its emissions per mile driven, but drove up emissions overall because of the increased number of total vehicles in use in Mexico.[15]

Effect of Used Vehicle Exports on High-Income Countries

The existence of foreign demand for a country's used vehicles can raise prices in the exporting country for such vehicles, at least modestly.[16] These higher prices may also increase trade-in values, and thus increase the likelihood that an aging vehicle's owner will trade in that vehicle for a new one.

While used vehicle exports may represent a significant percentage of total vehicle exports for some developed countries (e.g., the United States), the positive effects of used vehicle exports on domestic used vehicle prices in developed countries may be quite small. One paper described international trade in used vehicles between developed and developing countries as a "substitute for an explicit 'cash for clunkers' program."[17] For example, an analysis of registered vehicles in the United States found that less than 25 percent of the vehicles exported to Mexico in the years examined represented a "net exit" from the U.S. market. In other words, Mexican demand for used vehicles from the United States had little impact on used vehicle sales or prices in the United States; instead, it lessened the number of vehicles reduced to scrap.[18]

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[15] This is despite emissions standards only applying to new vehicles, not used ones. Davis and Kahn, "International Trade in Used Vehicles," January 2010, 13–14.

[16] In the United States the effect is quite small because the share of used vehicle exports compared to U.S. sales is quite small. Domestic used vehicle sales totaled 41.9 million in 2013, while only a few hundred thousand used vehicles were exported. The size of the domestic used vehicle market in other countries is unknown, but in those like Japan that discourage long-term vehicle ownership, its domestic market is likely much smaller. Binder, *Ward's Automotive Yearbook,* 2014, 220.

[17] "Cash for clunkers" is the colloquial name for the Car Allowance Rebate System, a $3 billion dollar U.S. federal scrappage program that provided an incentive for consumers to trade in older high-emission used vehicles and replace them with lower-emissions new vehicles. Davis and Kahn, "International Trade in Used Vehicles," January 2010, 2.

[18] Davis and Kahn, "International Trade in Used Vehicles," January 2010, 15–16.

Pelletiere and Reinert (2006) found that foreign countries' nontariff measures limiting used vehicle imports had a statistically significant negative effect on the level of U.S. used vehicle exports to those countries, but the same did not hold true for Japanese used vehicle exports.[19] For the United States, they found that countries that have preventive barriers to used vehicle imports were associated with 67 percent fewer U.S. exports to that country.

To the extent that greater international demand drives up used vehicle prices, this increase may boost trade-in values and thus support higher demand for new vehicles.[20] For countries with a smaller used vehicle market (e.g., Japan), the effect of used vehicle exports on domestic vehicle prices may be more significant because in a smaller market, the exported used vehicles would represent a larger share of demand for domestic used vehicles.

Used Passenger Vehicle Trade

During the period 2010–14, the estimated value of used vehicle exports from the United States, Canada, Japan, Mexico, and Korea rose more slowly than the value of their new vehicle exports. In 2014, the estimated value of these countries' used vehicle exports was at least $17.6 billion (figure 2).[21] This figure represents an increase of at least $2 billion (13 percent) over 2010, when used vehicle exports totaled $15.6 billion. However, during the same 2010–14 period, the total value of exports of both new and used passenger vehicles from these five countries rose 25 percent, from $238.8 billion in 2010 to $298.2 billion in 2014. As a result, the estimated share of used passenger vehicle exports fell from 6.5 percent in 2010 to 5.9 percent in 2014.

Used Passenger Vehicle Exporters

Of the five countries included in the gravity estimation, the United States is the largest exporter, Japan is the second largest, and Mexico ranks fifth. Used vehicle exports as a share of vehicle exports vary by country. In the United States, used vehicle exports in 2014 made up 14percent of U.S. vehicle exports by value. In Japan, used vehicle exports in 2014 represented 7 percent of vehicle exports by value.[22] Used vehicles accounted for no more than 2 percent of vehicle exports for the other three countries.[23]

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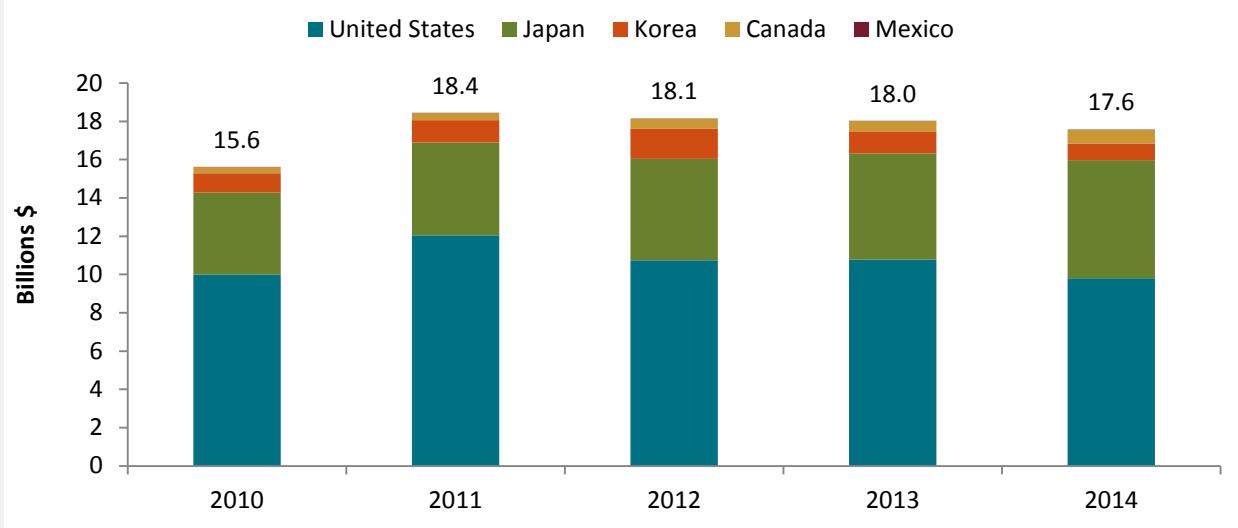
[19] Pelletiere and Reinert, "World Trade in Used Automobiles," 2006, 169–70.
[20] Data limitations make it unclear exactly how many used vehicles are exported each year. Sawyers, "Falling used-vehicle values threaten recovery." August 18, 2014.
[21] Analyst calculation using USITC/DataWeb data (accessed March 2, 2015); GTIS, Global Trade Atlas database (accessed July 22, 2015).
[22] All trade data used in this study are value data, not units.
[23] Author calculation based on GTIS data. GTIS, Global Trade Atlas database (accessed July 22, 2015).

Figure 2: Used vehicle exports, 2010–2014 (billions $)

Source: Analyst calculation using GTIS, Global Trade Atlas database (accessed July 22, 2015). Corresponds to appendix table B.2.

Top Markets for Used Vehicle Exports

Low- and lower-middle-income countries tend to import a larger share of used vehicles than they do other vehicles. The chart below shows shares of imports of all vehicles versus imports of used vehicles from Canada, Japan, Korea, Mexico, and the United States (figure 3). In each year, low- and lower-middle-income countries absorbed less than 10 percent of total vehicle imports, but as much as 20 percent of used vehicle imports.

Table 1 shows that the markets for used vehicle exports vary greatly in terms of wealth (measured in GDP per capita) and population. Populations in these markets range from less than 10 million to over 177 million. Examining these data uncovers several less-than-obvious factors influencing used vehicle demand.
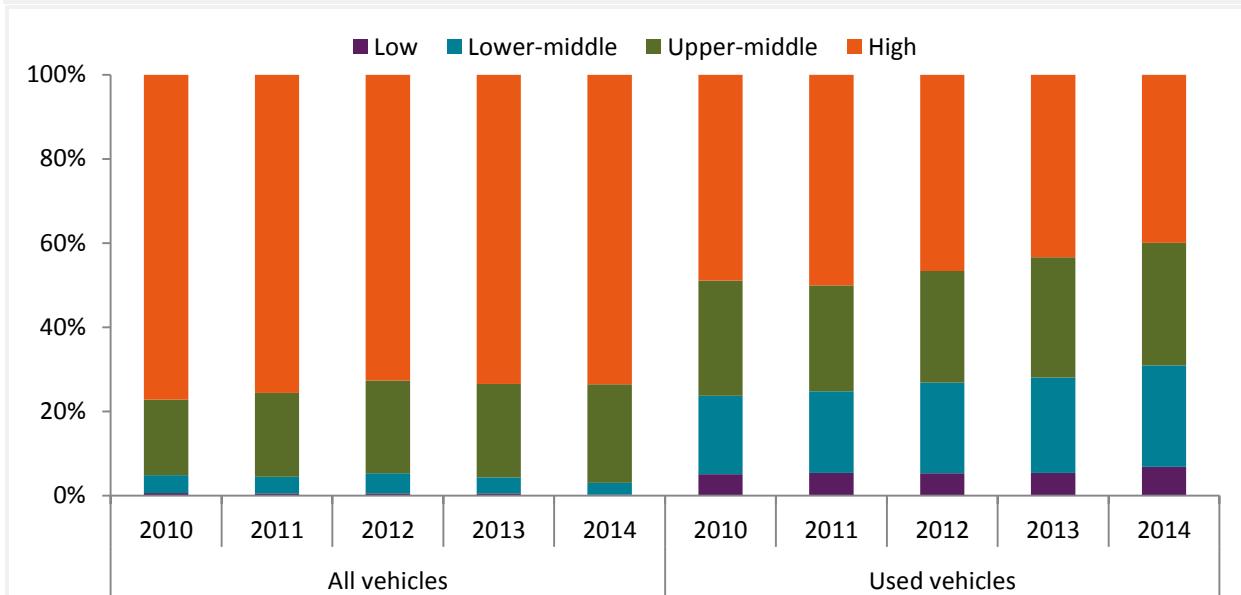
The United Arab Emirates (UAE) is a major importer of used passenger vehicles. From 2010 to 2014, the European Union (EU), Japan, Korea, Thailand, and the United States reported exporting over 1.4 million vehicles to the UAE.[24] The volume of imports seems outsized compared to the population of the UAE, for a relatively high ratio of cars to people. According to World Bank 2014 data, the UAE has a population of over 5.6 million people.[25] However, the UAE is also reportedly a major transshipment point.[26]

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[24] GTIS, Global Trade Atlas database (accessed January 2, 2015).
[25] World Bank Development Indicators 2014 (accessed July 23, 2015).
[26] Transshipment is the shipment of goods to an intermediate destination, then to yet another destination. Sadjadpour, "The Battle of Dubai," July 2011.

Figure 3: Shares of exports of all vehicles and used vehicles from Canada, Japan, Korea, Mexico, and the United States to the world, 2010–2014

Source: Income designations based on World Bank classification. Compiled by author based on data from GTIS, Global Trade Atlas database (accessed July 24, 2015). Corresponds to appendix table B.3.

Table 1: Top markets for used vehicle exports from countries in the model in 2014

Country	2014 Used vehicle imports (million $)	2014 GDP per capita	2014 Population (million)
United Arab Emirates	1,048	43,179	5.6
Russia	901	12,926	142.4
Nigeria	782	3,298	177.2
Mexico	749	10,715	120.3
Burma	634	1,221	55.7

Sources: World Bank Development Indicators 2014; Author calculations based on GTIS, Global Trade Atlas database (accessed July 27, 2015).

Russia was the second-largest importer of used passenger vehicles in 2014. Its main source was Japan, which supplied 71 percent of the used vehicles exported to Russia.[27] Although Russia is a producer of vehicles as well, Japan may supply much of Siberia and other eastern portions of Russia; these areas are quite distant from most of Russia's passenger vehicle assembly plants, which are located in western Russia.[28]

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[27] GTIS, Global Trade Atlas database (accessed July 23, 2015).
[28] There are two passenger vehicle plants in Vladivostok, which is Russia's largest Pacific Ocean port, but the rest of Russia's plants are in western Russia. Binder, *Ward's Automotive Yearbook 2015*, 11–12. 2015.

Nigeria's large domestic vehicle market and relative lack of local new vehicle production are likely the main reasons that Nigeria is the second-largest market for U.S. used passenger vehicle exports in both unit and value terms. Nigeria is a relatively large country, with relatively low GDP per capita. As discussed previously, lower-income countries like Nigeria tend to show a preference for used vehicles. However, Nigeria has policy measures in place that prevent the legal importation of used vehicles more than 10 years old.[29]

Mexico's geographic proximity to the United States and moderate GDP per capita likely contribute to Mexico's position as one of the largest importers of used vehicles. Another major factor has likely been the North American Free Trade Agreement (NAFTA), in which Mexico agreed to remove all policy measures restricting imports of used vehicles from the United States and Canada that were manufactured within the NAFTA region.[30] Mexico is a vehicle producer, but most of those vehicles are exported, so it's used vehicle exports may not have a significant impact on its domestic vehicle market.

Burma imported over $2.2 billion worth of used vehicles from 2010 to 2014. Nearly all (97 percent) of those imports came from Japan.[31] Similar to Russia, Burma likely imports high volumes of used vehicles from Japan because Japan is relatively close and has an abundant supply of available used vehicles. Further, Burma has little to no domestic production and a relatively low GDP per capita, making used vehicles a more likely choice for aspiring vehicle buyers.

Tariff and Nontariff Measures Affecting Used Vehicle Trade

According to data collected for this report, 80 countries have policy measures in place that limit used vehicle imports.[32] Of those 80 countries, 12 completely ban used vehicle imports, while the rest have import licenses, restrictions on the age of the vehicle, or other measures that limit used vehicle imports. These policies are often put in place to protect domestic dealers of new vehicles, to protect the environment from the emissions of used vehicles, or to protect domestic vehicle assembly (if it exists).[33] It's worth noting that the exporters included in the model report used vehicle exports to many of the countries that have laws in place banning the

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[29] Japanese Car Trade, "Import Rules and Regulations" (accessed July 22, 2015).
[30] NAFTA, Appendix 300-A.2 24 (a-f), http://www.sice.oas.org/trade/nafta/anx300a1.asp#Ap300-A.2 .
[31] GTIS, Global Trade Atlas database (accessed July 23, 2015).
[32] See appendix A for a full listing of countries with measures in place that affect used vehicle imports.
[33] Chu and Delgado, "Used Vehicle Imports Impact," 2009, 348.

import of used vehicles (with exceptions). With the exception of China, these exports are included in the model, because it is assumed that they are being imported under antique, diplomatic, or other exceptions to the import ban. However the sum of all exports to countries with bans on used vehicle imports are only 4.3 percent of the total exports reported in the model in 2014.

Types of Measures

There are four main types of tariff and nontariff measures affecting the importation of used vehicles: a complete ban, a ban on vehicles beyond a certain age, higher tariffs for used vehicles, and an import license requirement to legally import a used vehicle (table 2). The simplest, and most extreme, is a ban on all imports of used vehicles. Five South American countries have such a ban, as do several others worldwide. Many other countries restrict imports based on the age of the vehicle, ranging from as few as 3 years to as many as 10. Some countries charge a higher tariff on imports of used vehicles (compared to new vehicles), or cap the level of vehicle depreciation for tax purposes. One final policy that can limit the importation of used vehicles is the requirement of an import license. The state can then limit (or eliminate) the importation of used vehicles based on the number of licenses it distributes per year.[34] Restrictions based on the condition of a vehicle are another type of import-limiting measure—one that can be used in conjunction with other policy measures.

Table 2: Examples of countries with various measures affecting used vehicle imports.

Type of measure	Countries
Ban	Brazil, Bhutan, Canada,[a] Chile, China, Colombia, Ecuador, Ethiopia, Indonesia, Philippines, Sudan, Thailand, Turkey, Uruguay, and Venezuela
Banning imports of older vehicles	Algeria, Bangladesh, Barbados, Bolivia, Bosnia, Chad, Cyprus, Dominican Republic, Egypt, El Salvador, Gabon, Honduras, Hungary, India, Jamaica, Kenya, Kuwait, Lebanon, Mauritius, Morocco, Namibia, Nepal, Nicaragua, Nigeria, Oman, Pakistan, Paraguay, Qatar, Saudi Arabia, Senegal, Tanzania, Trinidad and Tobago, and Uzbekistan
Higher tariff	Haiti, Russia
Import license	Argentina, Australia, Botswana, Lesotho, Malaysia, Mexico, South Africa, Sri Lanka, and Swaziland

Source: Database of policy measures compiled by authors. For full list, see Appendix Table A.1.
 [a] Canada does not allow the import of used vehicles unless they meet the Canadian Motor Vehicle Safety Act, which tends to only be vehicles made for the U.S. and Canadian markets.

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[34] Pelletiere and Reinert, "World Trade in Used Automobiles," 2006, 163.

Reasons for Measures that Limit Used Vehicle Imports

Countries tend to create measures that limit used vehicle imports in order to protect domestic production and sales of new vehicles, especially if the countries produce passenger vehicles. Environmental protection and safety are two other reasons for creating such measures. Research by Pelletiere and Reinert found that domestic passenger vehicle production and used vehicle import restrictions were highly correlated.[35] In many developing countries, the least expensive new vehicles are often locally produced. It is domestic demand for these vehicles that is most likely to suffer from increases in used vehicle imports.[36]

However, countries that produce new vehicles are not the only ones that enact measures limiting used vehicle imports. Of the 140 countries included in the data examined for this paper, 101 are countries without domestic new vehicle production (non-producing countries) in 2014, and 58 of these 101 still have such measures on used vehicle imports.[37] These measures may exist due to "inherent disadvantages faced by used automobile interests in intra-industry trade policy competition."[38] That is, these measures may serve to shield new vehicle dealers, even absent domestic production, from potentially large losses if they had to compete with used vehicle imports for sales.[39]

At least one author posited that such measures remain in place in non-producing countries because policymakers have not closely examined the costs and benefits of liberalization. They may also survive due to a "collective action problem": the benefits from removing the measures would be spread to a large number of consumers, while the harm would be focused on a relatively small, but influential and vocal group (new vehicle dealers).[40] The individual benefit is too small to push consumers to strongly support removal of tariff or nontariff measures, but the harm is concentrated enough that new vehicle dealers are highly motivated to defend the measures.

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[35] Pelletiere and Reinert, "Used Automobile Protection and Trade," 2004, 749.

[36] Esteban and Shum's model did not include international trade, but it would be a reasonable assumption that an expansion of the secondary market to include foreign offerings would have a similar effect. Esteban and Shum, "Durable-goods Oligopoly with Secondary Markets," Summer 2007, 15.

[37] See appendix A for full data on variables.

[38] Pelletiere, "Why Do Countries Restrict Used Good Imports?" Spring 2003, 2.

[39] Pelletiere, "Why Do Countries Restrict Used Good Imports?" Spring 2003, 76–77.

[40] "The theory of collective action suggests that even if the cumulative loss to society is large, when the losses from a policy change to each individual are marginally small, sufficient opposition is less likely to be mobilized." Pelletiere, "Why Do Countries Restrict Used Good Imports?" Spring 2003, 75–77, 87; Clerides, "Gains from Trade in Used Goods," December 2004, 5.

Emissions reduction is another major reason often given for introducing policies that limit the import of used vehicles, because used vehicles, particularly older ones, tend to have less effective pollution controls. Another researcher, however, has claimed that while officials in non-producing countries may cite environmental and safety reasons when they enact import-limiting policy measures, "the interests of new car dealers are probably foremost in policymakers' minds."[41]

Gravity Model

Economic gravity models are intended to predict bilateral trade flows between nations based on the economic sizes of and distance between the countries involved. This paper employs an econometric model that builds upon the gravity framework used by Pelletiere and Reinert in 2006 to model barriers to used vehicle exports from the United States and Japan.[42] Our model adds used vehicle export data from three more countries: Canada, Korea, and Mexico. It also includes other components of gravity analysis that, while included in many gravity studies and widely seen as important, were not included in Pelletiere and Reinert's analysis. Examples include a shared border, a common language, colonial ties, and a free trade agreement (FTA).

Gravity models arose from Newton's universal law of gravitation in physics. When applied to international trade, the theory states that countries trade in proportion to their respective GDPs and the distance between them.[43] Traditionally, gravity models also include things such as whether or not the importer and exporter are landlocked, and whether a pair of countries share a common language, border, colonial history, or FTA. In our case, the GDP of each country may be an imperfect method for estimating demand for used vehicles, as countries with higher GDP per capita demand more new vehicles per capita independent of population. Thus, this model uses total vehicle population and GDP per capita separately.

One relevant criticism of traditional gravity models is that they often fail to account for the multilateral resistance terms (MRTs). MRTs capture the fact that bilateral trade flows are shaped not only by characteristics of trade between a given importer and exporter, but also by characteristics of their trade with other partners. However, this paper proxies MRTs by using exporter fixed effects, which also generate less biased estimates and account for unobserved

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[41] Clerides, "Gains from Trade in Used Goods," December 2004, 5.

[42] Pelletiere and Reinert. "World Trade in Used Automobiles: A Gravity Analysis of Japanese and U.S. Exports," 2006, 164.

[43] UN and WTO, *A Practical Guide to Trade Policy Analysis*, 2012.

heterogeneity.[44] Exporter fixed effects are used here to control for all exporter-specific country characteristics.

This model also uses one of two other potential fixed effects variables. It controls for time fixed effects, by creating a dummy variable for each year in the sample. Time fixed effects also contribute to obtaining unbiased estimates, which help account for MRTs that may change over time.[45] However, the model cannot use importer fixed effects because some variables of interest would need to be omitted. Instead, the model controls for various importer characteristics such as total vehicle population, GDP per capita, and vehicle production.[46] The model features improved estimates of U.S. and Canadian exports of used vehicles, various variables for measures that may restrict used vehicle imports, and traditional gravity model variables.

Finally, instead of the traditional OLS gravity model, this paper uses a Poisson pseudo-maximum likelihood (PPML) estimation technique due to the presence of heteroskedasticity,[47] a truncated sample size, and nonlinearities. According to Silva and Tenreyro (2006, updated in 2010 and 2015) the PPML technique is the best unbiased estimator of gravity models in samples with many zero values in the dependent variable and high degrees of heteroskedasticity.[48] The PPML technique has subsequently become the industry standard for gravity model estimation. Since the dataset used in this paper exhibits both of the qualities outlined by Silva and Tenreyro, we will use their technique to estimate the impact of various importer country characteristics on used vehicle trade among 140 importing countries between 2010 and 2014. Moreover, our model is focused specifically on trade in used vehicles and not on total trade, so the depedent variable reflects that.

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[44] Baldwin and Taglioni, "Gravity for Dummies," September 2006, 18.

[45] Ibid.

[46] In the context of this panel data model, MRTs would be completely controlled for with exporter-year fixed effects and importer-year fixed effects. However this is impossible to do and still identify our variables of interest, so our model only controls for exporter fixed effects and year fixed effects.

[47] Heteroskedasticity is nonconstant variance of the error term. When not corrected for in regression analysis the inferences made from the estimates predicted by the model will be biased.

[48] Silva and Tenreyro, "The Log of Gravity," November 2006, 640.

The variables in our model are defined as follows:

- **UsedPVExports**: Used vehicle exports by value (in thousands of dollars) from the exporter i to importer j during time t (2010 to 2014);[49]
- **lnDistance**: Log of the weighted distance between the exporter i and importer j;[50]
- **lnTotalVehicles**: Log of the estimate of the total vehicles present in the importing country j in year t;[51]
- **lnGDPcap**: Log of real GDP per capita for country j;
- **Landlocked**: A dummy variable equal to 1 if importer j is landlocked;
- **Language**: A dummy variable equal to 1 if importer j speaks the same official language as exporter i;
- **Contiguous**: A dummy variable equal to 1 if both countries share a border;
- **Colony**: A dummy variable equal to 1 if one country colonized the other at any point in history;
- **FTA**: A dummy variable equal to 1 if country j has a free trade agreement with the exporter i;
- **EU:** A dummy variable equal to 1 if the importer is a member of the European Union;
- **LowRestrict:** A dummy variable equal to 1 if the importer has restrictions that are not prohibitive;
- **HighRestrict:** A dummy variable equal to 1 if the importer has restrictions that are prohibitive;
- **SameSide:** a dummy equal to 1 if countries i and j drive on the same side of the road.
- **lnVehicleProduction:** log of the total vehicle production in the importing country j in year t;
- **lnTariff:** the log of the tariff value that the exporter faces to export to a particular import market in year t; and
- **α**: exporter fixed effects (unobservable country-specific effect) to account (imperfectly) for outward multilateral resistances; and
- **λ**: time fixed effects (unobservable time-specific effects) that helps to account for multilateral resistances associated to changes in time.

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[49] We use value in the estimation because quantity data is not consistent for every year and every country involved.

[50] Our distance variable is the *distw* variable used in much of gravity analysis that comes from the CEPII database. The variable is a weighted distance measure that takes into account the populations of every main agglomeration within a country to create a distance more accurate than the traditional capital-to-capital or border-to-border measurements of distance. For more information, see Head and Mayer, "Illusory Border Effects: Distance Mismeasurement Inflates Estimates of Home Bias in Trade," 2002.

[51] This is computed this by multiplying the World Bank's vehicles per 1000 by population data. Ideally one would proxy for demand by calculating total demand for vehicles in an importing country each year (domestic production in addition to net imports), but consistent data on net imports does not exist.

Independent Variables

We model trade costs using a combination of different variables. We utilize five traditional country characteristics in gravity analysis that take the form of dummy variables: **Colony, Contiguous, Distance, FTA, and Landlocked**. **Landlocked** is included because, according to the literature, transportation costs for landlocked countries are likely to be higher than would be implied by their distance from their trading partner.[52] Furthermore, it is a standard assumption in the literature that countries that share a border have lower costs of trade, so **Contiguous** is also included. We predict that the sign for the **Landlocked** and **Distance** coefficients will be negative, while for **Contiguous**, **Colony**, and **FTA** we expect it to be positive.

With respect to demand, we expect the coefficient on the GDP per capita of the importing country to be negative, since we expect wealthier countries to have a higher relative demand for new vehicles instead of used vehicles. We expect **TotalVehicles** to have a positive coefficient since this is our measure of the size of the total national automobile population. **VehicleProduction** is predicted to have a negative relationship with used vehicle imports, as we expect countries with higher levels of vehicle production to restrict potential competition from used vehicles. **SameSide's** relationship with the dependent variable is expected to be positive, as most consumers prefer to buy vehicles designed to drive on the same side of the road that the consumers drive on.[53]

Finally, with respect to our variables of interest we predict that the degree to which a country's regulations restrict used vehicle imports will have a significant effect on that country's used vehicle imports. In the model **LowRestrict** and **HighRestrict** are two dummy variables based on an updated version of the restrictiveness index compiled by Pelletiere and Reinert for their gravity model in 2004 to examine the effect of used vehicle import restrictions. For the index, zero represents a country where the import of used vehicles is completely unrestricted. One represents countries with limits no greater than the barring of the import of used vehicles older than five years. Two represents countries with limits stricter than barring imports of used vehicles older than five years, but still allowing the import of some used vehicles. Three represents countries that completely (or almost completely) ban the import of used vehicles.[54]

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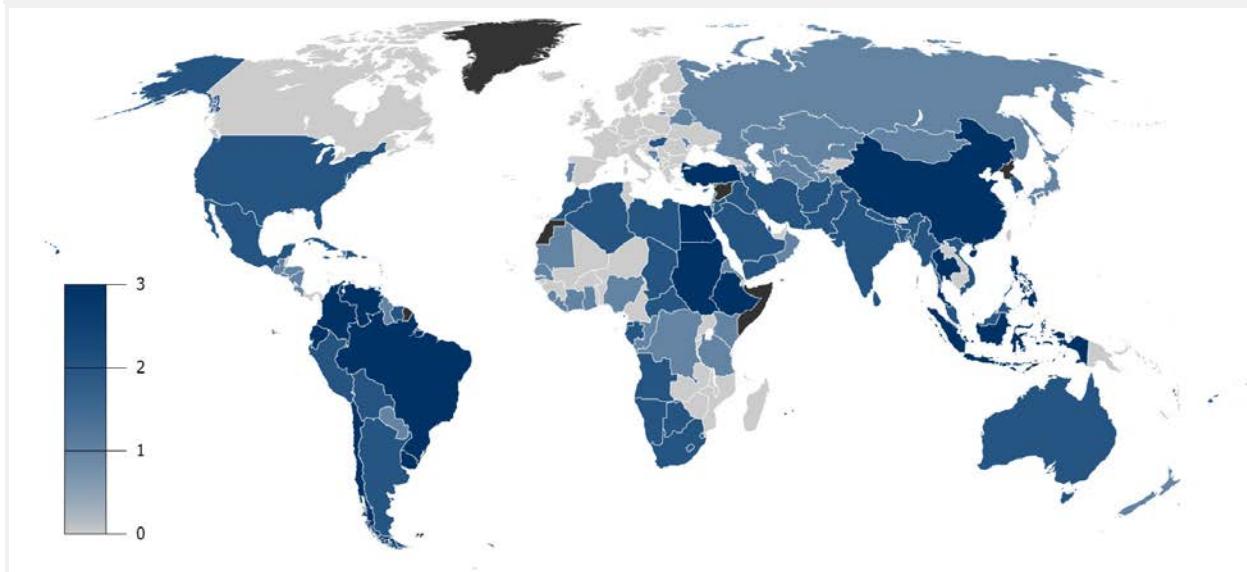
[52] All of these country (or country pair characteristics) also come from CEPII's GeoDist database. For more information, see Mayer and Zignago, "Notes on CEPII's Distances Measures," CEPII Working Paper 2011-25, 2011.

[53] In some countries it is legal to operate a car with a steering wheel on the opposite side of the road, particularly low-income countries.

[54] After examining our estimates, we discovered four countries with blanket restrictions on the import of used vehicles that appear to have relatively high levels of used vehicle imports on an absolute basis, but represent less than 7 percent of imports from those countries (Chile, Indonesia, Philippines, and Turkey). Some percentage of these vehicles are imported using antique, diplomatic, or personal exceptions. At least one source claims that some importers in Indonesia import used vehicles labeled as new vehicles on import documents. On those same vehicles' export documentation, these vehicles could be labeled used, explaining some of the discrepancy.

These data were collected manually based on authors' research into the used vehicle import regulations for each country (figure 4), and **LowRestrict** corresponds to countries with a 1 or 2, while **HighRestrict** applies to countries with a 3.

Figure 4: World political map by level of used vehicle import restriction

Source: Information compiled using author research and the map tool at http://gunn.co.nz/map. Corresponds to appendix table B.4.
Note: Countries in black have no data.

Tariffs are from the World Bank's TRAINS database, using a simple average of the tariffs for passenger vehicles (used or otherwise).[55] This database uses the most recent year available, which ranges from 2008 to 2013, depending on the country. The relationship between **Tariff** and the dependent variables is expected to be negative, i.e., lower tariffs should facilitate greater exports to a particular market.[56]

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[55] World Bank, TRAINS database (accessed March 18, 2015).
[56] For bilateral country pairings where the importer and exporter are FTA partners, the tariff according to the FTA tariff schedule was used.

Dependent Variable

The dependent variable for this equation is used vehicle exports from country *i* to country *j* in year *t*. The exporters included in the dataset are Canada, Japan, Korea, Mexico, and the United States. These are five of the six largest exporters of passenger vehicles globally, representing roughly 57 percent of all passenger vehicle exports (new and used) in 2014.[57] Used vehicle export data from these countries are used because few countries track used vehicle imports. The dataset includes estimates of U.S. and Canadian used vehicle exports calculated by the authors for those portions of the Harmonized Tariff System of the United States (HTS) that do not break out used vehicle exports.[58] Previous used vehicle research only included the available used vehicle export data without modification, thus underestimating U.S. used vehicle exports.[59] Unmodified used vehicle exports are used for Japan, Mexico, and Korea, as they each use country-specific 8- or 10-digit categories that cover specific export codes for all used vehicles.

Estimation of U.S. and Canadian used vehicle exports

This model is further enhanced by the use of an estimation technique to more accurately estimate used vehicle exports in Canada and the United States that are not reported in HS codes classifying exports specific to used vehicles. For the United States, only four of nine HS-6 digit passenger vehicle export subheadings have corresponding 10-digit Schedule B export codes specific to used vehicles (Canada has export subheadings for five of nine).[60] The other five HS subheadings commingle new and used exports in the same export codes.[61] These commingled codes include those for cars and sport-utility vehicles (SUVs) with gasoline engines larger than 1L to 1.5L, cars and SUVs with diesel engines 1.5L or smaller, electric vehicles, and pickup trucks and work vans (table 3). While very few cars and SUVs are made in the United States or Canada with engines 1.5L or smaller, millions of pickup trucks and work vans are produced in the United States and to a lesser extent, Canada.[62]

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[57] The EU was not included in the model because it does not offer any used vehicle-specific export data. The 57 percent calculated above excludes internal EU trade, if internal trade were included in the calculation of the share of global vehicle trade included in the model, then we would estimate that the countries in this dataset would make up roughly 40 percent of exports. GTIS, Global Trade Atlas database (accessed July 20, 2015).

[58] This estimate uses the same method originally developed for Coffin, "Used Vehicles Are an Important Component," 2015.

[59] To our knowledge, Canadian used vehicle exports have not been used in a gravity model.

[60] Those HS-6 categories are 870323, 870324, 870332, and 870333.

[61] Those HS-6 categories are 870322, 870331, 870390, 870421, and 870431.

[62] Binder, *Ward's Automotive Yearbook,* 2014, 170–173.
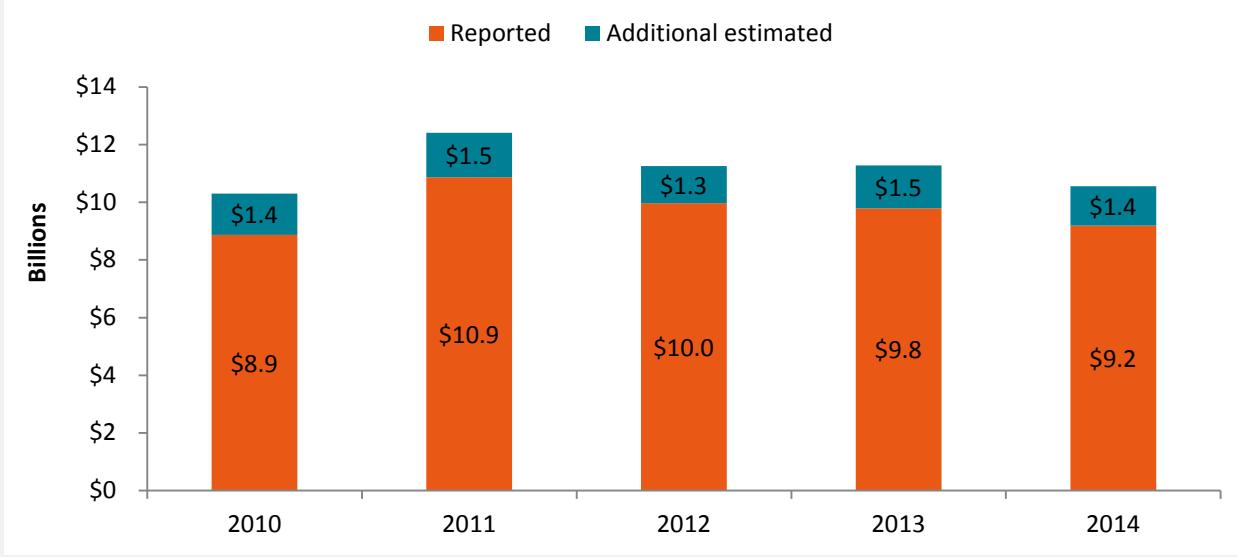
This paper estimates exports country by country, based on the share of used to new vehicle exports in the HS-6 subheadings that have corresponding 8 or 10 digit export classifications specific to used vehicles. The observed share is then applied to those HS-6 subheadings where used vehicles' share of exports is unknown. By estimating exports in this way, the estimate takes into account the preferences of each individual country for used versus new vehicles. However, this calculation may over- or underestimate used vehicles' share of exports if consumers in a given country have a greater or lesser preference for used vehicles in observed HS-6 subheadings than they do in those HS-6 subheadings where the used vehicle share of exports is unobserved.

Table 3: U.S. and Canadian passenger vehicle-related HS subheadings

HS-6 Code	Description	Types of vehicles	Used vehicle export classification (Y/N)
8703	Motor cars and other motor vehicles for the transport of persons	Passenger cars, SUVs, and minivans	
870322	With spark-ignition engines of a cylinder capacity exceeding 1,000 cc but not exceeding 1,500 cc	Passenger cars, SUVs, and minivans	Canada Yes, United States No
870323	Exceeding 1,500 cc, but not exceeding 3,000 cc	Passenger cars, SUVs, and minivans	Yes
870324	Exceeding 3,000 cc	Passenger cars, SUVs, and minivans	Yes
870331	With compression-ignition engines of a cylinder capacity not exceeding 1,500 cc	Passenger cars, SUVs, and minivans	No
870332	Exceeding 1,500 cc but not exceeding 2,500 cc	Passenger cars, SUVs, and minivans	Yes
870333	Exceeding 2,500 cc	Passenger cars, SUVs, and minivans	Yes
870390	Other	Electric cars and SUVs	No
8704	Motor vehicles for the transport of goods	Trucks and vans for the transport of goods	
870421	Other, with compression-ignition engines and a gross vehicle weight not exceeding 5 metric tons	Diesel pickup trucks and work vans	No
870431	Other, with spark-ignition engine and a gross vehicle weight not exceeding 5 metric tons	Gasoline engine pickup trucks and work vans	No

Source: Information derived from U.S. Census, Schedule B (accessed August 28, 2015); and Statistics Canada, "Canadian Export Classification 2015," (accessed January 19, 2016).

For 2014, the vast majority of the estimated used vehicle exports (87 percent or $9.2 billion) came directly from export codes (figure 5), and the estimate from the commingled export codes made up 13 percent of estimated exports ($1.4 billion). The estimation methodology used in this paper may underestimate the share of vehicles exported in the commingled export codes, because passenger vehicle manufacturers do not tend to produce vehicles of this type in the United States or Canada. Thus exports of such vehicles may include more used vehicles that were previously imported from other countries as new vehicles.

Figure 5: Reported and estimated U.S. and Canadian used vehicle exports, 2010–14

Source: Author calculations based on USITC/DataWeb data (February 24, 2015). Corresponds to appendix table B.5.

China: A special case

Export data appear to indicate that China is a major importer of used vehicles—a picture that is inconsistent with China's ban on used vehicle imports. However, many of its reported imports of used vehicles may actually be gray-market imports of new vehicles, with buyer networks reportedly purchasing new vehicles in the United States and exporting them to China as used vehicles. The reason is that a new luxury vehicle in China often sells for a significantly higher price, sometimes 300 percent higher, than in the United States.[63]

Since China bans the import of used vehicles, the vehicles sold may not have been labeled as used on any of the import documents. For this reason, in the gravity model, reported exports of used vehicles to China are coded as zero.

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[63] Goldstein, "U.S. Targets Buyers of China-Bound Luxury Cars," February 11, 2014; Bunkley, "Selling Vehicles for Export Angers Automakers," July 21, 2014.

Results

We find that the variables of interest—how restrictive a country's policies are with regard to importation of used vehicles—had a significant effect on the used vehicle exports in our dataset from the five exporting countries to 140 importing countries during 2010–14. Specifically, we find that an importing country's policies towards used vehicle imports being highly restrictive (comparing the most restrictive to no restrictions) is associated with a 76.7 percent less exports to that country.

A total of six regressions were run to examine used vehicle exports and what affects them. Regressions 1–4 cover all five exporters using an increasing number of variables (tariffs are added last because tariff data covered fewer countries than the other data in the dataset). The final two regressions are country specific for comparison with Pelletiere and Reinert's work. Regression 1 regresses solely on the standard components of a gravity model. Regression 2 adds in a control variable for whether or not the importer is a member of the EU (found to be significant in previous work) and a measure of how restrictive the importer's policies towards used vehicles are. Regressions 3 and 4 include additional control variables, with the difference being that in regression 4 tariff rates are also included (table 4).[64]

Looking first at regressions 1–4, most of the gravity model components are consistently significant and have the expected sign: distance between the two countries, total vehicles present in the importing country, GDP per capita of the importer, whether or not the importer is landlocked, whether or not the importer and exporter speak a common language, and whether the pair of countries share a border. The only exceptions to this are **Colony** which is insignificant (and does not have the expected sign) and **FTA** which is insignificant until **Tariff** is included in regression (4) at which point it becomes significant and negative. The final thing to note here is the high magnitude of **Contiguous**. This is likely due to the fact that **Contiguous** is only coded as a one in a total of 30 observations (U.S./Canada, Canada/U.S., U.S./Mexico, Mexico/U.S., Mexico/Belize, and Mexico/Guatemala, each 5 times for the five years of data), and more than half of those observations are combinations of countries that have a high volume of trade between them.

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[64] We included tariff rates as a separate regression because data limitations caused a large drop in our observational count when tariffs are controlled for, in order to control as best we can for any changes in results that might be caused by this.

Table 4: Model results

Variables	(1) UsedPV_exports	(2) UsedPV_exports	(3) UsedPV_exports	(4) UsedPV_exports
lnDistance	-0.42***	-0.50***	-0.42***	-0.53***
	(0.111)	(0.141)	(0.155)	(0.183)
lnTotalVehicles	0.30***	0.41***	0.72***	0.69***
	(0.040)	(0.040)	(0.039)	(0.047)
lnGDPCAP	-0.14**	-0.14**	-0.21***	-0.27***
	(0.063)	(0.063)	(0.049)	(0.076)
	(0.063)	(0.063)	(0.049)	(0.076)
Landlocked	-1.00***	-1.21***	-1.24***	-1.35***
	(0.178)	(0.183)	(0.177)	(0.196)
Language	0.55***	0.37*	0.79***	0.94***
	(0.195)	(0.193)	(0.134)	(0.245)
Contiguous	1.19***	0.54**	0.85***	1.14***
	(0.268)	(0.256)	(0.286)	(0.415)
Colony	-0.82***	-0.81*	-0.16	-0.40
	(0.306)	(0.432)	(0.366)	(0.402)
FTA	0.18	-0.02	-0.26	-0.92***
	(0.205)	(0.226)	(0.229)	(0.309)
EU		-1.37***	-1.30***	-1.13***
		(0.223)	(0.223)	(0.308)
LowRestrict		-0.19	-0.48***	-0.34*
		(0.278)	(0.142)	(0.204)
HighRestrict		-1.61***	-1.61***	-1.46***
		(0.286)	(0.247)	(0.315)
SameSide			1.37***	1.40***
			(0.170)	(0.175)
lnVehicleProduction			-0.10***	-0.09***
			(0.013)	(0.017)
lnTariff				-0.14
				(0.105)
Constant	11.44***	11.06***	6.00***	8.17***
	(1.117)	(1.315)	(1.600)	(2.091)
Observations	3,455	3,455	3,455	2,507
R-squared	0.365	0.405	0.496	0.507
Adjusted R-squared	0.364	0.403	0.494	0.504
Exporter FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
*** p<0.01, ** p<0.05, * p<0.1				

Source: Authors calculations.
Note: Robust standard errors are in parentheses.

With respect to the variables of interest, regressions 2–4 gradually introduce five new variables. **LowRestrict** is found to be significant and negative, associated with a 38.1 percent decrease in used vehicle exports to the importing country, in regression (3) but is only significant at the 10 percent level in regression (4) when **Tariff** is included, and is associated with a 28.8 percent decrease in used vehicle exports to the importing country. **HighRestrict** is significant even when the model controls for tariff rates, and in regression (4) is associated with a 76.7 percent decrease in used vehicle exports to the importing country. The rest of the variables are significant and in the direction we expected, with the exception of **Tariff**.[65] The importer being a member of the EU is associated with less exports to that country, the importer and exporter driving on the same side of the road is associated with more exports, and importer vehicle production is associated with less exports to that country.

Turning to country-specific modeling, table 5 reports the results of U.S. and Japan-specific regressions. These results mimic the specification of regression 4 in table 4. Comparing these findings to those in Pelletiere and Reinert, the country-specific regressions account for more years (2010 through 2014 instead of just 2001) and the results are noticeably different. When it comes to the variables of interest, **HighRestrict and LowRestrict** are negative and significant for exports from the United States, while **LowRestrict** is actually positive and significant for exports from Japan, while **HighRestrict** is not significant.

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[65] It's worth noting here that, due to restrictions in available tariff data, the regression loses 900 observations when tariffs are added. Countries such as United Arab Emirates (1st), Nigeria (3rd), Mexico (4th), Myanmar (5th), Sri Lanka (6th) and Jordan (9th) are all top ten recipients of used vehicle exports in the model that are excluded (or excluded in some cases) when tariffs are included. It's worth noting however that the results of the other variables appear fairly consistent regardless of whether or not tariffs are included.

We find that the total number of vehicles in the importing country remains significant and positive for both the United States and Japan. **SameSide** remains positive and significant for both countries. Moreover, **Language** remains positive and significant for the United States (this variable is omitted in the Japan regression due to a lack of partner countries with Japanese as the official spoken language). **Landlocked** is also found to be significant and negative for both countries. However, it is important to note that filtering the observations for just one exporter greatly dilutes the robustness and observational counts of the models, and these results are likely to differ if even a few observations with high exports differ in characteristics.

Table 5: U.S. and Japan single country model results

Variables	(7) United States UsedPV_exports	(8) Japan UsedPV_exports
lnDistance	1.20***	-1.21***
	(0.327)	(0.299)
lnTotalVehicles	0.75***	0.71***
	(0.083)	(0.096)
lnGDPCAP	-0.11	-0.49***
	(0.089)	(0.102)
Landlocked	-2.16***	-0.90***
	(0.406)	(0.306)
Language	0.82***	
	(0.316)	
Contiguous	2.45***	
	(0.577)	
Colony	-0.40	-6.29***
	(0.372)	(0.835)
FTA	0.37	-1.39***
	(0.426)	(0.371)
EU	-1.15***	-2.34***
	(0.329)	(0.399)
LowRestrict	-1.59***	0.68**
	(0.300)	(0.283)
HighRestrict	-2.81***	-0.68
	(0.461)	(0.577)
SameSide	1.10***	1.60***
	(0.297)	(0.322)
lnVehicleProduction	-0.12***	-0.07**
	(0.019)	(0.030)
lnTariff	0.14	-0.35**
	(0.127)	(0.141)
Constant	-9.58***	15.55***
	(3.395)	(3.202)
Observations	505	569
R-squared	0.678	0.381
Adjusted R-squared	0.669	0.367
Year FE	YES	YES

Source: Authors calculations.
Note: Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

As discussed earlier, we use PPML for our estimations to address potential concerns about heteroskedacity and zero exports. Below is a comparison of results using OLS and PPML. The results are quite similar in direction, but PPML properly including results of zero trade between bilateral pairs is likely the cause for the differences in magnitudes in the results between the models. Noticeable other differences are the magnitude and significance of **Contiguous** and **FTA**. These are due to the inclusion of country pairs with zero trade in used vehicles in the PPML model.

Table 6: Comparison between PPML and OLS

Variables	(1) PPML	(2) OLS	(3) PPML	(4) OLS
lnDistance	-0.43***	-2.00***	-0.54***	-1.54***
	(0.155)	(0.171)	(0.183)	(0.194)
lnTotalvehicles	0.72***	1.15***	0.68***	1.01***
	(0.039)	(0.053)	(0.047)	(0.072)
lnGDPCAP	-0.21***	-0.19***	-0.28***	-0.26***
	(0.050)	(0.066)	(0.076)	(0.080)
landlocked	-1.23***	-0.81***	-1.34***	-1.25***
	(0.177)	(0.205)	(0.196)	(0.237)
Language	0.79***	3.06***	0.94***	2.82***
	(0.134)	(0.216)	(0.246)	(0.247)
contiguous	0.89***	-2.73***	1.20***	-2.60***
	(0.284)	(0.817)	(0.414)	(0.873)
Colony	-0.16	-0.17	-0.40	0.02
	(0.365)	(0.609)	(0.401)	(0.636)
FTA	-0.27	1.48***	-0.95***	2.13***
	(0.230)	(0.288)	(0.309)	(0.348)
EU	-1.27***	-1.69***	-1.08***	-2.05***
	(0.219)	(0.246)	(0.302)	(0.264)
LowRestrict	-0.45***	-0.40**	-0.30	-0.45**
	(0.142)	(0.171)	(0.200)	(0.196)
HighRestrict	-1.55***	-1.67***	-1.37***	-1.97***
	(0.245)	(0.293)	(0.314)	(0.368)
SameSide	1.37***	4.20***	1.41***	4.02***
	(0.170)	(0.165)	(0.176)	(0.194)
lnVehicleProduction	-0.11***	-0.07***	-0.09***	-0.03
	(0.013)	(0.018)	(0.017)	(0.021)
lnTariff			-0.15	0.10
			(0.105)	(0.089)
Constant	6.07***	8.50***	8.30***	7.32***
	(1.600)	(1.766)	(2.081)	(2.068)
Observations	3,455	3,058	2,507	2,215
R-squared	0.496	0.622	0.507	0.538
Adjusted R-squared	0.494	0.620	0.504	0.535
Exporter FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Source: Authors calculations.
Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Conclusion

This paper introduces more accurate used vehicle export estimates for the United States and Canada, and improves upon the previous gravity estimation focused on used vehicles, conducted by Pelletiere and Reinert in 2006. First, this paper uses PPML to estimate the gravity equation instead of OLS, which as discussed previously, is more accurate with datasets with a high number of zeroes among importer-exporter pairs like this one. This paper's model also uses additional independent variables (**Colony**, **Tariff**, and **VehicleProduction**), refines previously used independent variables, and adds exporter and time fixed effects. Further, the model includes three additional exporters (Canada, Korea, and Mexico), more importers (140), and covers a five-year period, resulting in over three thousand importer-exporter pairs and making for a much more robust model.[66] Also, rather than just using GDP, the model uses total vehicle population to show the size of the importer market. The authors believe the use of total vehicle population results in a more accurate model.

In this paper, rather than looking at each country separately, the authors ran the regression using all five exporters, as it quadrupled the number of observations and allowed a more global understanding of how each dependent variable affects used vehicle imports. Examining these results, some of Pelletiere and Reinert's conclusions were verified, including the significant positive relationship between driving on the same side of the road and used vehicle imports, and the significant negative relationship between GDP per capita and preference for used vehicles. EU membership was also significant and negative, as Pelletiere and Reinert expected.

Overall, trade in used vehicles appears to behave in much the same way as trade in other goods, with variables like **Contiguous, Landlocked,** and **Language** showing significant positive or negative relationships as expected and discussed in the variables section. Furthermore, Pelletiere and Reinert expected that EU countries would be less likely to import used vehicles because they would likely trade internally, but their model had mixed results. Our model seems to support their original expectation.[67]

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[66] There were tariff data for only 2,507 of those instances.
[67] Pelletiere and Reinert, "World Trade in Used Automobiles," 2006, 164.

Two variables included in the model appear to have an effect that is different from the typical trade pattern, **GDPCAP** and **FTA**. The main difference from typical trade patterns, as discussed earlier in the theory section, was the negative relationship between used vehicle trade and GDP per capita. However, this relationship fits within the body of research on used vehicles and used goods, which states that lower-income countries will likely show a preference for lower-quality or used items. An unexpected difference from typical trade patterns in the results was the negative coefficient for **FTA**. We theorize that the removal of duties on the import of new and used vehicles from an FTA partner leads to more consumers choosing new vehicles over used vehicles, causing the negative coefficient in our model.

For variables specific to this used vehicles model, **LowRestrict**, **HighRestrict**, and **VehicleProduction** were significant and negative as expected. However, it is worth noting that the magnitude of the estimated effect of **HighRestrict** on exports is smaller than found by Pelletiere and Reinert. **HighRestrict** measures whether or not a country has restrictions in place preventing the importation of used vehicles, but the model only estimates that high levels of restrictiveness reduce exports to a country by 76.7 percent. There are two likely causes. The first is the large number of exceptions that countries include in their restrictions. The second is that the model uses export data, which tends to be less accurate than import data.[68] The export data could include incorrect destinations or inaccurate descriptions of the good being exported (e.g., the vehicle being exported might be new rather than used). The authors also expected that the presence of domestic vehicle producers would reduce used vehicle imports, because some of the used vehicle literature discusses how relatively strong domestic vehicle producers lobby the government to protect the domestic market from used vehicle imports.

Future Research

Future research could include better import data, more exporters, better tariff data, and a better or more differentiated restrictiveness index. Import data might help in reconciling how many importers appear to receive exports while having regulations in place preventing used vehicles from entering the country. The current model uses five exporters, as they were the top vehicle exporters that had differentiated used vehicle data. With more used vehicle export data, the model could be expanded for more robust results. The tariff data used in the model are TRAINS data, using simple averages of the tariff lines, but use of specific trade-weighted tariffs, if available, may add accuracy.[69] The restrictiveness measure used mainly reflects restrictions on the age of vehicles imported, but includes import licenses, bans, and capped

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[68] As mentioned previously, import data were not used because few countries track used vehicle imports, so the dataset would have been much smaller.
[69] Each country uses different HS 8-digit codes for passenger vehicles, and time constraints prevented the authors from examining HS 8-digit codes for every country included in the database.

depreciation. Breaking apart those measures into their individual components may yield more accurate results. Also, incorporating used vehicle sales data, or at least more recent vehicle ownership rates, would also likely improve the model.

Another area of future used vehicle research is the effect of reducing used vehicle imports through nontariff measures on an importing country's economy. With fewer used vehicle imports, for example, transportation costs in those countries may be higher, and those costs would influence the cost of numerous other goods, potentially affecting trade or even growth.

Bibliography

Baldwin, Richard, and Daria Taglioni. "Gravity for Dummies and Dummies for Gravity
    Equations." NBER Working Paper 12516, September 2006.

Behrens, Kristian, Cem Ertur, and Wilfried Koch. "Dual Gravity: Using Spatial Econometrics to
    Control for Multilateral Resistance." *Journal of Applied Econometrics* 27, no. 5 (August
    2012): 773–94. Originally published online December 12, 2010.
    http://onlinelibrary.wiley.com/doi/10.1002/jae.1231/full (fee required).

Binder, Alan K. *Ward's Automotive Yearbook.* Southfield, MI: Ward's Automotive Group, 2014.

Bunkley, Nick. "Selling Vehicles for Export Angers Automakers." *Automotive News,* July 21,
    2014. http://www.autonews.com/article/20140721/LEGALFILE/307219975/selling-
    vehicles-for-export-angers-automakers-but-is-it-illegal?

Chu, Ted, and Alejandro Delgado. "Used Vehicle Imports Impact on New Vehicle Sales: The
    Mexican Case." *Análisis Económico* 24, no. 55 (2009): 347–64.

Clerides, Sofronis. "Gains from Trade in Used Goods: Evidence from the Global Market for
    Automobiles." CEPR Discussion Paper No. 4859, January 2005.
    http://papers.ssrn.com/sol3/papers.cfm?abstract_id=721603.

Coffin, David. "Used Vehicles Are an Important Component." USITC Executive Briefings on
    Trade, January 2015.
    https://usitc.gov/sites/default/files/publications/332/executive_briefings/coffin_used_v
    ehicle_exports.pdf.

Davis, Lucas W., and Matthew E. Kahn. "International Trade in Used Vehicles: The
    Environmental Consequences of NAFTA." *American Economic Journal: Economic Policy*
    2, no. 4 (January 2010): 58-82.
    https://www.aeaweb.org/articles.php?doi=10.1257/pol.2.4.58 (fee required).

Esteban, Susanna, and Matthew Shum. "Durable-goods Oligopoly with Secondary Markets: The
    Case of Automobiles." *RAND Journal of Economics* 38 (Summer 2007): 332–54.

Goldstein, Matthew. "U.S. Targets Buyers of China-Bound Luxury Cars." *New York Times,*
    February 11, 2014. http://dealbook.nytimes.com/2014/02/11/u-s-targets-buyers-of-
    china-bound-luxury-cars/.

Golub, Stephen S. "Entrepôt Trade and Smuggling in West Africa: Benin, Togo and Nigeria." *The World Economy* 35, no. 9 (September 2012): 1139–61. Originally published online July 23, 2012. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9701.2012.01469.x/abstract (fee required).

Grubel, Herbert G. "International Trade in Used Cars and Problems of Economic Development." *World Development* 8, no. 10 (October 1980): 781–88. http://www.sciencedirect.com/science/article/pii/0305750X80900054 (fee required).

Head, Keith and Thierry Mayer. "Illusory Border Effects: Distance Mismeasurement." *CEPII Research Center* Working Paper, No 2002-01, January 2002. http://www.cepii.fr/PDF_PUB/wp/2002/wp2002-01.pdf.

Japanese Car Trade. "Import Rules and Regulations on Japan Used Cars in Nigeria." http://www.japanesecartrade.com/japancars/automobile-articles/japan-used-cars-import-regulations-in-nigeria (accessed July 22, 2015).

Mayer, Thierry, and Soledad Zignago. "Notes on CEPII's Distances Measures: The *GeoDist* Database." CEPII working paper no. 2011-25, December 2011. http://www.cepii.fr/PDF_PUB/wp/2011/wp2011-25.pdf.

Pelletiere, Danilo, and Kenneth A. Reinert. "Used Automobile Protection and Trade." *Empirical Economics* 29 (2004): 737–51. http://home.earthlink.net/~dpelleti/sitebuildercontent/sitebuilderfiles/pelletiereeefinal.pdf.

Pelletiere, Danilo, and Kenneth A. Reinert. "World Trade in Used Automobiles: A Gravity Analysis of Japanese and U.S. Exports." *Asian Economic Journal* 20, no. 2 (June 2006): 161–72. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8381.2006.00227.x-i1/references (fee required).

Pelletiere, Danilo. "Why Do Countries Restrict Used Good Imports? An Inquiry into the International Political Economy of Used Automobiles." PhD diss., George Mason University, Spring 2003.

Sadjadpour, Karim. "The Battle of Dubai: The United Arab Emirates and the U.S.-Iran Cold War." The Carnegie Papers, July 2011. http://carnegieendowment.org/files/dubai_iran.pdf.

Sawyers, Arlena. "Falling used-vehicle values threaten recovery." *Automotive News,* August 18, 2014. http://www.autonews.com/article/20140818/RETAIL/140819910/falling-used-vehicle-values-threaten-recovery.

Seaman, Kirk. "The 10 Cheapest Cars Sold in America for 2014." *Car and Driver,* April 8, 2014. http://blog.caranddriver.com/the-10-cheapest-new-cars-sold-in-america-for-2014/.

Silva, Santos J.M.C. and Tenreyro, Silvana. "The Log of Gravity." The Review of Economics and Statistics, November 2006, 88 (4): 641-658. http://personal.lse.ac.uk/tenreyro/jensen08k.pdf.

Statistics Canada, "Canadian Export Classification 2015," (accessed January 19, 2016). http://www.statcan.gc.ca/access_acces/alternative_alternatif.action?l=eng&loc=/pub/65-209-x/65-209-x2015000-eng.pdf.

Storchmann, Karl. "On the Depreciation of Automobiles: An International Comparison." *Transportation* 31, no. 4 (November 2004): 371–408. http://link.springer.com/article/10.1023%2FB%3APORT.0000037087.10954.72.

U.S. Department of Commerce (USDOC). International Trade Administration (ITA). Office of Transportation and Machinery. *Compilation of Foreign Motor Vehicle Import Requirements*, 2011.

U.S. Department of Commerce (USDOC). Census Bureau. Schedule B, 2015. http://www.census.gov/foreign-trade/schedules/b/index.html.

U.S. International Trade Commission (USITC) Interactive Tariff and Trade DataWeb (DataWeb)/U.S. Department of Commerce (USDOC). http://dataweb.usitc.gov (accessed various dates).

United Nations and World Bank. *A Practical Guide to Trade Policy Analysis*, 2012. https://www.wto.org/english/res_e/publications_e/wto_unctad12_e.pdf.

World Bank. (2010–2014). Data retrieved August 28, 2015, from World Integrated Trade Solution. Tariff and Trade Analysis (TRAINS) database.

Appendix A
Used Vehicle Trade and Restrictiveness

The table below shows all of the countries used in the dataset, along with their restrictiveness score and the used vehicle exports Canada, Japan, Korea, Mexico and the United States reported/estimated for 2010 to 2014 (table A.1). Canada is listed twice as an importer (once as a 0 and once as a 3) due to it having different policies towards the United States than it does with other exporters.

Table A.1: Estimated used vehicle imports by importing country and level of restrictiveness, 2010–14

Importer	Restrict	2010	2011	2012	2013	2014
United Arab Emirates	0	705,280,345	937,547,977	1,151,947,462	1,049,056,595	1,048,207,496
Benin	0	350,353,436	462,196,226	412,296,592	422,842,780	546,489,248
Canada	0	1,867,154,375	1,801,091,125	1,330,931,625	1,176,709,250	523,543,188
United Kingdom	0	177,981,189	213,079,744	222,798,649	313,596,171	390,879,481
Germany	0	416,021,509	503,388,414	318,888,409	257,337,693	349,627,930
Hong Kong	0	533,262,755	712,670,674	461,449,547	267,637,388	335,837,242
Georgia	0	111,611,711	212,293,011	191,185,367	295,299,895	296,380,896
Netherlands	0	191,592,945	199,081,428	171,800,870	186,517,980	242,604,931
Norway	0	25,508,172	27,453,541	22,064,820	177,903,068	215,133,493
Lithuania	0	282,632,181	581,594,001	253,903,816	295,016,116	207,626,699
Kyrgyzstan	0	44,450,966	111,155,197	83,459,533	119,347,712	152,208,760
Uganda	0	68,872,000	77,198,684	77,202,585	82,775,747	86,318,946
Finland	0	173,468,079	312,385,821	219,532,843	180,738,191	73,468,328
Mozambique	0	18,272,917	30,316,373	37,577,900	50,226,633	63,149,458
Zambia	0	18,010,612	36,343,931	63,731,479	66,975,516	56,685,022
France	0	59,714,102	60,365,713	44,830,929	41,888,461	53,980,172
Poland	0	54,170,990	49,222,414	36,884,424	40,361,407	47,644,589
Sweden	0	51,531,772	57,233,779	41,240,370	35,886,361	43,241,917
Switzerland	0	36,082,016	64,810,251	40,381,591	61,225,593	41,790,554
Italy	0	30,808,525	13,275,421	16,616,521	10,793,062	37,294,076
Togo	0	42,891,175	59,352,335	49,865,613	45,316,768	34,376,036
Bahamas	0	22,383,800	22,095,372	25,888,097	28,546,806	31,723,080
Latvia	0	65,594,777	71,700,991	28,413,748	36,437,332	30,277,288
Belgium	0	54,994,136	50,085,342	31,953,628	35,720,611	28,447,532
Panama	0	46,348,350	32,430,347	30,949,636	26,746,433	27,232,587
Zimbabwe	0	6,826,945	9,077,493	10,286,036	18,845,851	23,979,987
Bahrain	0	10,224,870	12,137,427	15,617,076	18,898,421	20,274,958
Spain	0	17,978,463	13,436,551	13,148,621	13,197,903	15,394,859
Malta	0	14,150,236	10,152,127	6,392,147	6,926,177	13,148,344
Denmark	0	7,420,018	4,510,601	6,653,225	6,341,594	12,968,536
Malawi	0	4,264,333	6,025,560	6,125,824	8,780,512	11,343,477
Albania	0	5,484,406	9,436,657	5,809,178	5,792,303	8,714,922
Papua New Guinea	0	11,152,838	14,227,781	16,892,488	10,392,973	7,101,574
Austria	0	4,602,785	3,729,807	6,307,334	10,453,762	7,097,003
Belize	0	6,380,913	5,699,819	6,802,649	7,030,136	6,669,937
Ukraine	0	11,451,756	10,747,671	6,337,794	8,402,080	6,299,052
Bulgaria	0	4,450,688	3,850,373	3,469,586	3,847,579	4,887,721
Ireland	0	2,930,001	1,264,237	881,970	1,844,272	4,793,825
Czech Republic	0	8,573,729	7,065,138	5,573,449	4,338,953	4,757,639
Estonia	0	2,948,151	5,455,831	3,962,483	4,951,821	4,756,741
Armenia	0	17,973,191	8,860,763	4,873,541	5,575,965	4,579,369

Importer	Restrict	2010	2011	2012	2013	2014
Tunisia	0	4,605,742	5,547,250	5,011,053	3,356,536	3,573,092
Burundi	0	2,307,009	3,111,708	1,662,152	2,307,173	3,308,120
Greece	0	9,447,882	3,328,895	1,690,200	3,602,819	3,236,912
Maldives	0	823,353	1,648,045	1,329,305	1,449,452	3,118,483
Luxembourg	0	2,991,953	404,855	828,093	410,278	2,742,187
Lao People's Democratic Republic	0	38,166,035	57,746,329	18,199,495	2,311,086	2,687,921
Burkina Faso	0	588,634	1,131,394	1,357,024	3,527,566	2,239,483
Saint Vincent and the Grenadines	0	2,875,378	2,210,603	2,184,653	1,766,064	1,955,966
Mali	0	470,188	1,138,087	945,306	1,952,303	1,890,738
Slovakia	0	2,411,033	2,262,148	1,523,529	760,458	1,860,299
Croatia	0	5,054,028	2,910,115	2,037,291	1,796,461	1,547,790
Rwanda	0	1,104,708	1,341,538	1,816,923	1,090,588	950,035
Iceland	0	1,413,639	1,114,173	1,286,879	1,044,781	836,168
Kiribati	0	568,191	787,960	1,317,760	1,750,879	742,924
Slovenia	0	1,640,109	696,164	210,678	966,747	547,081
Macedonia, the former Yugoslav Republic of	0	140,298	79,151	178,769	106,067	344,553
Guinea-Bissau	0	66,105	196,015	85,463	111,017	54,227
Russian Federation	1	768,235,355	1,125,966,590	1,479,276,580	1,259,593,018	901,039,991
Nigeria	1	603,862,004	808,621,277	927,662,229	1,006,511,945	781,886,923
New Zealand	1	294,254,329	331,785,337	344,060,167	464,583,355	540,799,889
Kenya	1	248,731,398	227,305,333	252,383,944	350,932,988	390,055,176
Mongolia	1	97,876,199	291,584,990	240,778,214	223,066,759	187,635,393
Ghana	1	138,871,598	233,321,194	255,970,614	267,390,932	158,552,156
Japan	1	198,554,977	297,446,672	314,688,437	202,108,303	114,239,883
Tanzania, United Republic of	1	77,024,006	75,994,691	83,749,855	96,419,263	113,960,394
Guatemala	1	60,594,872	75,027,266	70,227,881	64,266,046	57,441,586
Costa Rica	1	44,267,174	60,618,363	56,670,853	41,331,200	48,010,365
Congo	1	18,897,538	22,469,411	31,340,264	31,479,401	38,324,076
Guyana	1	29,493,430	32,232,681	35,405,803	34,393,109	31,202,810
Honduras	1	32,551,693	35,085,691	39,859,949	31,689,299	23,766,438
El Salvador	1	16,308,837	18,650,215	27,109,788	27,810,919	20,271,752
Senegal	1	12,394,348	11,922,234	14,358,222	12,507,486	18,602,109
Paraguay	1	24,650,191	31,405,797	16,251,396	17,583,744	18,203,841
Kazakhstan	1	93,784,688	146,527,853	22,702,549	24,252,266	17,423,362
Tajikistan	1	12,605,996	10,257,997	11,163,281	9,211,361	13,481,188
Israel	1	26,283,158	28,044,643	17,194,671	12,559,674	11,734,591
Oman	1	2,806,891	4,855,854	6,481,515	8,119,273	8,735,344
Nicaragua	1	8,807,134	9,803,466	9,755,120	8,526,272	7,969,229
Sierra Leone	1	9,560,925	12,878,974	11,419,493	14,423,929	6,926,962
Liberia	1	15,416,178	24,188,881	22,838,897	9,551,069	5,585,169
Gambia	1	2,918,932	3,035,641	3,727,849	4,002,687	4,374,200
Belarus	1	20,482,860	42,288,790	3,079,832	6,496,746	4,116,320
Turkmenistan	1	461,871	743,889	501,506	105,943	980,876
Eritrea	1	245,796	429,386	537,006	729,570	775,564

Importer	Restrict	2010	2011	2012	2013	2014
Bosnia and Herzegovina	1	962,825	363,546	288,497	264,834	586,226
Cape Verde	1	31,576	110,154	132,989	4	87,451
Moldova, Republic of	1	71,697	3	59,186	584,064	34,097
Sao Tome and Principe	1	2	16,101	158,788	3	17,567
Mexico	2	329,235,206	324,376,904	333,523,314	643,847,551	748,571,153
Myanmar	2	32,507,404	156,317,893	777,763,557	635,538,386	634,499,753
Sri Lanka	2	258,826,232	457,767,858	125,028,803	268,827,467	559,358,694
Jordan	2	631,100,694	579,952,825	790,379,213	804,514,199	540,788,685
Libyan Arab Jamahiriya	2	259,315,450	101,459,527	626,704,015	516,115,468	295,530,660
Dominican Republic	2	286,215,541	252,958,543	206,038,581	212,038,943	245,427,510
United States	2	70,022,747	90,346,656	122,059,059	134,449,334	229,317,606
Bangladesh	2	231,632,131	168,855,166	76,269,186	122,217,382	220,157,538
Pakistan	2	84,001,500	194,327,856	258,337,300	142,399,063	167,924,310
Yemen	2	88,298,972	72,366,838	134,912,087	174,769,088	155,076,362
South Africa	2	162,839,059	171,940,976	131,461,331	124,303,150	103,289,163
Australia	2	120,085,767	136,766,171	110,991,994	106,532,687	101,828,646
Singapore	2	36,676,813	30,598,990	39,925,244	38,823,225	96,553,862
Trinidad and Tobago	2	37,831,683	35,825,399	57,689,635	80,371,864	78,079,515
Bolivia, Plurinational State of	2	15,185,710	33,650,352	36,921,476	66,685,863	68,469,893
Viet Nam	2	355,627,559	261,766,685	108,839,439	43,898,103	66,471,072
Kuwait	2	93,737,150	133,153,500	120,300,443	76,889,046	64,099,686
Korea, Republic of	2	50,515,433	50,709,564	45,475,394	52,644,144	52,781,206
Mauritius	2	34,777,707	27,114,315	36,494,323	49,031,181	48,249,991
Cyprus	2	34,592,484	16,384,142	14,839,637	16,958,611	29,963,210
Qatar	2	9,033,733	10,452,348	19,772,536	27,050,686	29,737,781
Botswana	2	11,644,574	25,805,807	30,961,779	17,322,891	21,037,270
Angola	2	34,971,487	19,476,875	26,433,045	23,731,390	18,008,467
Fiji	2	3,263,375	4,482,508	7,013,745	12,049,294	15,770,457
Namibia	2	9,044,776	8,015,208	10,373,503	9,381,232	11,097,640
Barbados	2	10,625,307	10,753,589	8,382,001	7,514,219	10,275,397
Afghanistan	2	47,200,104	38,451,908	34,298,811	16,546,885	6,086,296
Morocco	2	7,354,105	9,278,380	4,145,278	3,645,339	4,812,229
Peru	2	132,148,672	61,092,461	60,013,796	7,274,969	4,797,173
Brunei Darussalam	2	12,770,140	2,507,077	3,649,102	13,601,422	4,772,376
Swaziland	2	3,440,390	2,031,909	2,710,874	2,594,398	3,538,434
Argentina	2	5,675,723	5,356,288	3,127,485	2,974,304	3,463,714
Hungary	2	731,304	1,126,685	864,675	2,368,772	2,932,851
Iran, Islamic Republic of	2	6,003,046	6,770,504	9,814,060	4,234,492	1,465,397
Seychelles	2	345,858	267,537	175,389	115,097	554,943
Central African Republic	2	472,209	632,890	199,067	67,701	54,505
Nepal	2	235,328	31,424	3	16,753	10,060
Syrian Arab Republic	2	16,269,535				
Chile	3	307,447,303	335,492,778	289,909,191	331,953,852	260,910,232

Importer	Restrict	2010	2011	2012	2013	2014
Indonesia	3	231,948,339	161,020,351	167,680,972	109,619,968	121,806,306
Turkey	3	70,269,235	66,897,004	159,841,691	139,058,241	97,900,142
Philippines	3	74,518,603	52,916,357	74,518,083	64,717,246	63,827,848
Venezuela, Bolivarian Republic of	3	15,300,376	10,739,851	10,318,044	9,348,192	17,016,194
Ecuador	3	13,062,481	9,964,426	7,438,656	7,444,938	13,932,390
Canada	3	5,151,518	4,474,882	3,998,154	5,125,201	8,237,041
Sudan	3	26,996,297	11,296,244	8,967,323	8,126,741	7,749,831
Colombia	3	7,972,112	5,596,410	6,496,017	9,649,851	7,492,825
Brazil	3	17,500,311	21,004,567	5,253,806	4,066,228	4,435,899
Ethiopia	3	487,933	1,009,812	578,665	611,778	1,035,284
Bhutan	3	8,518	79,911	4	6,731	192,652
China	3	0	0	0	0	0
Comoros		6,305	3	1,614	3	10,350

Source: Authors research and calculations based on GTIS, Global Trade Atlas Database (accessed January 19, 2016).

**Appendix B
Data from Figures Used in Report**

Table B.1: Total vehicle exports included and excluded from model, 2010–2014

	2010	2011	2012	2013	2014
Included exports	238,870,707,571	262,155,360,381	291,224,728,720	294,528,587,754	298,241,240,504
EU28 (External Trade)	104,315,438,179	134,221,741,902	143,748,566,475	152,957,693,519	156,839,325,203
Other excluded exports	52,407,630,185	57,620,580,382	62,861,832,741	70,731,952,843	68,410,539,259

Source: Compiled by authors using GTIS, Global Trade Atlas Database (accessed December 8, 2015). Table corresponds to figure 1.

Table B.2: Used vehicle exports by reporting country, 2010–2014

Exporter	2010	2011	2012	2013	2014
United States	9,982,793,066.44	12,044,893,224.01	10,746,173,001.85	10,767,447,732.28	9,806,962,464.54
Japan	4,306,304,034.00	4,844,132,105.00	5,288,736,417.00	5,564,364,525.00	6,161,399,582.00
Korea	1,003,168,679.00	1,183,457,113.00	1,599,283,216.00	1,149,063,304.00	872,239,154.00
Canada	312,474,585.14	358,474,333.21	501,831,113.15	526,885,156.00	719,043,398.70
Mexico	9,646,925.00	11,763,691.00	10,687,263.00	7,871,848.00	7,226,072.00
Total	15,614,387,289.58	18,442,720,466.22	18,146,711,011.00	18,015,632,565.28	17,566,870,671.24

Sources: Compiled by authors using GTIS, Global Trade Atlas Database (accessed July 24, 2015). Table corresponds to figure 2.

Table B.3: All vehicle exports by destination country's level of income

Income level	2010	2011	2012	2013	2014
Low	2,395,966,744	2,498,794,098	2,509,816,759	2,626,818,130	1,064,418,096
Lower-middle	18,738,404,049	20,065,586,246	23,050,907,301	19,373,327,572	13,717,139,250
Upper-middle	78,194,377,874	100,760,663,829	107,341,069,943	112,595,734,080	115,944,433,378
High	336,604,202,277	381,581,291,683	353,133,237,035	372,233,841,256	363,924,257,365
Total	435,932,950,944	504,906,335,856	486,035,031,038	506,829,721,038	494,650,248,089

Sources: GTIS, Global Trade Atlas Database (accessed July 24, 2015). Table corresponds to figure 3.

Table B.4: Used vehicle exports by destination country's level of income

Income level	2010	2011	2012	2013	2014
Low	791,753,926	988,934,889	964,269,645	968,670,980	1,193,185,335
Lower-middle	2,910,689,192	3,576,015,223	3,903,929,532	4,073,371,026	4,236,923,091
Upper-middle	4,264,375,711	4,640,437,485	4,810,798,549	5,144,755,977	5,126,373,865
High	7,637,958,391	9,227,546,373	8,450,042,876	7,793,118,301	7,020,074,025
Total	15,604,777,220	18,432,933,970	18,129,040,602	17,979,916,284	17,576,556,316

Sources: Compiled by authors using GTIS, Global Trade Atlas Database (accessed July 24, 2015); World Bank, databank (accessed September 16, 2015). Table corresponds to figure 4.

Table B.5: Reported and estimated used vehicle exports from the United States and Canada

Exporter	2010	2011	2012	2013	2014
Reported used exports	8,566,453,197	10,518,570,775	9,479,971,187	9,291,181,271	8,495,429,794
Estimated used exports	1,426,164,502	1,532,581,394	1,268,435,830	1,451,720,641	1,339,922,100

Sources: GTIS, Global Trade Atlas Database (accessed July 24, 2015). Table corresponds to figure 5.

Appendix C
Formulas

This section explains the formulas used to calculate the effect different independent variables in our model have on the dependent variable based on the type of independent variable in question.

Suppose you have a model lnY = a*lnX + b*DummyVariable, where Y and X are continuous variables and DummyVariable is 0/1;

- The percentage change in Y for a 1 percentage change in X is equal to a. For this type of variable, in logs, the estimated coefficient is the elasticity. This is the case for **Distance**, **TotalVehicles**, **GDPcap**, **Vehicleproduction** , and **Tariff** in our estimations.

- The percentage change in Y when DummyVariable goes from zero to one is equal to: $(e^{(b*1)} - e^{(b*0)}) / e^{(b*0)} = e^{b}-1$. This is the case for **Language**, **Landlocked**, **Contiguous**, **Colony**, **FTA**, **EU**, and **Sameside** in our estimations.