Empirical Economics (2004) 29:737–751
DOI 10.1007/s00181-004-0216-6

EMPIRICAL ECONOMICS

Used automobile protection and trade: Gravity and ordered probit analysis

Danilo Pelletiere, Kenneth A. Reinert

School of Public Policy, George Mason University, Arlington, VA 22201–4498, USA
(e-mail: kreinert;dpelleti@gmu.edu)

First version received: December 2002/Final version received: August 2003

Abstract. There is a great deal of protection against used automobile imports in many countries of the world that has gone largely unnoticed in the trade policy literature. Indeed, there has been no recent attempt to systematically analyze the determinants of used automobile trade and the role of protection in this trade. This paper makes a preliminary attempt, introducing an ordered measure of protection levels in 132 countries. A gravity model of used automobile exports from the United States shows that protection measures against used automobile import have a statistically-significant, suppressive effect on trade flows. An ordered probit analysis of the protection measures themselves points to new automobile production interests as a key factor behind used automobile protection. Other relevant explanatory factors of protection are income levels, democratic regime, transitional status, WTO membership, and income distribution

Key words: Used goods, international trade, gravity model, ordered probit

JEL classification: F13, F17, C20, C25

1. Introduction

One characteristic of both trade theory and empirical trade policy analysis is its near-exclusive focus on new goods. In fact, however, international markets in used goods are well developed. For obvious reasons, these markets are

The authors would like to thank Ken Button, Michael Ferrantino, Kingsley Haynes, the late Don Lavois, Keith Maskus, Arvind Panagariya, Baldev Raj, Thomas Strattman, Roger Stough, Wendy Takacs, Michael Walsh, and two anonymous referees for helpful comments and discussions.

more important for durable goods, used automobiles being one important case. The magnitude of used automobile trade can be appreciated from the fact that, excluding trade with Canada, the United States exported approximately one third as many used automobiles as new automobiles in 1999. That said, however, there is a great deal of protection against used automobile imports in many countries of the world that has gone largely unnoticed in the trade policy literature.[1] Indeed, since the analysis of Grubel (1980), there has been no attempt to systematically analyze the determinants of used automobile trade and the role of protection in this trade. This paper makes a preliminary attempt, introducing an ordered measure of used automobile protection levels in 132 countries.

There is now a small but significant literature on international trade in used capital.[2] The consensus of this literature is that developing countries benefit from free trade in used capital and durable goods. This conclusion is based primarily on the observation that used capital and durable goods are relatively labor intensive in their use, maintenance, and repair. Labor abundant, developing countries are therefore better able to utilize them than labor scarce, developed countries. Additionally, some authors (e.g., Smith 1974; Navaretti et al. 2000) have suggested that the lower technological level of used machines suits the skill levels of developing countries.

With regard to the specific case of used automobiles, Grubel (1980) identified four reasons that automobiles depreciate more slowly in developing countries: lower cost of labor-intensive repairs, lower average incomes leading to lower demand for luxury features relative to basic utility features, a lower depressive effect on old model prices of newly-introduced models, and lower breakdown opportunity costs due to lower average levels of human capital. The fact that automobiles depreciate more slowly in developing countries, combined with protective measures against imports in those countries led Grubel to conclude that unsatisfied demand for used automobiles in developing countries is large and that the gains from trade in used automobiles would accrue in large part to the developing countries.

Over two decades have passed since Grubel's analysis, and a great deal of trade liberalization has taken place in that time. However, as we explain below, severe restrictions are in place against imports of used automobiles in many countries of the world. Using an ordered measure of protection against used automobiles, this paper both assesses the unmet demand for used automobiles from the United States and provides a political economy analysis of existing protection levels.[3] We proceed as follows. In Section 2, we describe the ordered protection measure we use throughout the remainder of the paper. In Sect. 3, we employ two gravity models of trade in used automobiles to assess the extent to which these levels of protection matter. In Sect. 4, we conduct an ordered-probit, political economy analysis of used automobile protection to shed light on its sources and processes. Finally, in Sect. 5, we present our conclusions and an important caveat.

---

[1] Panagariya (2000) is a notable exception.

[2] See, for example, Sen (1962), Smith (1974, 1976), Grubel (1980) Bond (1983), Pack (1978), Mainwaring (1986), and Naveretti et al. (2000).

[3] As we mention at the end of the paper, the ordered nature of our protection measure prevents us from addressing simultaneous equations bias and inconsistency.

2. Measuring protection levels

To date, there has been no comprehensive and consistent database on protection levels against used automobile imports. To remedy this and to make the analyses of this paper possible, we have compiled such a database using a variety of sources. The official published or on-line sources included in this database are the U.S. Department of Commerce International Trade Administration's *Compilation of Foreign Motor Vehicle Import Restrictions* (1999, 2001), *Report on Remanufactured Parts Import Requirements* (1999), and the *Worldwide Used Equipment Regulations* database, and the United States Department of State's *Country Commercial Guides* (2001), as well as a review of data provided in individual country reports of the U.S. government's Trade Information Center (www.trade.gov/td/tic/). Information was also gathered from the United States Trade Representative's *Foreign Trade Barriers* (2000) report. A similar review was conducted of World Trade Organization (WTO) documents, with reports emanating from the Trade Policy Review Panels being a noteworthy source.

Reviews of international business and trade press reports, country customs information, and other government sources were used to provide additional information and, where possible, determine the nature of policies and the timing of policy changes. In the case where two authoritative sources reporting on a subject were clearly contradictory, an effort was made to obtain country-specific information from officials to clarify the policy that would have existed in our benchmark year 1999. Though formal responses to a survey administered to commercial attaches were limited, these results and follow-up phone interviews were used in a few cases to further check the reports of published sources. If a clear determination was still not possible, the country was excluded from further consideration. Other countries were excluded from the database where no information from any official source was available.

The data collection methods described above were applied to 159 countries. Of these, 132 countries were judged to have sufficient evidence to discern and confirm a specific policy with regard to used automobile protection.

Table 1. An ordinal measure of used automobile protection

Score	Policy summaries	Number of countries (Total = 132)
0	No additional restrictions on imports or 'Blue Book' valuation applied.	58
1	Taxes escalate with the age of the vehicle; capped depreciation; age limit of 6 years or older applied; or a small additional fee/duty.	24
2	Age limits of 5 years or fewer applied; cannot be imported fully assembled; or a combination of these or lesser restrictions.	29
3	Imports prohibited; required import licenses not being approved.	21

Since most used automobile restrictions include non-tariff measures of a various and creative nature, it was not possible to construct a continuous measure of protection. Instead, we mapped the policies on to an ordinal scale ranging from 0 to 3 with 1999 as a common focus year. Each score contains a subset of policies deemed to be more restrictive than those assigned to the previous score. These are presented in Table 1, along with the number of countries falling into the category.

Our ordinal measure of protection ranges from 0 to 3. This measure is best viewed as a discrete indicator for a *latent* and continuous protection variable that is too difficult to measure as such. A value of 0 in Table 1 indicates that there are minimal restrictions on imports of used automobiles with little differentiation between new and used automobile protection. Generally, import valuation takes place based on market values such as those of the "Blue Book." A value of 1 in Table 1 indicates the existence of a clear and discriminatory restriction, however slight, to imports of used automobiles vis-à-vis new automobiles. These measures include age-based tax escalation, capped depreciation, and age limits of 6 years or older.[4] A value of 2 in Table 1 indicates a relatively high degree of protection against imports of used automobiles. These measures include age limits of 5 years or less and a requirement that the automobiles be disassembled before importation (yes, really). Finally, a value of 3 in Table 1 indicates that imports of used automobiles are prohibited.

The ordinal nature of our protection measure is not a significant problem when it is used as independent, dummy variables in the gravity models of Sect. 3. However, in the political economy analysis of Sect. 4, where it enters as a dependent variable, ordered probit estimation is required.

3. Does it matter? A gravity model analysis

The discussion of the previous section, particularly Table 1, indicates that used automobile protection is widespread. In this section, we ask the question: Does it matter? Do the non-tariff measures described in Sect. 2 have a significant, protective effect on trade?[5] To answer this question, we employ two types of gravity models of the used automobile trade using export data for the United States.[6] The first model takes as its dependent variable the log

[4] While some observers treat capped depreciation as a general import *incentive* (e.g., Echeverria et al. 2000), to our minds, it is clearly a *restriction over the lifetime* of an automobile. First, capped depreciation clearly obscures the true relationship between an individual automobile and its value, hindering the efficient working of the market. Second, the assessment is complicated by model and other changes over time, and together these factors are likely to create considerable friction at the border to make assessments and resolve disputes. More importantly, however, automobiles continue to depreciate after the maximum depreciation year. Past this year, it is increasingly the case that the value of the automobile will be *overstated* for customs purposes, and the importer will have to pay an increasingly high import tax and duty burden relative to the automobile's actual purchase price or market value.

[5] Past work on this issue (e.g. Grubel 1980; Pelletiere and Reinert 2002) largely assumed a significant, restrictive effect. Here, we test that assumption.

[6] The gravity model has a very large literature. For some notable examples, see Leamer and Stern (1974), Anderson (1979), and Bergstrand (1985). For some important, recent contributions, see Deardorff (1998), Feenstra et al. (2001), and Evenett and Keller (2002).

of average annual used automobile exports of the United States over the 1998 to 2000 period. The second model takes as its dependent variable a transformation of used automobile exports as a proportion of total automobile exports. In both models, the export data are in unit, not value, terms. We consider each model in turn.

3.1. Gross exports

Our first gravity model seeks to explain the volume of used automobile exports of the United States to 113 of our 132 countries for which data on the explanatory variables are available. The model is specified as follows:[7]

$$\ln e_i = \alpha + \beta_1 \ln gdp_i + \beta_2 \ln pop_i + \beta_3 \ln dist_i + \beta_4 left_i + \beta_5 protect_i + \beta_6 avgtar_i + \beta_7 regdum_i + \varepsilon_i \quad (1)$$

On the left-had side of Eq. 1 is the log of U.S. average annual exports to country i during the 1998 to 2000 period. These export data are in unit, not value terms.[8] The first right-hand side variable is the natural log of GDP in country i as measured by 1999 World Bank purchasing power parity (PPP) data.[9] Representing total income in country i, the sign of this variable is expected to be positive. The second right-hand side variable is the natural log of 1999 population of country i as measured by World Bank data. The sign of this variable is expected to be negative because increases in population reduce per-capita income. The third right-hand side variable is the natural log of distance. This is measured in kilometers from the United States to the capital of importing country i, and the sign is expected to be negative. The distance measure used here is the shortest distance from the five large regional ports of the United States (New York, Miami, Houston, Los Angeles, and Seattle).[10] The fourth right-hand side variable is a dummy variable for countries with left-hand side driving patterns and, given significant retrofitting costs, the sign is expected to be negative. The fifth right-hand side variable is dummy variable relating to the ordinal protection measure discussed in

[7] The standard gravity model can be specified in (at least) three ways. First, we can simplify Eq. 1 as: $\ln e_i = \alpha + \beta_1 \ln gdp_i + \beta_2 \ln pop_i + \beta_3 \ln dist_i + \varepsilon_i$. Second is an often-used re-specification as $\ln e_i = \gamma + \delta_1 \ln gdp_i + \delta_2 \ln(\text{gdp/pop})_i + \delta_3 \ln dist_i + \varepsilon_i$. Third is an alternative specification as $\ln e_i = \tau + \nu_1 \ln pop_i + \nu_2 \ln(\text{gdp/pop})_i + \nu_3 \ln dist_i + \varepsilon_i$. These specifications are equivalent, and the parameters are related to each other as follows: $\beta_1 = \delta_1 + \delta_2 = \nu_2$, $\beta_2 = -\delta_2 = \nu_1 - \nu_2$, *and* $\beta_3 = \delta_3 = \nu_3$.

[8] Export data are taken from the U.S. International Trade Commission web site (www.itc.gov). See their Interactive Tariff and Trade Database.

[9] In some cases where World Bank data are not available (e.g., Taiwan), we use US Central Intelligence Agency World Fact Book estimates.

[10] In gravity analyses, distance is usually measured from a single city (e.g., Boisso and Ferrantino 1997). The characteristics of the used automobile trade, however, suggest the above measure. The availability of used automobiles is directly related to the geographical distribution of the population, and this population in the United States is concentrated in border-states. Given the shape of the United States and the fact that disaggregated used automobile export data shows a geographical distribution among regional ports, the above shortest distance measure makes sense. The distance data are taken from U.S. Census and U.S. Geological survey data.

Section 2. As will be discussed below, this variable enters into Eq. 1 in three different ways.

The sixth right-hand side variable is the average new and used automobile tariff level.[11] A high tariff is expected to reduce demand for all automobiles, including used. It also serves as an (imperfect) indicator of the protectiveness of the underlying automobile import regime. When included in the gross export model with the used automobile protection score, the tariff variable may help to distinguish the impact of used automobile protection from the restrictions inherent in a generally protective automobile import regime. Its expected sign is negative.

The last right-hand side variable is a regional dummy. This could be important due to the fact that we are only considering exports of used automobiles from the United States to the countries of our sample. Our particular concern here is Europe and Asia, which have their own well-developed, regional markets in used automobiles. For those regions, our expectation is that the sign of the dummies would be negative. For the Americas, we would expect a positive sign, while for Africa, the expected sign is uncertain.

The results of the estimation of Eq. 1 are presented in Columns 1 through 3 of Table 2. Overall, these estimations indicate that, indeed, the protective measures against used automobile trade have a significant effect. Let's examine each estimation in turn. Column 1 of Table 2 takes as its protective measure a dummy variable indicating that the ordinal variable described in Table 1 has a value of 1, 2 or 3. In this regression, the GDP, population, distance, and left-hand side driving variables are all of the expected signs and significant at the one percent level. The protection dummy has the expected sign but is not statistically significant. The average tariff measure and the Europe dummy are also of the expected sign and significant at the one-percent level. The Americas and Asia dummies have the expected signs but are not statistically significant. The Africa dummy has a positive sign.

Column 2 of Table 2 is distinguished from Column 1 in that it takes as its protective measure a dummy variable indicating that the ordinal variable described in Table 1 has a value of 2 or 3. In this regression, the protection dummy has the expected sign and is significant at the one-percent level. All other results are qualitatively the same as Column 1.

Column 3 takes as its protective measure a dummy variable indicating that the ordinal variable described in Table 1 has a value of 3. This protective measure is also significant at the one percent level and, in this regression, the Americas dummy becomes significant at the five percent level. Again, all other results are qualitatively the same as Column 1.

We can conclude from these results that used automobile protective measures falling into our protective categories 2 and 3 do indeed have a suppressive effect on used automobile imports.[12] To obtain a more intuitive feel for the magnitude of this effect, we use the model of Column 3 of Table 2

[11] The HTS number here is 870323.

[12] This result should provide a rebuttal to official claims by member countries of the WTO that protective measures against imports of used automobiles should not be considered trade distorting because there is little demand for used automobile imports.

Table 2. Gravity model results for U.S. used automobile exports

	1	2	3	4	5
Explanatory variable	Gross exports	Gross exports	Gross exports	Export proportion	Export proportion
Constant	14.66 (5.13)**	12.35 (4.28)**	11.083 (3.82)**	6.75 (4.84)**	6.66 (4.92)**
Lngdp	1.33 (6.93)**	1.45 (7.58)**	1.422 (7.72)**		
Lnpop	−0.68 (3.47)**	−0.73 (3.84)**	−0.62 (3.31)**		
Ln(gdp/pop)				−0.31 (3.58)**	−0.32 (3.86)**
Lndist	−1.25 (4.72)**	−1.05 (3.90) **	−1.10 (4.28)**	−0.34 (2.81)**	−0.32 (2.73)**
Left	−1.29 (3.57)**	−1.13 (3.18)**	−1.53 (4.38)**	−0.38 (2.38)*	−0.49 (3.08)**
Protect = 1,2,3	−0.97 (0.31)				
Protect = 2, 3		−0.94 (2.63)**		−0.20 (1.32)	
Protect = 3			−1.63 (3.36)**		−0.45 (2.31)*
Avgtar	−0.75 (4.75)**	−0.65 (4.11)**	−0.61 (3.91)**	−0.15 (2.14)	−0.13 (1.80)
Europe	−1.17 (2.57)**	−1.51 (3.29)**	−1.45 (3.29)**	0.16 (0.74)	0.18 (0.88)
Americas	0.69 (1.21)	0.95 (1.69)	1.23 (2.17)*	0.14 (0.55)	0.25 (1.00)
Asia	−0.31 (0.54)	−0.28 (0.50)	−0.04 (0.07)	0.48 (1.93)	0.60 (2.38)**
Africa	0.86 (1.44)	0.74 (1.28)	0.69 (1.21)	0.54 (1.93)	0.51 (1.85)
Observations	113	113	113	110	110
R-squared	0.70	0.72	0.73	0.40	0.42

Note: Absolute values of t-statistics are in parentheses. *Denotes significance at the 5% level.**Denotes significance at the 1 % level.

to compare predicted exports in the presence and absence of protection. These calculations show that, across our sample as a whole, U.S. used automobile exports would increase by 34% in the face of trade liberalization. At the average used automobile price for 1999 of approximately US$8,000, this translates into an increase in export sales of approximately a half billion U.S. dollars. At the average casual sales price of approximately $4,000, it translates into an increase in export sales of approximately one quarter billion dollars. In assessing the 34% figure, it is important to keep in mind that the United States is only one major source of used automobile exports, the European Union and Japan being two others. Further, because of its large internal market for used automobiles, the Unites States is less export-oriented than the EU and Japan. For this reason, the 34% figure is probably an underestimate of the potential increase in global used automobile trade that could occur if import restrictions were liberalized.

To answer the question posed by this section, "Does it matter?" the answer is "Yes, it does." Restrictions on used automobile imports do appear to suppress welfare-enhancing global trade in this product.

3.2. Proportion exports

Our second gravity model seeks to explain the exports of used automobile exports of the United States as a proportion of total automobile exports for 110 of our 132 countries for which data are available. The model is specified as follows:

$$\ln\left[prop_i/(1-prop_i)\right] = \alpha + \beta_1 \ln\left(gdp_i/pop_i\right) + \beta_2 \ln dist_i + \beta_3 left_i + \beta_4\, protect_i + \beta_5\, avgtar_i + B_6\, regdum_i + \varepsilon_i \quad (2)$$

The left-hand side of Eq. 2 is a transformed measure of $prop_i$, the proportion of annual automobile exports from the United States to country i due to used automobiles, averaged over the 1998 to 2000 period. The left-hand side transforms $prop_i$ as $\ln\left[prop_i/(1-prop_i)\right]$ to overcome the bounded nature of the proportion measure $prop_i$. The purpose of examining $prop_i$ is to test an assertion of Grubel (1980), namely that there is an inverse relationship between per-capita incomes and the demand for used automobiles relative to new automobiles. Consequently, instead of taking the natural logs of GDP and population as right-hand side variables in a standard gravity equation model as in Eq. 1, we focus directly on the natural log of GDP per capita. This is the first right-hand side variable in Eq. 2. The second through sixth right-hand side variables are all the same as in Eq. 1, however. Our expected signs for the natural log of distance, the left-hand side driving dummy, ordinal protection, and average tariff are the same as in Eq. 1. However, we no longer have expected signs for the regional dummies. Regional markets in both used and new automobiles might affect both the numerator and denominator of $prop_i$ in the same way. This was not the case with e_i in Eq. 1. In the case of the average tariff, which also might affect both the numerator and denominator of $prop_i$ in the same way, our expected negative sign reflects Alchian-Allen effects which biases demand towards the relatively high quality good, new automobiles.[13]

The results of the estimation are presented in Columns 4 and 5 of Table 2. Column 4 presents the estimation for the case in which the protection dummy indicates that the ordinal variable described in Table 1 has a value of 2 or 3. Column 5 presents the estimation for the case in which the protection dummy indicates that the ordinal variable described in Table 1 has a value of 3. The coefficients on the natural log of per-capita income are indeed negative and significant at the one-percent level. This confirms Grubel's (1980) assertion: there is an inverse relationship between GDP per capita and demand for used automobiles relative to new automobiles. The coefficients for the natural log of distance are also of the expected signs and are significant at the one-percent level. The protection variables in both Columns 4 and 5 have the expected sign, but only the coefficient in Column 5 is statistically significant.

Countries with used automobile import restrictions not only import fewer used automobiles. They also appear to import fewer used automobiles relative to new automobiles compared to the rest of the sample, all else being equal. This suggests that these policies are restrictive *and* discriminatory.

4. Political economy of protection: An ordered probit analysis

The rationales given by country governments for discrimination against used automobile imports most often fall into two categories: (1) problems with valuation and protection against fraud and corruption, and (2) safety and

[13] See Alchian and Allen (1964) and Hummels and Skiba (2002), for example.

environmental concern. In most cases, a combination of these arguments is used.[14] In general, however, there is cause for skepticism toward the idea that safety, environmental and similar concerns drive the restrictions on used automobiles. First, the average age of the fleet in many of these countries is far below that of the age of imports. A number of authors have argued that allowing used automobiles imports is likely to *improve* the environmental and safety standards of the automobile fleets in these countries (Kahn 1994; Panagariya 2000). Often the safety and environmental standards of new automobiles produced in countries such as India, Mexico, and Brazil are below those of secondhand products from Japan, Europe, or the United States. Second, from a strictly regulatory perspective, environmental or safety regulations would seem a more efficient way to achieve these ends than import restrictions on used automobiles, at the same time that such restrictions would serve as a barrier to older automobiles without emissions technology.

If it is not health and safety concerns that drive protection levels, what is it? One possibility to be explored below is that domestic and foreign producer interests are a key factor. This possibility was recognized by Grubel (1980) who noted that imports of used automobiles used only for a short period of time can quickly undercut the sales of new automobiles in developing country markets.[15] This leads us into the realm of the political economy of protection.

The political economy of trade literature originated with Mayer (1984) and has been reviewed by Nelson (1988), Vousden (1990, Chapt. 8), Rodrik (1995), and Milner (1999). Unfortunately, unlike in the case of the gravity analysis of Sect. 3, this literature does not provide a well-established estimating equation. What it does provide is a framework of a *market for protection* with a demonstrated need to identify demand-side and supply-side factors. This is the broad approach we take here, with such factors composing the right-hand-side variables of our estimating equation. The protective measure described in Sect. 2 becomes a dependent, left hand side variable. Because this measure is of a non-continuous, ordered nature, we must utilize the ordered probit estimation procedure introduced by McKelvey and Zavoina (1975).

Our probit estimating equation is as follows:

$$\begin{aligned} protect_i = {} & \alpha + \beta_1 auto_i + \beta_2 regime_i + \beta_3 \ln gdpcap_i + \beta_4 wto_i + \beta_5 fixed_i \\ & + \beta_6 trans_i + \beta_7 gini_i + \varepsilon_i \end{aligned} \tag{3}$$

On the right-hand side of Eq. 3 are seven, country-related explanatory variables relating to the demand and supply sides of the market for used automobile protection. These are summarized in Table 3 and include: the presence of an automobile industry, political regime, income level, WTO membership, exchange rate regime, transitional status, and income distribution. We consider each of these in turn.

As suggested by Grubel (1980) and discussed above, political pressures to restrict imports of used automobiles (a demand for protection) can arise from

[14] See, for example, Pelletiere and Reinert (2002).

[15] It is not necessarily the case, however, that "if a country wishes to have production for its new-automobile industry it cannot have free trade in used automobiles" (Grubel, 1980, p. 784), since the new automobiles could be exported.

Table 3. Factors affecting the market for used automobile protection

Demand side	Supply side
Presence of new automobile production	Political regime
Average per-capita income	WTO membership
Exchange rate regime	Transitional status
Income distribution	

the presence of *new* automobile production or assembly within the country in question. For this reason, the first explanatory variable on the right-hand side of Eq. 3 measures the presence of an automobile industry in country *i*. We employ three alternative forms of this variable. First, we use the natural log of new automobile production and assembly in 1999 (lnprod).[16] Second, we use a dummy variable indicating the presence of automobile production or assembly in 1999 (prod). Third, we consider a dummy variable indicating the 1999 installed *capacity* for production (capac), irrespective of whether it was actually used for production in that year.[17] The third measure is, in our view, the preferred measure from a political economy point of view, but we include the other two to ensure the robustness of the hypothesized "Grubel effect." In all three cases, our hypothesis is that the presence of an automobile industry is positively associated with the ordinal protection measure.

The extent to which pressures for protection can be translated into actual protective policy appears to depend on the political regime, and these regimes vary widely in their characteristics across our large sample of developing, transitional, and newly-industrialized countries. This is measured in the second right-hand side variable in Eq. 3 and is a supply-side factor in the market for used automobile protection. We follow Mansfield, et al. (2000) in using the Marshall and Jaggers (2001) "Polity" data as a regime measure.[18] We explore two dummy variable regime breakdowns (dem and cohere). The first is between democratic and non-democratic regimes. Consistent with Mansfield et al. (2000) our hypothesis is that democracies better channel pressure for protection into policy. That said, however, there is no *a priori* reason that an autocrat would be against free trade. What might be more important is the ability of the government to identify, implement, and maintain a policy stance. Therefore, our second breakdown is between regimes considered in the Polity data to be "coherent" and those that are not. Our hypothesis is that coherent regimes also better channel pressure for protection into policy.

[16] The production data is from the Paris-based Organisation Internationale des Constructeurs d'Automobiles (OICA). Both the production and capacity levels are highly collinear with country size, so country size itself cannot be entered into the probit analysis.

[17] Our capacity data is taken from the World Automobile Industry Trends Yearbook.

[18] More information on this dataset can be found at www.bsos.umd.edu/cidcm/inscr/polity/. As described in Mansfield et al. (2000), a polity score of 6 or greater was used to denote a coherent democracy, while a score of -6 or less was used to indicate a coherent autocracy. Intermediate values characterize incoherent regimes. In Polity IV, used here, the polity score is based on five indications of the competitiveness of executive recruitment, constraints on the chief executive, and openness of participation.

Next, we consider the possibility that average income levels might also help determine the level of used automobile protection from the demand side of the protection market. At lower income levels, the politically-important upper-middle class might be dependent on used automobiles, whereas at higher income levels, this class might be in a position to afford new automobiles. For this reason, we include the log of PPP-adjusted 1999 GDP per capita as a third explanatory variable. Our hypothesis here is that this variable will be positively associated with the ordinal protection measure. That is, protection for used automobiles is a normal good.

Membership in the WTO subjects countries to scrutiny through the trade policy review mechanism and dispute settlement procedures. Further, used automobile protection is a subject in a number of WTO trade policy review reports and questioning by other members. For this reason, is conceivable that WTO membership acts as a supply-side deterrent to used automobile protection or may encourage liberalization of existing restrictions. We test for this possibility using a dummy variable. Our hypothesis is that this variable is negatively associated with the ordinal protection measure.

We also include a consideration of exchange rate regime as a government demand side factor. As suggested by Corden (1991), there is some tendency for countries pursuing a fixed exchange rate regime to increase protection levels to support an overvalued currency. For example, Yatawara and Ajona (2001) use pooled data to demonstrate that "a fixed exchange rate regime increases the likelihood of tightening commercial policy, and reduces the likelihood of liberalization" (pp. 3 and 16). In a number of cases, balance of payments concerns are raised in justifying restrictions on used automobile restrictions. Given these considerations, the fifth right-hand side variable in Eq. 3 is a dummy variable to indicate the presence of a fixed exchange rate regime during any of the years 1995 to 1998.[19] Our hypothesis is that this variable is positively associated with the ordinal protection measure.

Our extensive review of sources used in compiling the data set described in Section 2 left us with the impression that transitional economies were differentiated as a group from other countries in having lower protection levels against used automobiles. This appears to reflect their latecomer status as entrants into the world trading system. For this reason, the sixth variable on the right hand side of Eq. 3 indicates transition status, and our hypothesis is that this supply-side variable is negatively associated with the ordinal protection measure.[20] That is, we expect that the institutional features of transitional countries are less likely to supply used automobile protection.

Used automobiles are durable goods consumed most intensively by the lower middle classes of the countries in our sample. Measured inequality in these countries is likely to by an indicator of the ability of upper classes to

[19] In terms of International Monetary Fund nomenclature, we consider a 'fixed' exchange rate as on pegged to the US dollar, the pound sterling, the French franc, other currencies, or currency baskets.

[20] The transition countries in our sample include Latvia, Czech Republic, Croatia, Moldova, Slovenia, Albania, Russia, Estonia, Slovakia, Bulgaria, Kazakhstan, Lithuania, Romania, Belarus, Georgia, Poland, Uzbekistan, Ukraine, Hungary, Yugoslavia, and Vietnam.

appropriate rents from the lower middle classes, including through used automobile protection. For this reason, we include the Gini coefficient as the last right-hand side variable in Eq. 3, reflecting the demand side of the market for used automobile protection. Unfortunately, these data are available for only 88 of the 104 countries included in our probit analysis. For this reason, they are only utilized once in a reduced-sample estimation. Our hypothesis is that this variable is positively associated with the ordinal protection measure.

The results of our ordered-probit analysis are presented in Table 4. The model of Column 1 is characterized by its use of the log of automobile production and the democracy regime dummy, as well as the other variables of Eq. 3, except for the Gini coefficient that does not appear until Column 5. With the exception of the fixed exchange rate regime variable, each coefficient of Column 1 has the expected sign. The only statistically significant variables, however, are automobile production at the one-percent level, WTO membership at the five percent level, and transitional status at the one percent level. The key result here is that restrictions on used automobile imports do indeed appear to be driven by political pressure associated with new automobile production (both domestic and foreign) as first suggested by Grubel (1980). What we call the "Grubel effect" appears to exist.

The model of Column 2 substitutes a production dummy variable for the log of automobile production, and again the "Grubel effect" proves to be statistically significant at the one percent level. So too, however, is the log of income per capita. This indicates that the ability of the middle classes to afford new automobiles might make used automobile protection more likely. That is, as mentioned above, demand for used automobile protection appears to be a normal good.

As stated above, our preferred means of capturing the "Grubel effect" is through a *capacity* dummy, and we do this in Column 3 of Table 4. The capacity dummy is statistically significant and more so than the other two approaches of Columns 1 and 2. It is in this preferred model that democratic regime becomes statistically significant at the five percent level. It does then appear that democracies better channel pressures for used automobile protection into actual protective policy. In this preferred model, the positive income effect remains. Also, the significance of WTO membership increases to the one percent level in restricting the supply of used automobile protection. As in each model, transitional status makes used automobile less likely, again by restricting the supply of protection.

Column 4 changes the regime variable from that of Column 3. Instead of democracy, we expand the dummy set to include all coherent regimes. While the coefficient is positive as expected, it is not statistically significant, and the statistical significance of the other explanatory variables decreases.

Column 5 of Table 4 uses a reduced sample of 88 countries to test the role of income distribution in used automobile protection.[21] Like Column 4, it is based on the capacity and coherent regime dummy variables, but does not include the transitional dummy.[22] The capacity dummy and income per

[21] This sample size is *below* that considered to be sufficient for ordered probit analysis, namely 100. Therefore, the results of Column 5 should be interpreted with caution.

[22] It was not possible to use the democratic regime dummy due to multicolinearity problems.

Table 4. Ordered probit results for used automobile protection

	1	2	3	4	5
Explanatory variable	Log production and democracy	Production dummy and democracy	Capacity dummy and democracy	Capacity dummy and coherent	Capacity dummy and coherent
Lndprod	0.503** (4.97)				
Prod		0.507** (5.26)			
Capac			0.686** (7.32)	0.679** (7.23)	0.574** (5.72)
Dem	0.102 (1.07)	0.128 (1.37)	0.168* (2.10)		
Cohere				0.155 (1.88)	0.106 (1.13)
Lngdpcap	0.169 (1.72)	0.192* (1.99)	0.172* (2.11)	0.151 (1.82)	0.210* (2.08)
Wto	−0.207* (2.08)	−0.229* (2.31)	−0.228** (2.68)	−0.197* (2.40)	−0.090 (1.01)
Fixed	−0.120 (1.34)	−0.114 (1.29)	−0.059 (0.77)	−0.068 (0.89)	−0.074 (0.84)
Trans	−0.309** (3.11)	−0.305** (3.12)	−0.436** (4.77)	−0.422** (4.65)	
Lngini					0.255** (2.72)
Observations	104	104	104	104	88
Pseudo R-squared	0.16	0.17	0.29	0.29	0.23

Note: Absolute values of z-statistics are in parentheses. *Denotes significance at the 5% level. **Denotes significance at the 1% level.

capita variable remain significant for the reduced sample. The natural log of the Gini coefficient is both of the expected sign (positive) and statistically significant at the one percent level. It does appear, then, that inequality contributes to used automobile protection from the demand side as hypothesized. That is, the ability of upper classes to appropriate rents from the lower middle classes appears to play a role in used automobile protection.

What can we conclude from the political economy results of Table 4? First, there is strong evidence that the capacity to produce automobiles, either domestic- or foreign-owned, comes with pressures (or demand) to restrict imports of used automobiles. This is an empirical confirmation of the hypothesized "Grubel effect." There is some evidence that the supply of protection against used automobile imports is more likely to appear in democracies than in autocracies. There is also some evidence that protection pressures are higher as incomes increase and that WTO membership deters such pressures. There is strong evidence that, as a group, transitional economies are less likely to protect than non-transitional economies, a reflection of what we term the "latecomer effect." Finally, there is strong evidence, albeit based on a restricted sample, that demand-side pressures to restrict imports of used automobiles are more likely to arise the more unequal is the distribution of income.

5. Conclusions and caveat

International markets in used automobiles are fairly well developed, but protection measures in these markets are very common. To date, there has been no comprehensive and consistent database on used automobile protection. This paper has developed such a database, based on a 4-point,

ordinal scale. A gravity analysis of U.S. used automobile exports, utilizing the database, indicates that protection measures indeed appear to have a statistically significant suppressive effect on used automobile trade flows. An ordered probit analysis of the protection measures themselves suggests that, as hypothesized by Grubel (1980), it is political pressure from *new* automobile production interests that generates demand for the protection measures. There is some evidence that these demands to protect against used automobile imports are more likely to be met in democracies than in autocracies. There is also some evidence that protection pressures are higher as incomes increase and that WTO membership makes it less likely that protective demands will be met. Finally, there is strong evidence, albeit based on a restricted sample, that pressures to restrict imports of used automobiles are more likely to arise the more unequal is the distribution of income.

As discussed in Sect. 2 of this paper, used automobile protection does not in any way lend itself to measurement with a nominal scale. Instead, we have had to rely in this paper on the ordinal scale presented in Table 1. This ordinal scale appears as alternative, right-hand-side dummy variables in the results of Table 2 and as the left-hand-side variable in the results of Table 4. Clearly, then, there are unaddressed issues of simultaneous equations bias and inconsistency in our results, issues not easily addressed in the context of an ordered scale. While it is difficult to suggest how bias and inconsistency affect the internal validity of our estimates, it is clear that the results of Tables 2 and 4 must be interpreted with some care.

References

Alchian AA, Allen WR (1964) University economics. Wadsworth, Belmont, California

Anderson JE (1979) A theoretical foundation for the gravity equation. American Economic Review 69:106–116

Bergstrand JH (1985) The gravity equation in international trade: Some microeconomic foundations and empirical evidence. Review of Economics and Statistics 67:474–481

Boisso D, Ferrantino M (1997) Economic distance, cultural distance, and openness in international trade: Empirical puzzles. Journal of Economic Integration 12:456–484

Bond EW (1983) Trade in used equipment with heterogeneous firms. Journal of Political Economy 91:688–705

Corden WM (1991) Exchange rate policy in developing countries. In: de Melo J, Sapir A (eds) Trade theory and economic reform: North, South, and East: Essays in Honor of Bela Belassa. Blackwell. Cambridge, Massachusetts

Deardorff A (1998) Determinants of bilateral trade: Does gravity work in a neoclassical world? In: Frankel J (ed) The regionalization of the world economy. University of Chicago Press, Chicago

Echeverría J, Johnstone N, Mejías R, Porras I (2000) The environmental effects of tax differentiation by vehicle characteristics: Results from Costa Rica. International Institute for Environment and Development, Working Paper No. 34, London

Evenett SJ, Keller W (2002) On theories explaining the success of the gravity equation. Journal of Political Economy 110:281–316

Feenstra RC, Markusen JR, Rose AK (2001) Using the gravity equation to differentiate among alternative theories of trade. Canadian Journal of Economics 34:430–447

Grubel HG (1980) International trade in used automobiles and problems of economic development. World Development 8:781–788

Hummels D, Skiba, A (2002) Shipping the good apples out? An empirical confirmation of the Alchian-Allen conjecture. National Bureau of Economic Research, Working Paper 9023, Cambridge, Massachusetts
Kahn ME (1994) Growing car ownership in LDCs: The impact on environment and trade. Columbia Journal of World Business 29:12–19
Leamer EE, Stern RM (1974) The commodity composition of international trade in manufactures: An empirical analysis. Oxford Economic Papers 26:350–374
Mainwaring L (1986) International trade in new and used machines. Cambridge Journal of Economics 10:247–263
Mansfield ED, Milner HV, Rosendorff BP (2000) Free to trade: Democracies, autocracies, and international trade. American Political Science Review 94:205–321
Mayer W (1984) Endogenous tariff formation. American Economic Review 74:970–985
McKelvey RD, Zavoina W (1975) A statistical model for the analysis of ordinal level dependent variables. Journal of Mathematical Sociology 4:103–120
Milner, HV (1999) The political economy of international trade. Annual Review of Political Science 2:91–114
Navaretti GG, Soloaga I, Takacs W (2000) Vintage technologies and skill constraints: Evidence from U.S. exports of new and used machines. World Bank Economic Review 14:91–109
Nelson, D (1988) Endogenous tariff theory: A critical survey. American Journal of Political Science 32:796–837
Pack H (1978) The optimality of used equipment: Calculations for the cotton textile industry. Economic Development and Cultural Change 26:307–325
Panagariya A (2000) The new tyranny of the automobile industry. Economic Times (India), October 25
Pelletiere D, Reinert KA (2002) The political economy of used automobile protection in Latin America. The World Economy 25:1019–1037
Rodrik, D (1995) Political economy of trade policy. In: Grossman, GM, Rogoff, K (eds.) Handbook of International Economics, vol. III. Elsevier, Amsterdam
Sen AK (1962) On the usefulness of used machines. Review of Economics and Statistics 44: 346–348
Smith MAM (1974) International trade in second-hand machines. Journal of Development Economics 1:261–278
Smith MAM (1976) International trade theory in vintage models. Review of Economic Studies 43:99–113
Vousden N (1990) The Economics of Trade Protection. Cambridge University Press, Cambridge
Yatawara RA, Ajona R (2000) Trade protection: commercial policy versus exchange rate policy. Unpubl. working paper, Department of Economics, University of Delaware