IS PROTECTION FOR SALE? EVIDENCE ON THE GROSSMAN-HELPMAN THEORY OF ENDOGENOUS PROTECTION

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Abstract—Grossman and Helpman (1994) present a theory of endogenous protection by explicitly modeling government-industry interactions for which mere ''black-box'' models previously existed. They obtain a Ramsey pricing-type solution to the provision of protection which emphasizes the role of inverse import penetration ratios and import elasticities. On the lobbying side, the model makes predictions about lobbying competition and lobbying spending according to deadweight costs from protection. The model not only makes for richer theory in terms of rigor and elegance, but its predictions are directly testable. Whether the Grossman-Helman model stands up to real-world data is investigated in this paper. Predictions from both the protection side and lobbying side are tested using cross-sectional U.S. nontariff barrier data. We also compare the ''second-generation'' Grossman-Helpman model with a more traditional specification. Our results call for serious consideration of this model in the political economy literature.

I. Introduction

Grossman and Helpman (1994) (henceforth G-H) present a special-interest model of protection that involves *n* lobbies and one policymaker. The fundamental idea behind their model is a well-established one: Specific factors in an industry combine to form a lobby with the intention of maximizing rents from protection net of lobbying expenditures. Politicians who formulate trade policy seek income from lobbying in order to finance campaign spending. What is new in the G-H model is that it makes explicit a mechanism through which lobbying contributions are converted into protection, and lobbies solve their optimal lobbying spending problem. The modeling innovation central to G-H is the use of a menu auction in which several principals (lobbies) bid on a vector of trade taxes and subsidies. They present to an agent (government) a menu—a mapping from trade tax vectors into contributions. In making their bids, lobbies take into account the government's objective function.

On the protection side of the model emerges an elegantly simple prediction of the structure of cross-industry levels of protection. The structure mimics a Ramsey rule emphasizing the role of two variables—import elasticity and inverse import penetration. This prediction, set out in section II, is in sharp contrast to what was intuitively believed to be true in earlier studies. On the lobbying side, G-H consider the set of truthful Nash equilibria. The government's objective function is a weighted sum of PAC spending and social welfare, which push in diametrically opposite trade-policy directions. Hence, a prediction from the model is that lobbying contributions must compensate the government for the deadweight costs from protection. A second prediction is that greater lobbying competition should lead to higher lobbying spending, with the payout increasing in the political power of the opposing lobbies.

The G-H framework has been adopted in the analysis of the formation of trade blocs, trade bargaining, and the setting of ''equilibrium'' international rules under possibly different institutional settings. It has hence shown the potential to be the theoretical paradigm in the political economy literature. It is therefore necessary for empirical work to substantiate it. In this paper, we subject the predictions from the G-H model to empirical scrutiny using a rich nontariff barrier (NTB) data set for the U.S. The NTB data, combined with lobbying and industry characteristics data, span four-digit SIC industries in 1983. The econometric model is designed to represent the theory as closely as possible while also solving measurement-error problems.

Probably the main failing of the voluminous literature on endogenous protection (and a reason why the G-H model has become a contender) is that other models have been articulated less formally. As a result, their predictions are ad hoc and open to interpretation. The G-H predictions, on the other hand, emerge precisely from a fully specified model. Our empirical results find broad support for predictions from the G-H model on both the protection side and the lobbying side. We also compare the G-H model with a traditional specification. The parsimonious G-H model performs surprisingly well.

The paper proceeds as follows. In section II, the G-H model is summarized and predictions from the protection side and the lobbying side are stated. In section III, the data and empirical methodology are discussed. Section IV analyzes the empirical results. Finally, we offer closing observations.

II. The Grossman-Helpman Hypotheses

G-H consider a small open economy producing *n* goods. Each good is produced using a mobile factor, labor, and a factor specific to that sector (a numeraire good is produced using only labor). In some sectors, owners of specific factors form lobbying groups like political action committees (PACs) to influence politicians who make or amend trade policy. Politicians maximize an objective function with two distinct components: political contributions by lobbies and aggregate social welfare. Protection across sectors is measured as a vector of import and export taxes and subsidies on

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/the n goods. In the first stage, each lobby simultaneously presents the government with a "contribution schedule" that maps every possible policy vector of taxes and subsidies into a lobbying contribution. The contribution schedule of each lobby maximizes its aggregate utility given by factor income plus consumer surplus less contributions by its members. Lobbies know the objective function of the government and incorporate it into their contribution schedules. The Nash equilibrium set of contribution schedules is one in which each lobby's schedule maximizes the aggregate utility of its members, given the schedules of the other lobby groups. In the second stage, the government chooses the policy vector implemented by the Nash equilibrium contribution schedules and collects the corresponding contributions from every lobby. From this menu-auction model (due to Bernheim and Whinston (1986)), G-H make predictions on the protection side and lobbying side, which we test.

A. *Pattern of Protection Across Industries*

On the protection side of the model, we test an extension of their Proposition **2** (pp. 842) to include intermediate inputs. The prediction is stated here and proved in the appendix. If there is one intermediate input, X, produced under CRS and used by some or all industries, the cross-industry pattern of protection is given by

$$\frac{t_i}{1+t_i} = \frac{I_i - \alpha_L - \alpha_X}{a + \alpha_L + \alpha_X}\left(\frac{z_i}{e_i}\right) + \frac{p_X^*}{e_i m_i}\frac{\partial m_X}{\partial p_i}\cdot t_X, \qquad I = 1, \ldots, n. \tag{1}$$

In equation (1), $t_i = (p_i - p_i^*)/p_i^*$ is the ad valorem tariff or subsidy for good i in equilibrium, where p_i is the domestic price for good i and p_i^* its world price. In the first term on the right-hand side of equation (1), I_i is an indicator variable that equals one if sector i is organized into a lobby. The parameters α_L and α_X are, respectively, the fraction of the population organized into final good lobbies (industries labeled L) and the intermediate good lobby (industry labeled X). Hence, $\alpha_L + \alpha_X \leq 1$. $a > 0$ is the weight that the government places on aggregate welfare (gross of contributions) relative to aggregate political contributions. If government places weight a_1 on aggregate campaign contributions and weight a_2 on aggregate welfare net of contributions, then a in equation (1) equals $a_2/(a_1 - a_2)$.[1] Hence, there is no restriction on the size of a, provided $a_2 > a_1$. Lower a values, say, $a < 2$, substantially differentiate between the relative weight on aggregate welfare net of contributions vis-a-vis aggregate contributions. If $a > 4$, then $a_2 > 0.8a_1$, and so high values of a yield similar weights. $z_i = y_i/m_i$ is the equilibrium ratio of output to imports, and $e_i = -m'_i p_i/m_i$ is the absolute elasticity of import demand. If industry i is a net import industry, it is protected ($t_i > 0$) or obtains an import subsidy ($t_i < 0$) depending on whether it is organized ($I_i > 0$) or not ($I_i < 0$). In the second term on the right-hand side of equation (1), the cross partial $\partial m_X/\partial p_i$ is positive because an increase in p_i leads to import substitution of good i so that demand for the intermediate good used in the production of i increases. Hence, protection in industry i is an increasing function of the tariff on the intermediate input, t_X.

The intuition behind the G-H results is the intuition behind Ramsey pricing. Consider an example of an economy with two goods plus a numeraire good.[2] The two goods are produced from the numeraire with constant marginal cost equal to 1. Consumers face market prices equal to marginal cost plus a commodity tax fixed by the government. Tax proceeds are returned to the economy as a lump sum. Suppose a distortion constrains the government to raise an amount R of tax revenues. It solves the following second-best maximization problem in order to maximize the indirect utility of consumers:

$$\max_{p_1,p_2} v(p_1, p_2) \text{ s.t. } (p_1 - 1)x_1(p_1, p_2) + (p_2 - 1)x_2(p_1, p_2) \geq R.$$

The solution yields ad valorem tax rates, $t_i = (p_i - 1)/p_i$, $i = 1, 2$, given by $t_1 = \alpha/e_1(p_1)$, and $t_2 = \alpha/e_2(p_2)$, where $e_i(p_i)$ is the absolute price elasticity of demand for good i, α is some positive constant, and the solutions are evaluated at the maximum. This Ramsey tax formula implies that, if the demand for good 1 is uniformly less elastic than that for good 2, the optimal tax rate is higher for good 1 due to the lower deadweight loss from taxing good 1 than taxing good 2 at the same rate. For example, if good 1 is totally inelastic, there is no deadweight loss and the first best can be reached by taxing just this good.

The G-H rule in equation (1) is an extension of the Ramsey rule to a case in which the objective function weights consumer welfare and political contributions. Hence, the G-H rule emphasizes import elasticities e_i, and industry stakes measured by the output-to-import ratio z_i. Because deadweight loss from protection is higher in industries with high import elasticities, the government is averse to protecting these industries, all else equal. Further, competing lobbies in downstream industries will lobby relatively strongly against protection to upstream industries with high elasticities. Thus, the G-H model predicts that industries with higher import elasticities will be afforded lower protection. Now, z measures the stakes from protection, and

[1] That is, maximizing the government's objective function $a_1C + a_2(W - C)$, where C is aggregate contributions and W is aggregate welfare is equivalent to maximizing $C + aW$, with $a = a_2/(a_1 - a_2)$. See G-H (1994, pp. 838).

[2] This example is taken from Mas-Colell et al. (1995, ch. 22).

industries with high z values will make larger lobbying contributions. Further, low import volume, which raises z, does not impose enough of a social cost on agents that may otherwise organize opposition to protection in that sector. In order to obtain empirically testable implications, write equation (1) as

$$\frac{t_i}{1+t_i} = -\frac{\alpha_L + \alpha_X}{a + \alpha_L + \alpha_X}\left(\frac{z_i}{e_i}\right) + \frac{1}{a + \alpha_L + \alpha_X}\left(I_i \times \frac{z_i}{e_i}\right) + \frac{p_X^*}{e_i m_i}\frac{\partial m_X}{\partial p_i} \cdot t_X. \tag{2}$$

Then the G-H predictions are that

(i) the coefficient on z_i/e_i is negative,
(ii) the coefficient on $I_i \times z_i/e_i$ is positive,
(iii) because $\alpha_L + \alpha_X < 1$, the sum of their coefficients must be positive, and
(iv) protection in industry i is an increasing function of the tariff on intermediate inputs, t_X.

In addition to those qualitative predictions, a quantitative implication of equation (2) is that the coefficients on z_i/e_i and $I_i \times z_i/e_i$ can be used to infer the size of a—the weight that government places on aggregate welfare relative to the weight on aggregate political contributions.

An empirical issue concerns the identification of industries that are politically organized in the trade arena; that is, we need to identify industries for which $I_i = 1$. Our data is on total lobbying spending across industries, and not trade-related lobbying spending. In order to identify politically organized industries in the trade arena, we estimate an auxiliary regression to predict trade-related PAC spending using purely trade-related variables. Details are provided in the data section below and in the appendix. A similar method is used in Gawande (1997a, 1998b).[3]

Goldberg and Maggi (1997) also investigate the protection side of the G-H model. There are distinct differences in scope and methodology between our study and theirs. The Goldberg-Maggi paper is entirely focused on the protection equation, while ours is broader in scope and encompasses important hypotheses about lobbying competition. Further, we extend the G-H model to include intermediate inputs, because G-H emphasize their belief that the strongest lobbying opposition probably comes from downstream industries. Methodologically, we differ on an important point. Because import elasticities are estimated in a separate study, we view the import-elasticity variable as a generated regressor for which corrections need to be made. Regardless, using different approaches and methods, both our paper and theirs find general support for the G-H hypotheses.

B. *Pattern of Political Contributions*

Two distinct predictions are evident on the lobbying side of the G-H model.

Compensation According to Deadweight Loss: In order to abstract from competition among lobbies (we consider it below), suppose there is only one lobby. The lobby need spend just enough to make the government indifferent between free trade and providing the lobby with some protection. This amount equals $a[W(p^*) - W(p)]$, where $W(p^*)$ is aggregate welfare at the free-trade price vector p^*, and $W(p)$ is aggregate welfare at the protection-distorted price vector p, and a is as before. This suggests the following cross-sectional test: All else equal, the greater the deadweight loss (DWL), the greater will be political spending. Because the only available measures of efficiency losses are from computational general equilibrium (CGE) studies of a small subset of the industries considered in this study, we use a proxy measure for DWL. Vousden (1990, pp. 49) provides the formula based on straight-line compensated demand curves for imports,

$$\frac{\text{DWL}}{\text{VA}} = 0.5\left(\frac{t}{1+t}\right)^2 \frac{e}{z}, \tag{3}$$

where DWL/VA is deadweight loss as a fraction of value added, $1/z$ is imports as a fraction of value added, $t = (p - p^*)/p^*$ is the ad valorem tariff-equivalent of NTB protection, and e is the absolute own (compensated) price elasticity of import demand. Since DWL/VA is not directly measurable, we postulate the relationship between the log of PAC spending as a proportion of value added (PAC/VA) and the log of DWL/VA as $\ln(\text{PAC/VA}) = h(\ln(\text{DWL/VA}))$.[4] Then the compensation-according-to-deadweight-loss hypothesis can be written as $h' > 0$. Because, from equation (3), $\ln(\text{DWL/VA}) = \text{constant} + 2\ln(t/(1+t)) + \ln e + \ln(1/z)$, this hypothesis can be written in terms of estimable

[3] A second concern is the unavailability of export-side data on two variables—export subsidies and export elasticities. The G-H model also predicts that, if industry i is a net export industry, then it will obtain an export subsidy ($t_i > 0$) or an export tax ($t_i < 0$) depending on whether it is organized ($I_i > 0$) or not ($I_i < 0$). We simply presume that industries lobby only for import protection/subsidies. We do not believe this poses problems for U.S. protection because export subsidization is, as yet, an infrequently used instrument. Hufbauer and Erb (1984) document that, relative to other developed countries, the U.S. had the lowest amount of total subsidies as a percentage of GDP (their table 1) among developed countries (equal to 0.43% of GDP in 1980 compared to 2.51% for France and 1.32% for Japan), and also the lowest amount of export credit authorizations as a percentage of total exports (their table 3: In 1979, this was 8.1% for the U.S., 47.5% for the U.K., 39.7% for Japan, and 42.5% for France).

[4] Scaling DWL and PAC spending by value added (VA) also removes spurious scale effects in the estimation.

elasticity coefficients as

$$0.5 \times \frac{\partial \ln \left(\frac{\text{PAC}}{\text{VA}}\right)}{\partial \ln \left(\frac{t}{(1+t)}\right)} + \frac{\partial \ln \left(\frac{\text{PAC}}{\text{VA}}\right)}{\partial \ln \left(\frac{1}{z}\right)} + \frac{\partial \ln \left(\frac{\text{PAC}}{\text{VA}}\right)}{\partial \ln (e)} > 0.$$

Lobbying Competition: An innovation by G-H is the modeling of the lobbying game between the government and special-interest groups as a menu auction, which leads to an analytically well-defined maximization problem (equation (A4) of the appendix). The menu-auction model has testable implications on the lobbying side, specifically concerning competition among rival lobbies. Because the model admits a number of equilibrium outcomes on the lobbying side, G-H refine the theory further and consider only truthful Nash equilibria. This leads to specific predictions about the nature of lobbying competition on the one hand, and about the division of surplus between lobbies and the government on the other.

Consider the case in which members of lobbies are a small fraction of the population, so that the actions of any lobby does not affect other lobbies. The menu auction then simplifies into a set of independent principal-agent relationships. Each lobby compensates according to deadweight loss times the weight a and obtains the corresponding amount of protection. Each organized industry therefore captures its private surplus. Now consider the case with rival lobbies. Competition among opposing lobbies now raises the amount of lobbying spending by each lobby. Suppose there are two rival lobbies. Each lobby must now contribute at least enough that the government is indifferent between protecting both industries (where both lobbies contribute a positive amount) versus protecting just one industry (where only one lobby contributes). The stronger, richer lobby will be willing to spend a large amount in order to obtain the maximum protection. In order to prevent or alleviate this, the smaller lobby will have to spend at least the difference between what the government can obtain from the strong lobby in the absence of the small lobby's participation and what the government can obtain from the strong lobby when both lobbies participate politically. Hence, each lobby must make a compensation to the government according to the political strength of its rival so as to avoid a more adverse outcome.

We measure lobbying competition by the bargaining strength of downstream users, whose interests conflict with protectionism among upstream producers. We use two measures: the share of the upstream lobby's output that is sold downstream as intermediate goods (DOWNSTREAMSHR), and a Herfindahl measure of buyer concentration among downstream industries for the upstream lobby's output (DOWNSTREAMHERF). The higher these measures are, the greater the bargaining strength of downstream lobbies (users), requiring the upstream lobby (producer) to make greater political contributions.

III. Econometric Specification

In the G-H model, firm lobbying is simultaneously determined with the level of protection. In the first stage, each firm provides the government with a mapping of every possible vector of trade taxes into its lobbying expenditure; hence, lobbying expenditure is a response to possible trade taxes. The equilibrium set of contribution schedules then implements a policy vector that maximizes the government's objective function; hence, the optimal vector of trade taxes is endogenously determined with lobbying expenditures. Therefore, the cross-industry trade tax equation in (2) must be jointly estimated with the cross-industry lobbying spending equation (3). In the econometric analysis, we employ stochastic versions of equation (2) and (3). To this we add a third equation for imports. The fact that imports are endogenously determined with trade barriers has been recognized by Trefler (1993), and the need for modeling its endogeneity has been expressed by Grossman and Helpman (1994) in their criticism of existing empirical studies of protection.

The Grossman-Helpman model suggests a parsimonious specification in which a central role is given to three variables: the inverse import penetration ratio z, the import elasticity e, and the level of protection, t. However, the voluminous empirical literature on endogenous protection (for example, Baldwin (1985), Caves (1976), Trefler (1993), and Ray (1981)) points to a larger number of other factors including market structure, firm concentration, industry voting strength, skill composition of employees, average earnings, labor intensity, and geographical concentration. The larger model has been advocated on the basis of sensible size and signs of coefficient estimates and its explanatory power. We therefore estimate two specifications: the sparse specification motivated by the pure G-H model, and a larger specification based on existing empirical work that nests the G-H model. In terms of the variables described in table 1, the two model specifications are

$$\begin{aligned}
\frac{\text{NTB}}{1+\text{NTB}} &= \alpha_0 + \alpha_1 \frac{z}{e} + \alpha_2 \left(I \times \frac{z}{e}\right) \\
&\quad + + \alpha_3 \text{ INTERMTAR} \\
&\quad + \alpha_4 \text{ INTERMNTB} + \epsilon_1 \\
\ln \frac{\text{PAC}}{\text{VA}} &= \beta_0 + \beta_1 \ln \frac{\text{NTB}}{1+\text{NTB}} + \beta_2 \ln e \\
&\quad + \beta_3 \ln \frac{1}{z} + \beta_4 \ln \text{DOWNSTREAMSHR} \\
&\quad + \beta_5 \ln \text{DOWNSTREAMHERF} \\
&\quad + \beta_6 \ln \text{HERF} + \epsilon_2 \\
\frac{1}{z} &= \delta_0 + \delta_1 \frac{\text{NTB}}{1+\text{NTB}} + X_M \Delta + \epsilon_3
\end{aligned} \tag{4}$$

TABLE 1.—DESCRIPTIONS OF VARIABLES USED IN THE ECONOMETRIC ANALYSIS

Variable	Description
NTB_j	U.S. all nontariff barrier coverage of imports from partner j, 1983
TAR	U.S. post-Tokyo round ad valorem tariffs. (Ratio)
PACFIRM	Corporate PAC spending per contributing firm, over 1977–1984. ($100 Mn)
PACTRADE	Trade-related PACFIRM/VA. (see appendix)
VA	Value Added, 1983. ($ Bn)
IMP_j	U.S. Imports from partner j, 1983 ($ Bn)
EXP_j	U.S. Exports to partner j, 1983 ($ Bn)
IMP	U.S. total imports across all partners
EXP	U.S. total exports across all partners
CONS	U.S. consumption, 1983 ($Bn) = VA + IMP − EXP
NTB_j^*	Partner j's NTB coverage of its imports from the U.S., 1983. (ratio)
UNION	Fraction of employees unionized, 1981
SCIENTISTS	Fraction of employees classified as scientists and engineers, 1982
MANAGERS	Fraction of employees classified as managerial, 1982
UNSKILLED	Fraction of employees classified as unskilled, 1982
AVGEARN	Average earnings per employee, 1982. ($000/year)
FIRMSCALE	Measure of industry scale: Value added per firm, 1982. ($Bn/firm)
CONC4	Four-firm concentration ratio, 1982
STATES	Number of states in which production is located, 1982
NE82	Number of employees, 1982. (Mn. persons)
IMPGROWTH	Change in U.S. import-consumption ratio between 1979 and 1982.
ΔTAR	Change in ad valorem tariffs due to Tokyo round cuts
EARNGROWTH	Change in earnings between 1979 and 1982.
NEGROWTH	Growth in employment during 1982.
LABORSHARE	Labor intensity = share of payroll in value added, 1982.
DOWNSTREAMSHR	Percentage of an industry's shipments used as intermediate goods in other
DOWNSTREAMHERF	Intermediate-goods-output buyer concentration. (see appendix)
HERF	Herfindahl index of firm concentration
INTERMTAR	Average tariff on intermediate goods use in an industry. (see appendix)
INTERMNTB	Average NTB coverage of intermediate goods use in an industry. (see appendix)
ELAST0	Own price elasticity of imports. (from Sheills et al. (1986))
CROSSEL0	Cross price elasticity between home (U.S.) and imports. (from Sheills et al. (1986))
ELAST1	ELAST0 corrected for errors-in-variables (see appendix)
CROSSEL1	CROSSEL0 corrected for errors-in-variables (see appendix)
z	(CONS/IMP)/10000
z/e	[(CONS/IMP)/|ELAST1|]/10000
$D_g, g = 1, \ldots, 4$	Dummies for four industry groups: Food processing, Resource-intensive, General manufacturing, and Capital-intensive
K/L	Capital-Labor ratio
$(K/L)_g, g = 1, \ldots, 4$	$K/L \times D_g$, where $D_g, g = 1, \ldots, 4$ are the four industry-group dummies

and

$$\frac{\text{NTB}}{1+\text{NTB}} = \alpha_0 + \alpha_1 \frac{z}{e} + \alpha_2 \left(I \times \frac{z}{e}\right) + \alpha_3 \text{INTERMTAR} + \alpha_4 \text{INTERMNTB} + X_N \Gamma + \epsilon_1$$

$$\ln \frac{\text{PAC}}{\text{VA}} = \beta_0 + \beta_1 \ln \frac{\text{NTB}}{1+\text{NTB}} + \beta_2 \ln e + \beta_3 \ln \frac{1}{z} + \beta_4 \ln \text{DOWNSTREAMSHR} + \beta_5 \ln \text{DOWNSTREAMHERF} + \beta_6 \ln \text{HERF} + X_P \Pi + \epsilon 2 \tag{4$'$}$$

$$\frac{1}{z} = \delta_0 + \delta_1 \frac{\text{NTB}}{1+\text{NTB}} + X_M \Delta + \epsilon_3.$$

Consider first the parsimonious model specification given by equation (4). The first equation is based on the G-H prediction about the rate of protection across industries given in equation (2). We measure the level of protection (t in equation (2)) by the overall nontariff barrier coverage ratio (NTB). (Issues relating to its measurement are discussed in the following data section.)

The specification of the second equation of the system (4) is based on equation (3). The dependent variable is measured by lobbying spending per contributing firm, scaled by value added (PACFIRM/VA). (Its construction is also detailed in the data section.) This equation facilitates estimation of the effect of deadweight loss on lobbying spending. The contribution-according-to-deadweight-loss hypothesis is given as $0.5 \times \beta_1 + \beta_2 + \beta_3 > 0$. The empirical examination of the lobbying competition hypothesis is based on the two variables DOWNSTREAMSHR and DOWNSTREAMHERF. Finally, although G-H presume the lobbying organization problem to be solved, the Herfindahl index of firm concentration, HERF, is included. It has been shown to be a critical determinant of the success in the formation of a lobby (Gawande (1997a)). The strong lobbying competition hypothesis is the joint hypothesis $\beta_4 > 0$ and $\beta_5 > 0$, while a weaker hypothesis is that either one is positive. The third equation is a specification of the imports equation which includes the endogenous variable NTB/(1 + NTB) on the right-hand side, the K/L ratio interacted by industry group dummies, comparative advantage variables, and own and cross price elasticities. Its specification is motivated by Trefler (1993) but is more parsimonious.

Now consider the larger specification (4)′. In the NTB equation, the set of exogenous political economy variables used in Gawande (1998a) is included as control variables X_N. They are based on the work of Baldwin (1986), Brock and Magee (1978), Caves (1976), Corden (1974), Olson (1965), and Trefler (1993). The set of variables represent both special-interest theories of protection as well as theories that emphasize the public interest. Firm concentration and firm size (FIRMSCALE, CONC4) are proxies for the ability to overcome the free-riding problem in order to form industry-level lobbies, and hence indirectly measure special-interest pressure. PAC spending (PACFIRM/VA) is a more direct measure of special-interest pressure. Geographic concentration, number of employees, and unionization (STATES, NE82, UNION) measure the sheer voting strength and legislative representation of industries, and measure other sources of special-interest pressures. The skill composition of workers is measured by the percentage of scientists and engineers, managers, and unskilled workers (SCIENTISTS, MANAGERS, and UNSKILLED, respectively). They measure comparative advantage of industries and hence their position on protectionism. Average earnings, earnings growth, employment growth, and growth of imports (AVGEARN, EARNGROWTH, NEGROWTH, and IMPGROWTH) are designed to capture to what extent the government maintains the status quo by rescuing declining industries. They represent the public-interest component of government's social-welfare function that is responsible for protection according to need rather than protection according to lobbying power. Finally, real-exchange rate elasticity of imports and exports and cross price elasticity of imports with respect to domestic price (RERMELAST, RERXELAST, and CROSSEL1) capture differential exchange rate pass through effects in the cross-section of industries.

Many empirical studies would appear to contradict the G-H proposition that protection is positively related to the inverse import penetration ratio.[5] However, unlike the G-H model, those empirical models have looser theoretical foundations, and their specification is therefore more ad hoc.[6] Hence, we test the G-H model's predictions in the absence of any well-specified hypothesis. Because the theoretical model offers tight predictions and specifications, we find the simple method of checking size and signs of coefficients to be appropriate. On the other hand, we need to address the real concern of whether a larger model merely overfits the data but is not a compelling candidate for the true data-generating process. The larger NTB model has been justified in the literature due to its intuitively correct signs on included variables and its improved explanatory power. In a sense, therefore it is a competing model, for it is the standing paradigm. The burden of proof is on the G-H model if it seeks to replace it. To this end, we compare the large model with the parsimonious G-H model using the Akaike information criterion and the Schwarz information criterion. Since the models are nested, these criteria are appropriate. The results, while not conclusive, are surprising.

The system of equations in (4) includes not just the three left-side endogenous variables NTB/(1 + NTB), ln (PAC/VA), and $1/z$ but also nonlinear functions of those variables on the right-hand side. The NTB equation, for example, includes z on the right side, and the PAC spending equation includes ln (NTB/(1 + NTB)) and ln $(1/z)$ on the right side.[7] In order to consistently estimate the structural coefficients of the system, therefore, we use the two-stage least-squares estimator proposed by Kelejian (1971). In the first stage, the reduced form for the three endogenous variables and their nonlinear transformations are estimated using as instruments the exogenous variables, their quadratic terms, and their cross products taken two at a time. (See also Strickland and Weiss (1976) for a similar analysis of another issue.)[8]

The G-H hypotheses are summarized in table 2. In the empirical analysis, we first report our findings about the protection side. In addition to the predictions about z/e and $I \times z/e$, the G-H model implies that the higher the protection afforded intermediate goods (INTERMTAR, INTERMNTB), the higher will be the protection granted on the final good that uses them. Finally, we compare the G-H model in equation (4) with the larger model in equation (4)′. On the lobbying side, the hypothesis of compensation-according-to-deadweight-loss is tested using lobbying spending per contributing firm, scaled by value added (PACFIRM/VA). Finally, the G-H model implies that greater lobbying competition, measured by DOWNSTREAMSHR and DOWNSTREAMHERF, leads to greater spending by the industry.

TABLE 2.—GROSSMAN-HELPMAN HYPOTHESES ABOUT PROTECTION AND LOBBYING

Issue Variables	Predicted Sign
NTB Equation	
1. $(z/e, I \times (z/e))$	$(-, +)$
2. $\alpha_1 + \alpha_2$	+
3. INTERMTAR	+
4. INTERMNTB	+
LOBBY Equation	
5. ∂ ln (PACFIRM)/∂ ln (DWL)	+
6. ∂ ln (PACTRADE)/∂ ln (DWL)	+
7. DOWNSTREAMSHR	+
8. DOWNSTREAMHERF	+

1. z = Consumption/Imports (CONS/IMP)/10000; e = import elasticity (ELAST1), I = indicator for politically organized industries. (See the appendix for the construction of I.) Variable definitions in table 1.
2. α_1 is the coefficient on z/e, and α_2 is the coefficient on $I \times (z/e)$.

IV. Data

A description of the variables used in the analysis appears in table 1. In the estimation of the systems (4) and (4)′, we

[5] For example, Baldwin (1985) has found evidence of a positive (negative) relationship between tariffs (tariff cuts) and import penetration across industries. This runs counter to the G-H prediction.

[6] See Gawande (1998a) for a method with ad hoc specification or when its connection to theory is tenuous.

[7] Ln (NTB/(1 + NTB)) is set to −10 whenever NTB = 0, that being lowest value taken.

[8] The larger system admits 34 distinct instruments (including the four industry group dummies), and the linear, quadratic, and number of possible two-term cross products itself is 561. Hence, we include the linear terms, the squared terms, and the interactions of the linear terms with e in estimating the reduced-forms equations. We experimented with interactions of the linear terms with other variables, and the estimates of the structural coefficients do not vary much since the explanatory power of the reduced-form regressions are consistently high.

employ an aggregate measure of NTBs. This measure includes price-oriented measures such as antidumping duties and countervailing duties, quantity-oriented measures such as quotas and voluntary export restraints, and threats of quality and quantity monitoring. The extent of protection is measured by the NTB coverage ratio (that is, the fraction of an industry's imports covered by one or more of such nontariff measures).[9] Aggregate U.S. NTB coverage ratios across all partners—as well as bilateral NTB coverage ratios between the U.S. and five large trading partners (France, Germany, Italy, Japan, and the U.K.)—are used in this study. These data are as of 1983 and were constructed from World Bank tapes and UNCTAD NTB inventory data.

We measure z/e as follows. z is measured as the inverse import penetration ratio CONS/IMP scaled by 10,000 (because otherwise the value of z for industries with small imports would be very large). For the U.S., this is close to the theoretically correct measure, VA/IMP. e is measured by the import elasticites estimated in Sheills et al. (1986). Their estimates at the three-digit SIC level (ELAST0) are replicated at the four-digit level for this study. Since many estimated price and cross-price elasticities in Sheills et al. have high standard errors and estimated values, their direct use may yield highly questionable results. We purged the elasticity data of the inherent errors-in-variables problem using Gawande (1997b), as described in the appendix. CROSSEL0 is also similarly purged.

Industry characteristics data were constructed from the 1982 Census of Manufacturing and various Annual Surveys of Manufactures. The data section of the appendix details the construction of the variables used in the study. PACFIRM (or political action committee campaign contribution per contributing firm) was constructed from the Federal Election Commission tapes over the four Congressional election cycles 1977–1978, 1979–1980, 1981–1982, and 1983–1984 as described in the Appendix. Bilateral trade variables (EXP_j, IMP_j) were constructed from COMPTAP tapes. Value added (VA) and the Herfindahl index (HERF) were obtained from the 1982 Census of Manufacturing. INTERMTAR, INTERMNTB, DOWNSTREAMSHR, and DOWNSTREAMHERF were constructed from the Input-Output tables of the U.S. as described in the appendix. Complete data, especially elasticity data, were available on

TABLE 3A.—2SLS ESTIMATES FROM AGGREGATE U.S. NTBS: THREE-EQUATION MODEL {NTB, LOBBYING, IMPORT} GROSSMAN-HELPMAN SPECIFICATION (PARSIMONIOUS)

	Model 1			
	NTB Eq.		LOBBY Eq.	
	Coef.	s.e.	Coef.	s.e.
NTB/(1 + NTB)	DEP	—	—	—
Ln (PACFIRM/VA)	—	—	DEP	—
z/e	**−3.088****	1.532	—	—
$I \times z/e$	**3.145****	1.575	—	—
INTERMTAR	**0.780****	0.242	—	—
INTERMNTB	**0.362****	0.062	—	—
Ln (HERF)	—	—	**0.177****	0.068
Ln (IMP/CONS)	—	—	**0.298****	0.064
Ln (NTB/(1 + NTB))	—	—	*−0.069***	0.027
Ln (ELAST1)	—	—	**0.376***	0.247
Ln (DOWNSTREAMSHR)	—	—	**0.321****	0.105
Ln (DOWNSTREAMHERF)	—	—	**0.278****	0.091
Constant	−0.042**	0.017	−2.195**	0.348
N	242		242	
k	5		7	
R^2	0.234		0.166	
Model F	18.10**		7.82**	
AIC	−1.369		3.047	
SIC	0.648		−1.574	
Ln L	170.7		−361.7	
∂ Ln (PAC/VA)/∂ Ln (DWL/VA)	—		**0.639****	0.250

1. Estimates of third equation (Dependent variable = IMP/CONS) shown in appendix.
2. ** $|t| \geq 2$, * denotes $2 > |t| \geq 1$. For the model F, ** and * denote statistical significance at 1% and 5% respectively. AIC = Akaike Information Criterion = -2 (ln L $-$ k)/n. SIC = Schwarz Information Criterion = ln L/n $-$ 0.5k(ln n/n).
3. $z/e = [(\text{CONS/IMP})/|\text{ELAST1}|]/10000$, $I \times z/e$ = indicator of political organization $\times\ z/e$.
4. ∂ Ln (PAC/VA)/∂ Ln (DWL/VA) is the elasticity of PACFIRM with regards to deadweight loss (both scaled by value added). It is computed as follows: Let α_t, α_m, and α_e, respectively, denote the coefficients on Ln (NTB/(1 + NTB)), Ln (IMP/CONS), and Ln (ELAST1). Then ∂ Ln (PAC/VA)/∂ Ln (DWL/VA) = $0.5\alpha_t + \alpha_m + \alpha_e$.
5. Of the 448 four-digit SIC industries, elasticity data allowed the use of 242. (See appendix.)

242 four-digit SIC industries, which is the sample used in this study.

Politically organized industries were identified as follows. We regressed PACFIRM/VA on bilateral import penetration by partner j interacted with twenty two-digit SIC dummies. Those two-digit industries with positive coefficients were considered organized in the trade arena vis-a-vis partner j. This was repeated for all five partners (France, Germany, Italy, Japan, and the U.K.), and the union of the organized two-digit industries taken. For these industries, $I_i = 1$. Of our sample, 68.2% were politically organized.

V. Empirical Analysis

A. {*U.S. NTB Coverage of Aggregate Imports, PACFIRM/VA, IMP/CONS*} *System*

Table 3a presents 2SLS estimates from the parsimonious three-equation system in (4). Just the NTB equation and the lobbying equation are reported, for the G-H predictions concern those equations. The import equation is reported in the appendix. Asterisked estimates are interpreted as being statistically significant. A single asterisk implies that $2 > |t| \geq 1$, and a double asterisk implies $|t| > 2$. A rationale for using this criterion to denote statistical significance is that only if a variable has a coefficient with $|t| \geq 1$ will its exclusion lower the model's adjusted R^2 and its inclusion

[9] The use of coverage ratios in place of what in the theory is an ad valorem tariff requires the belief that coverage ratios are positively correlated with their tariff equivalents across industries. The presumption becomes more credible when, as we do, price elasticities are included to control for this effect on the right-hand side. The computation of tariff-equivalents is an enormously expensive task, and, given the state of the art in computational general equilibrium, such computations are based on assumptions about market and production structures that are merely convenient rather than approximations to reality. Even so, very few studies exist, and the information contained in those studies is too thin to support useful inferences in an econometric study such as this. Econometric studies using NTB coverage ratios to make strong and credible inferences about the pattern of NTBs include Leamer (1990), Trefler (1993), and Gawande (1997a). Trefler has also found a high correlation between ad valorem tariff data and the corresponding ad valorem tariff coverage ratio, which further encourages the use of NTB coverages.

TABLE 3B.—2SLS ESTIMATES FROM AGGREGATE U.S. NTBS: THREE-EQUATION MODEL {NTB, LOBBYING, IMPORT} LARGE SPECIFICATION (SUBSUMES GROSSMAN-HELPMAN SPECIFICATION)

	Model 2			
	NTB Eq.		LOBBY Eq.	
	Coef.	s.e.	Coef.	s.e.
NTB/(1 + NTB)	DEP	—	—	—
Ln (PACFIRM/VA)	—	—	DEP	—
z/e	**−5.427****	2.773	—	—
$I \times z/e$	**5.709****	2.312	—	—
INTERMTAR	**0.856****	0.341	—	—
INTERMNTB	**0.342****	0.078	—	—
EXP/VA	−0.124**	0.062	—	—
PACFIRM/VA	0.224*	0.186	—	—
FIRMSCALE	1.469**	0.572	—	—
CONC4	−0.002	0.054	—	—
NE82	0.395*	0.229	—	—
UNION	−0.060*	0.048	—	—
STATES	0.762	2.085	—	—
IMPGROWTH	0.163*	0.101	—	—
ΔTAR	−0.118*	0.106	—	—
EARNGROWTH	−1.603	8.604	—	—
UNSKILLED	−0.332*	0.232	—	—
EMPGROWTH	0.045	0.060	—	—
LABORSHARE	0.114*	0.097	—	—
SCIENTISTS	0.395*	0.269	—	—
MANAGERS	−0.129	0.256		
RERMELAST	0.048**	0.024		
RERXELAST	−0.001	0.014	—	—
CROSSEL1	−0.020**	0.009		
$D_g, g = 1, \ldots, 4$	See Note 2		See Note 3	
Ln (HERF)	—	—	**0.232****	0.068
Ln (IMP/CONS)	—	—	**0.324****	0.063
Ln (NTB/(1 + NTB))	—	—	*−0.129***	0.027
Ln (ELAST1)	—	—	**0.275***	0.246
Ln (DOWNSTREAMSHR)	—	—	**0.224****	0.104
Ln (DOWNSTREAMHERF)	—	—	**0.135****	0.100
N	242		242	
k	26		10	
R^2	0.346		0.207	
Model F	4.58**		6.51**	
AIC	−1.447		3.009	
SIC	0.537		−1.580	
Ln L	201.1		−354.1	
∂ Ln (PAC/VA)/∂ Ln (DWL/VA)	—		**0.534****	0.250

1. See notes to table 3a.
2. All four dummies statistically insignificant at 5%.
3. All four dummies are negative and statistically significant at 1%.

raise it (for example, Greene (1993, pp. 193). In bold are the estimates that affirm the G-H predictions, while the italicized estimates are contrarian.

First, consider the NTB equation. The most significant feature of this table is that, just as predicted by the G-H model, the coefficient on z/e (that is, the ratio of inverse import penetration-to-import elasticity)[10] is negative, while the coefficient on $I \times z/e$ is positive. Both are measured precisely with absolute t values greater than 2. The estimates of −3.088 on z/e and 3.145 on $I \times z/e$ translate, respectively, into standardized beta coefficients (equal to $b_{2SLS} \times S_x/S_y$, where S_x/S_y is the ratio of sample standard deviations of the independent to dependent variable) of −0.917 and 0.912. These are both significant in magnitude and imply that a one-standard-deviation increase in z/e or $I \times z/e$ will change U.S. NTB coverage by approximately 0.9 standard deviations in the direction of the coefficient signs.

These results provide a strong affirmation of the G-H model predictions and stand in sharp contrast to the received wisdom from the existing empirical literature on protection, which is that $1/z$, not z, should be positively related to protection. This finding differs from the literature for three reasons. First, import elasticities have rarely been used as explanatory variables, and, hence, the ratio z/e has not traditionally been used in the empirical literature. Its inclusion is one of two unique features that distinguishes the G-H model from past models. The Ramsey pricing intuition inherent in the G-H model is borne out in the empirical results here. Second, while the role of political organization has been recognized since Olson (1965), the traditional treatment has been to measure it through proxy variables such as concentration ratios, scale, and Herfindahl measures. The value of the theoretical rigor of the G-H model is that it is able to be precise about how political organization should be treated empirically, which is through the interaction of an organization dummy with the inverse import penetration-to-elasticity ratio. This is the second unique feature of the G-H model that distinguishes it from previous models. Third, studies that explicitly account for endogeneity of imports have not affirmed the hypothesized positive effect of imports on the level of protection. For example, Trefler found that import penetration did not significantly determine 1983 NTB coverage, while Ray (1981) found that imports inversely affected the formation of 1970 NTBs.

Two quantitative implications are also testable. The first is that the sum of the coefficients on z/e and $I \times z/e$ is positive. The estimates in table 3a do not support this implication, for their sum is statistically not significantly different from zero. From equation (2), because the coefficients on z/e and $I \times z/e$ are, respectively, $-(\alpha_L + \alpha_X)/(a + \alpha_L + \alpha_X)$ and $1/(a + \alpha_L + \alpha_X)$, the result that they sum to zero implies that $\alpha_L + \alpha_X = 1$. That is, the fraction of the population that is organized into lobbies equals 1. Casual evidence suggests this result is debatable for the population at large. However, because the sample covers 242 manufacturing industries, this result should apply to manufacturing workers in those industries. Given the large-firm concentration ratios in U.S. manufacturing (mean four-firm concentration ratio equals 0.40 with a standard deviation of 0.21) and the fact that a high proportion of the largest firms is organized politically, our results do not unduly overstate the extent of political organization in U.S. manufacturing.

The second quantitative implication of the G-H model is that estimates of the coefficients $\alpha_1 = -(\alpha_L + \alpha_X)/(a + \alpha_L + \alpha_X)$ and $\alpha_2 = 1/(a + \alpha_L + \alpha_X)$ allow us to infer the value of a—the relative weight government places on aggregate welfare relative to aggregate lobbying spending.

[10] Note that the variable e is actually measured as ELAST1 after correcting the elasticity estimates for the error-in-variables problem as explained in the appendix.

The value of a is given by $(1/\alpha_2) + (\alpha_1/\alpha_2)$.[11] The problem with inferring a is, of course, that the estimates of α_1 and α_2 are sensitive to the scaling of z, and e. Because we scaled z by 10,000, in original units the estimates of α_1 and α_2 become -0.000309 and 0.000315. a is thus estimated to be 3,175, implying that government weights total campaign contributions (a_1) almost equally as aggregate welfare net of campaign contributions (a_2). (See the discussion below equation (1).)

This estimate of a is in conflict with the empirical evidence from computational general equilibrium studies that have attempted to assess the welfare loss from protection. They indicate that efficiency losses are many-fold greater than what lobbies spend to obtain protection. Hufbauer et al. (1986) estimate that the sugar quota of 1983 imposed $550 million in welfare losses, while Stern (1988) estimates that the highly concentrated sugar lobby contributed $1 million during that year. This suggests a value for a of approximately 0.0018. Similarly, the dairy subsidy is estimated to have caused $1.6 billion in welfare losses in 1984, while the dairy PACs contributed $3.3 million that year, yielding a value of a of approximately 0.0026. Our estimates of a suggest that PAC contributions are greater than deadweight costs, on average. On the other hand, if the estimates of a from the CGE studies are representative, then it points to deficiencies in measuring z, e, and I in the econometric work.

While our measures are not perfect, they are the best measures that exist. We leave it to future work to assess our results, but we believe the true value of a is closer to our estimates than is the estimate from the CGE cases cited above for three reasons. The first is that our results from the lobbying side presented below show a high degree of lobbying competition in manufacturing, especially from downstream users. Since agricultural output is sold to end users who may not be strongly politically organized as a consumer group, we conjecture that the amount of lobbying contributions relative to deadweight loss is much larger in manufacturing than in the sugar and dairy cases. Conceivably, this could raise a by a large factor. Second, it is not clear whether protection to agriculture is granted according to need or according to lobbying power. If it is the former, then a is close to zero for agriculture, simply because lobbying contributions are not required to obtain protection. Third, the dairy and sugar cases are not representative of the manufacturing sector. The fundamental fact is that U.S. protection of its manufacturing industries is far lower on average than in most of its developed partner countries. Of our sample, 47% receives zero protection even though some of them lobby.

The final prediction on the protection side—that the rate of protection on intermediates positively influences the rate of protection on the final good—is also strongly supported by positive and precisely measured estimates on INTERMTAR and INTERMNTB variables. Their estimated coefficients of 0.780 and 0.362 translate, respectively, into beta coefficients of 0.203 and 0.373. While smaller in magnitude than the beta coefficients on z/e and $I \times z/e$, they are not insignificant. Perhaps the magnitude is small because the rate of protection on intermediates is itself endogenous: It is lower the more powerful the manufacturers of final goods are. (See footnote 13.)

Now we consider the lobbying side. The lobbying equation affirms the key prediction of the G-H model that PAC spending responds to deadweight loss from protection. The elasticity of PAC spending with respect to deadweight loss is estimated to be 0.639 with a t value greater than 2. A doubling of deadweight loss from protection requires PAC spending per contributing firm (scaled by VA), PACFIRM/VA, to rise by 63.9%.[12] This finding indirectly affirms the modeling of the government's objective function as simply the weighted sum of political contributions and aggregate welfare. The contribution-according-to-deadweight-loss hypothesis is a consequence of that formulation.

The second prediction on the lobbying side—that lobbying competition with downstream industries will lead to greater lobbying spending—is strongly validated. The greater the share of an industry's output that is used by downstream industries (DOWNSTREAMSHR), the greater the political opposition it is likely to face. In order to provide itself with protection, it must therefore pay to overcome the political opposition. The greater the concentration of downstream industries (DOWNSTREAMHERF), the smaller is the free-riding problem among those firms, and the greater their personal stakes in preventing the purchase of protection by upstream rivals. The estimates in table 3a indicate that, if DOWNSTREAMSHR were to increase by 10%, PAC spending per contributing firm would rise by 3.21% in order to purchase its optimal level of protection. And, if DOWNSTREAMHERF were to increase by 10%, PAC spending per contributing firm would rise by 2.78%. These smaller elasticities relative to the elasticity of lobbying with regards to deadweight loss indicate that lobbying competition, while important, takes a backseat to deadweight loss considerations. The large values we found for a are consistent with the smaller lobbying competition elasticities. The large weight placed by government on aggregate welfare relative

[11] Where $\alpha_1 + \alpha_2 = 1$, this simplifies to $a = (1/\alpha_2) - 1$.

[12] There is also a quantitative implication based on equation (3). Because, lobbying contributions (PAC/VA) should approximately equal a(DWL/VA), we can infer a from the lobbying-side results. Because $\partial \ln (\text{PAC/VA})/\partial \ln (\text{DWL/VA}) = \partial(\text{PAC/VA})/\partial(\text{DWL/VA}) \times (\text{DWL/VA})/(\text{PAC/VA})$, we can recover $a = \partial(\text{PAC/VA})/\partial(\text{DWL/VA})$ by multiplying our elasticity estimate by (PAC/VA)/(DWL/VA), where DWL/VA is computed from equation (3). At the means, we get $a = 0.639 \times (0.049/0.004) = 7.83$. While this is a far smaller estimate of a than what we obtain from the protection side, they yield similar inferences about the weight on welfare net of lobbying spending ($= a_2$) relative to lobbying contributions ($= a_1$): $a = a_2/(a_1 - a_2)$. (See page 4.) With $a = 7.83$, $a_2 = 0.89a_1$. Hence, the government places almost 90% as much weight on aggregate welfare net of contributions as on aggregate contributions. With our large estimate of a from the protection side of 3,165, $a_2 = a_1$. The two weights are therefore not very far apart.

to political contributions forces lobbies to contend first with compensating government for deadweight loss.

Table 3b presents the set of 2SLS estimates from the large model. All the results essential to the G-H model are upheld from the larger model. The protection side of the model continues to affirm the main prediction that protection varies inversely with z/e for unorganized industries and positively with it for organized industries. The inferred value of a from these results is approximately 1,751. The coefficient estimates on INTERMTAR and INTERMNTB validate the G-H model's second prediction that the higher the protection on intermediate goods used, the higher the protection afforded the final good.[13]

On the lobbying side, the model's prediction that PAC spending is responsive to deadweight loss is inferred to be true with a high degree of confidence. ∂ Ln (PACFIRM/VA)/ ∂ Ln (DWL/VA) is estimated to be 0.534 with a t-value greater than 2.[14] The second hypothesis about lobbying competition from downstream industries is also validated with a high degree of confidence. PAC spending per contributing firm rises with DOWNSTREAMSHR and with DOWNSTREAMHERF. However, the inclusion of the industry group dummies in the lobby equation reduces the size of their coefficients. In sum, U.S. NTB data produce evidence strongly favoring the Grossman-Helpman hypotheses about the pattern of protection and the pattern of lobbying. Further, that evidence is robust across two specifications—one a sparse model based purely on the G-H model, and the other a more ad hoc, larger model based on the existing empirical literature that subsumes the G-H model.

An important question concerns whether the G-H specification is the correct one, in which case the larger model merely overfits the data and cannot be seriously considered to represent the data-generating process. On the other hand, the larger model has gained acceptance in the literature precisely because the inclusion of other variables have improved its fit, and the coefficients on those variables are sensible. If the G-H model is to become the new paradigm, it must bear the burden of proof. To answer this deeper question, we use the Akaike information criterion (AIC) and the Schwarz information criterion (SIC) to compare the two models (Judge et al. (1985, pp. 870–873)). The AIC value is computed as $-2(\ln \text{L} - k)/n$ and the SIC values as $\ln \text{L}/n - 0.5k(\ln n/n)$, where n is the sample size, k is the number of regressors, and ln L is the log of the maximum likelihood. Hence, lower AIC values are preferred, while higher SIC values are preferred. While the AIC penalizes for additional regressors somewhat more than the adjusted R^2 criterion does, the SIC penalizes additional regressors severely. The Akaike criterion favors the NTB equation specification in the larger model: The NTB equation in table 3b has an AIC value of -1.447 compared to the value of -1.369 in table 3a. However, the evidence in not unambiguous. The Schwarz criterion favors the smaller NTB equation: The NTB equation in table 3a has an SIC value of 0.648, which is more favorable than the SIC value of 0.537 for the larger NTB equation.[15] What is surprising about this result is that an accepted formal criterion judges the almost spartan G-H specification to be a better candidate for the data-generating process than the larger traditional NTB equation.

Another way of looking at the Schwarz criterion is to ask how many additional regressors beyond the G-H model could be justified, given the sample size and the two maximum log-likelihoods. For the NTB equation, only eleven additional regressors can be justified according to the Schwarz criterion. However, the larger model has 21 more regressors, which damages its case as a better candidate for the NTB data-generating process. On the other hand, according to the Akaike criterion, the number of additional regressors does not damage its case seriously. The evidence on the lobbying equation is similar. The Akaike criterion favors the large model with three additional regressors, while, according to the Schwarz criterion, the improvement to the maximum log-likelihood does not justify three additional regressors with a sample size of 242. We leave it to the reader to take sides. We think our evidence suggests, at least, that the G-H model must be taken as a serious alternative.

B. *Sensitivity Analyses*

We performed three major sensitivity analyses on the specification of the NTB equation. First, we investigate sensitivity to linearity. Trefler (1993) estimates an NTB-Imports system as a simultaneous Tobit model.[16] Because that would be difficult to do here due to the nonlinear transformations of the endogenous variables, we take an

[13] We investigated the effect on the estimates on INTERMTAR and INTERMNTB, were they to be considered endogenous. This may be appropriate if lobbying competition among the intermediate producers and final goods producers makes protection on both goods endogenous. Naturally, this can be done only in the context of the large model, for the NTB equation in the small model has no identifying restrictions if those variables are considered endogenous. The linear, quadratic, and cross-product terms of the remaining exogenous variables in the system were used to estimate their reduced forms. In specifying a structural specification for the variables INTERMTAR and INTERMNTB, we included the additional regressor (VS-VA)/VS, where VS = value of shipments and VA = value added. This variable measures the fraction of an industry's sales (VS) that comprises intermediate goods (VS-VA). It serves to identify the two equations individually. The estimates are qualitatively no different from the estimates reported in table 3b. z/e has a coefficient estimate of -4.906, $I \times z/e$ of 5.158, INTERMTAR of 1.015, and INTERMNTB of 0.368. They are all precisely measured with t-values greater than 2. This model is actually slightly preferred to the reported model in table 3b on the basis of both the AIC and SIC criteria.

[14] This is in spite of the contrary negative estimate on Ln (NTB/ (1 + NTB)) in the lobby equation, which is more than made up by the responsiveness of PACFIRM/ VA to import elasticity (ELAST1) and import penetration (IMP/CONS).

[15] If the additional regressors are highly collinear, k is driven up without driving up R^2, thus making the Schwarz criterion artificially favor the GH model.

[16] Because there is censoring of the NTB coverage below zero, a Tobit model is appropriate. One reason why censoring occurs is because of the absence of export subsidy data. If the U.S. fails to countervail a foreign export subsidy, this acts like a negative NTB.

alternative route based on the Smith-Blundell (1986) exogeneity test. The vectors of residuals from the reduced-form equations for the right-side endogenous variables in the NTB equation (z/e, $I \times z/e$) using linear, squared, and cross-products as regressors are included as additional variables in the structural NTB equation. The NTB equation is then estimated by Tobit. The inclusion of the residual vectors corrects for any endogeneity in the corresponding variables and restores consistency to their coefficient estimates (and those on other variables as well). Carrying out this procedure did not qualitatively affect the results; in some cases, it raised the magnitudes of the coefficient estimates on z/e, and $I \times z/e$ significantly above their 2SLS results reported above. The results on the protection side are thus robust to whether a linear or Tobit specification is used.

Second, in order to assess the individual importance of the inverse import penetration z and the inverse elasticity $1/e$, we estimate the models with the variables z, $I \times z$, $1/e$, and $I \times 1/e$ included separately. The results about z/e and in $I \times z/e$ reported above are driven mainly by the inverse import penetration z and less so by the inverse elasticity $1/e$. Perhaps this points to a deficiency in the precise measurement of e, despite our careful effort to clean up the error-in-variables (EIV) problem.

Third, we explored whether the results also hold with bilateral NTB and trade data between the U.S. and five countries: France, Germany, Italy, Japan, and the U.K. Only US-Japan NTBs yield results about z/e and $I \times z/e$ (the z's are now defined as inverse bilateral import-penetration ratios) that are close to the aggregate results, implying that the aggregate data are greatly influenced by US-Japan NTBs. Other than US-Japan NTBs, bilateral data yield weaker inferences about the G-H predictions from the smaller NTB equation. Perhaps the G-H model holds better in the setting of interindustry trade than intraindustry trade, because US-Japan trade is better characterized as the former and US-EC trade as the latter. Furthermore, the Armington assumption inherent in these results calls for the use of bilateral elasticities rather than elasticities based on aggregate imports. This ambitious task is left open for further research.

On the lobbying side, we investigate the sensitivity of the reported results in table 3a and 3b to a second measure of PAC spending: purely trade-related PAC spending, PACTRADE, constructed as described in the appendix. These are reported in the last two columns of table 4. The first two columns of estimates are taken from table 3a and 3b. The first row of estimates affirms the robustness of the contributions-according-to-deadweight-loss hypothesis across both models and measures of PAC spending. The elasticities are also fairly significant in magnitude.

The existence of lobbying competition is borne out by the statistically and economically significant estimates on DOWNSTREAMSHR and DOWNSTREAMHERF. They are robust across both measures of lobbying strength, both measures of lobbying spending, and both model specifica-

TABLE 4.—GROSSMAN-HELPMAN HYPOTHESES: LOBBYING SIDE. 2SLS ESTIMATES FROM LOBBY EQUATION EVIDENCE FROM AGGREGATE U.S. NTBs

Variables	Dependent Variable: Ln (PACFIRM/VA) Small Model	Dependent Variable: Ln (PACFIRM/VA) Large Model	Dependent Variable: Ln (PACTRADE) Small Model	Dependent Variable: Ln (PACTRADE) Large Model
∂ Ln (PAC)/ ∂ Ln (DWL)	**0.639****	**0.540****	**0.505****	**0.376***
	(0.250)	(0.251)	(0.206)	(0.205)
DOWNSTREAMSHR	**0.321****	**0.224****	**0.278****	**0.182****
	(0.104)	(0.105)	(0.086)	(0.085)
DOWNSTREAMHERF	**0.278****	**0.136***	**0.248****	**0.130***
	(0.091)	(0.100)	(0.075)	(0.082)
Other Variables	See Note 4			
R^2	0.166	0.202	0.147	0.203
AIC	3.047	3.009	2.658	2.603
SIC	−1.574	−1.580	−1.379	−1.374
Ln L	−361.7	−354.1	−314.6	−305.0

1. ∂ Ln (PAC/VA)/∂ Ln (DWL/VA)is the elasticity of PACFIRM or PACTRADE with regards to deadweight loss (both scaled by value added), computed as $0.5\alpha_t + \alpha_m + \alpha_e$, where α_t, α_m, and α_e, respectively, denote the coefficients on Ln (NTB/(1 + NTB)), Ln (IMP/CONS), and Ln (ELAST1).
2. DOWNSTREAMSHR = Share of industry's output used as intermediate goods by downstream industries. DOWNSTREAMHERF = Intermediate-goods-buyer Herfindahl index.
3. ** $|t| \geq 2$, * denotes $2 > |t| \geq 1$. AIC = Akaike Information Criterion. SIC = Schwarz Information Criterion (See table 3a for definitions).
4. Small model is as in table 3a and large model as in table 3b. Full output available from the authors.

tions. Their somewhat small magnitudes are consistent with the large values we earlier found for a. The lobbies realize that, in order to obtain protection, the main obstacle is to compensate government for deadweight loss. The lobbying picture that emerges in our study is characterized by many active lobbies in the trade arena successfully purchasing some protection mainly by compensating government according to deadweight loss, but also overcoming some lobbying competition.

VI. Summary and Conclusion

The Grossman-Helpman framework presents a new paradigm in the political economy literature, but whether it can replace existing models warrants an empirical examination. The model's advantage over existing theories about the determinants of protection is that its predictions are tightly connected with the theory, while implications from the models in the traditional literature are ad hoc. In this paper, we empirically examine the model's predictions about the pattern of protection and lobbying spending using cross-industry data on U.S. NTB coverage ratios and U.S. lobbying spending. The empirical evidence from a three-equation system strongly confirms the model's main prediction on the protection side—that, in politically organized industries, protection varies with z/e where z is the inverse import penetration ratio, and e is the absolute price elasticity of imports. This is a striking result because it goes against the commonly believed, though theoretically unproven, notion that protection should increase with the import penetration ratio, not its inverse. Quite surprisingly, the sparse G-H specification that emphasizes the three factors—inverse import penetration, import elasticity, and whether industries are politically organized—is favored by the Schwarz information criterion over a much larger specification popular in the existing empirical literature, but which has loose connections with any underlying theories. The second prediction—that the higher the protection to intermediate inputs, the greater will be the protection afforded the final good—also receives strong affirmation from variables measuring NTB and tariff protection on intermediates.

On the lobbying side, the evidence broadly affirms the prediction that PAC spending compensates the government for the deadweight loss from protection. We also find that the government places almost equal weight on total net welfare (gross welfare less contributions) relative to total lobbying spending. The importance of welfare considerations is consistent with the strong evidence on the compensation-according-to-deadweight-loss hypothesis, and also with the observation that U.S. trade barriers are generally low relative to barriers in developed partner countries. The second hypothesis on the lobbying side of the model is that competition among lobbies will induce lobbies to spend according to the political strength of their rivals. This hypothesis receives strong support from evidence on variables we have constructed specifically to measure competition from downstream lobbies. We find precise evidence that PAC spending rises with the share of an industry's output used by downstream industries as intermediate inputs and also the concentration of downstream users.

The broad picture that emerges about the U.S. pattern of protection is that it *is* influenced by lobbying spending and lobbying competition, and that, hence, protection is ''sold.'' The dominant factor underlying U.S. protection, and the reason that protection is lower than in other similarly developed countries, is that the U.S. government attaches almost equal weight to aggregate welfare (net of political contributions) as it does to aggregate contributions. Thus, the biggest obstacle to obtaining protection is compensating government for deadweight loss from protection. While lobbying competition requires lobbies to contribute over and above deadweight loss, this component of lobbying spending takes second position to the deadweight loss compensation.

In conclusion, we point to an extension of the empirical work presented here. The G-H model abstracts from the issues relating to lobbying organization. A promising line of work by Mitra (1998) provides a theory of lobby formation within a framework of endogenous protection. As such, it complements and enriches the lobbying side of the G-H model. Future empirical work can test richer hypotheses on the lobbying side, as well as investigate whether our conclusions about the G-H model continue to hold.

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APPENDIX

A.1 Data

Measurement of NTBs: The construction of NTB coverage ratios is detailed in Leamer (1990). Those are at the three-digit SITC (R1) level. They are concorded into the four-digit SIC level for this study. NTB coverage ratio data have been used in the studies by Leamer (1990), Trefler (1993), Gawande (1998a), Lee and Swagel (1997), and Goldberg and Maggi (1997).

Other Variables In the following, COMTAP refers to the *Compatible Trade and Production Database*, 1968–1986, CM refers to the 1982 *Census of Manufactures*, ASM for the 1983 *Annual Survey of Manufactures*, and CPS to the 1983 *Current Population Survey*. U.S. bilateral and total (across all partners) imports and exports are aggregated up from tariff line data.

Political Action Committee (PAC) campaign contribution data is from the Federal Election Commission (FEC) tapes for the election cycles 1977–1978, 1979–1980, 1981–1982, and 1983–1984. Because PACs are associated with individual firms, the variable PACFIRM was constructed as follows. Using COMPUSTAT tapes, firms were classified into three- or four-digit SIC industries. Where firm coverage was incomplete in COMPUSTAT, we classified PACs into two-digit SIC industries using Weinberger and Greavey (1984) and replicated this at the four-digit level. Summing across the mappings and dividing by the number of contributing firms gave PACFIRM. This is the same variable used in Gawande (1998b).

Value added used to construct U.S. consumption is from ASM. REPRST is constructed from the county data in the *Geographic Area Series* of the COM. Earnings and employment (AVEARN) is also from ASM as are capital stock figures. NE82 and CONC4 are taken from CM. Division of workers by skill class (P_SCI, P_MAN, P_UNSK) is from CPS. UNION is from Kokkelenberg and Sockell (1985). DOWNSTREAMSHR and DOWNSTREAMHERF are computed from the input-output Use tables at the two-digit I-O code level (comprising 79 manufacturing, service, and government sectors). The variables are constructed for the 58 manufacturing industries at the two-digit I-O level and then mapped into the four digit SIC level using the concordance mapping provided with the I-O tables. Let $U = [u_{ij}]$ be the intermediate use matrix, where u_{ij} is the amount of industry i output used by industry j as intermediate inputs. The ith row of U shows how the output of industry i is distributed across intermediate users (and also final demanders, but that is not important here). Let the output of industry i that is used as intermediate goods by other industries be denoted TI_i where $TI_i = \Sigma_j u_{ij}$. Then, for industry i, DOWNSTREAMSHR$_i$ (share of output that goes into intermediate goods use by other industries) is computed as TI_i/VS_i, where VS_i is i's value of shipments, and DOWNSTREAMHERF$_i$ (Herfindahl measure of intermediate-goods-output buyer concentration) is measured as $\Sigma_j u_{ij}^2/(TI_i)^2$. The level of protection afforded intermediate goods *used* by industry j is computed as the weighted average of industry protection levels where the weights are the *use* of those industry outputs as intermediate goods by industry j. The two measures we use of industry protection levels are tariffs (T) and NTB coverage (N). Hence INTERMTAR$_j = \Sigma_i u_{ij} T_i/\Sigma_i u_{ij}$, and INTERMNTB$_j = \Sigma_i u_{ij} N_i/\Sigma_i u_{ij}$.

A.2 The Grossman-Helpman Hypothesis with Intermediate Goods: Derivation of Equation (1)

Let there be one importable intermediate good and n final goods, each produced at home with labor and a sector-specific capital. Suppose the intermediate good is used in the production of some or all of the final products, except the numeraire good. The numeraire good is produced only with labor.

Denote the intermediate good sector as sector $n + 1$ (In the paper, this is labeled good X). Let the price of the intermediate good be p_{n+1}. The price of final good i is p_i. Then the reward to specific factor in the intermediate good sector will be $\pi_{n+1}(p_{n+1})$. The reward to specific factor used in the production of final good i will be given by $\pi_i(p_i, p_{n+1})$. The indirect utility of an individual is given by $V(p, E) = E + s(p)$, where, $p = (p_1, \ldots, p_n)$ is the vector of domestic prices of nonnumeraire final goods, E is total expenditure of the individual, and $s(p)$ is the consumer surplus derived from these goods. Then, aggregate gross welfare will be

$$\begin{aligned} W(p, p_{n+1}) = {} & l + \sum_{i=1}^{n} \pi_i(p_i, p_{n+1}) + \pi_{n+1}(p_{n+1}) \\ & + \sum_{i=1}^{n} (p_i - p_i^*) m_i(p_i) \\ & + (p_{n+1} - p_{n+1}^*) m_{n+1}(p_i, p_{n+1}) + Ns(p) \end{aligned} \tag{A1}$$

where $m_i =$ import of final good i, $m_{n+1} =$ import of the intermediate good, p_i^* is the world price of good i, and l and N respectively measure total labor supply and total voting population. Suppose, that in some exogenous set of sectors L and in the intermediate good sector, the owners of the specific factors are organized into lobby groups. Gross welfare of members of the lobby group in sector i is

$$\begin{aligned} W_i(p, p_{n+1}) = {} & l_i + \pi_i(p_i, p_{n+1}) \\ & + \alpha_i \Bigg[\sum_{i=1}^{n} (p_i - p_i^*) m_i(p_i) + (p_{n+1} - p_{n+1}^*) \\ & \times m_{n+1}(p_i, p_{n+1}) + Ns(p) \Bigg] \end{aligned} \tag{A2}$$

where l_i is the total labor supply of owners of the specific factor used in sector i and α_i is the fraction of voting population that holds this specific factor. Similarly, gross welfare of the members of the lobby group in sector $n + 1$ is

$$\begin{aligned} W_{n+1}(p, p_{n+1}) = {} & l_{n+1} + \pi_{n+1}(p_{n+1}) \\ & + \alpha_{n+1} \Bigg[\sum_{i=1}^{n} (p_i - p_i^*) m_i(p_i) + (p_{n+1} - p_{n+1}^*) \\ & \times m_{n+1}(p_i, p_{n+1}) + Ns(p) \Bigg] \end{aligned} \tag{A3}$$

l_{n+1} being the total labor supply of owners of the specific factor used in the intermediate goods sector and α_{n+1} being the fraction of voting population that holds this specific factor.

G-H assume that the interaction between the lobbies and the government takes the form of a ''menu-auction'' and show that the government behaves as if it were maximizing the following social welfare function:

$$\Phi = \sum_{i \in L} W_i(p, p_{n+1}) + W_{n+1}(p, p_{n+1}) + aW(p, p_{n+1}), \qquad a \geq 0 \tag{A4}$$

Members of lobby groups receive the larger weight $(1 + a)$ while individuals that are not represented by lobbies receive the weight a. The first-order condition is

$$\begin{aligned} \frac{\partial \Phi}{\partial p_i} = {} & (a + I_i) \frac{\partial \pi_i}{\partial p_i} + (a + \alpha_L + \alpha_{n+1}) \\ & \times \left(m_i + (p_i - p_i^*) \frac{\partial m_i}{\partial p_i} + (p_{n+1} - p_{n+1}^*) \frac{\partial m_{n+1}}{\partial p_i} + N \frac{\partial s(p)}{\partial p_i} \right) \end{aligned} \tag{A5}$$

Then, the equilibrium tariff/subsidy on the final good i is solved as

$$\frac{t_i}{1 + t_i} = \left(\frac{I_i - \alpha_L - \alpha_{n+1}}{a + \alpha_L + \alpha_{n+1}} \right) \frac{z_i}{e_i} + \frac{q_{n+1}}{e_i m_i} \frac{\partial m_{n+1}}{\partial p_i} \tag{A6}$$

where $t_i = (p_i - p_i^*) p_i^*$, $z_i =$ equilibrium ratio of domestic output to imports of the final good i, $e_i = -m_i'$, p_i/m_i is the elasticity of import demand (or of export supply) of final good i, $\alpha_L = \Sigma_i \alpha_i$, $q_{n+1} = (p_{n+1} - p_{n+1}^*) = t_{n+1} p_{n+1}$, and I_i is an indicator variable that equals 1 if sector i is politically organized and 0 otherwise. In equation (1) of the paper, the intermediate good is labeled X.

A.3 Construction of Trade-Related PAC Spending (PACTRADE)

Trade-related PAC spending is constructed using an auxiliary regression. We assume away any export-related lobbying (because export subsidy and export elasticity data is unavailable); thus, the auxiliary regression uses only import data to extract import-related lobbying from total lobbying expenditures. We use the model

$$\frac{\text{PACFIRM}}{\text{VA}} = \alpha_0 + \sum_{i=1}^{20} \alpha_i \left(D_i \times \frac{\text{IMP}_j}{\text{CONS}_j} \right). \tag{A7.1}$$

In equation (A7.1), U.S. bilateral import penetration ratio with partner j is interacted with the twenty two-digit dummies. Since the model on which table 3a and 3b are based contain aggregate imports, we cannot use IMP to identify organized industries. Hence, IMP_j is used for this purpose. Those two-digit industries for which the predicted value of the dependent variable is positive are considered organized in the trade arena vis-a-vis partner j. Five such sets of organized industries can be identified using U.S.-France, U.S.-Germany, U.S.-Italy, U.S.-Japan, and U.S.-U.K. bilateral imports. We take the union of the sets to come up with the set of organized industries for estimating the system (4) and (4)′. To construct PACTRADE, we take the average of the five predicted series from the five regressions.

A.4 Construction of ELAST1 and CROSSEL1: Errors-in-Variables Correction

In equation (1) of the paper, the key import elasticity variable needs to be separately estimated. Fortunately, these elasticities have been estimated for each of the three-digit SIC industries by Sheills et al. (1986). Let E denote the estimates of own price elasticity of imports (ELAST0 in table 1). For some industries i, E_i is quite imprecisely estimated, while for others it is sharply estimated, with a sample range of [−23.85, −0.042] (a few import elasticities have a contrary positive sign and are discarded) with widely varying standard errors. Direct use of unadjusted E will lead to erroneous and unpredictable results. We use an errors-in-variables correction on E using Gawande (1997b), which is based on the method of W. Fuller (1987). E_i is modeled as the observed value of the true (unobserved) own price elasticity, e_i, which is measured with error:

$$E_i = e_i + u_i, \tag{A8}$$

where u_i is the measurement error in E_i with mean 0 and *known* variance, $\sigma^2_{u,i}$. This variance is equal to the square of the estimated standard errors reported on the estimates E_i in Sheills et al. (1986). A simple method to correct for the EIV problem (see for example, Fuller (1987, ch. 3)) is to replace e_i in equation (1) by the prediction $\hat{E}_i$ constructed as follows. Denote the sample variance of E by $\overline{\sigma}^2_E$ and the mean of the measurement error variances by $\overline{\sigma}^2_u$. Let $\hat{\sigma}^2_e = \overline{\sigma}^2_E - \overline{\sigma}^2_u$ and $\overline{E}$ denote the sample mean.

TABLE A.1.—2SLS ESTIMATES OF IMPORTS EQUATION BELONGING TO THE {NTB, LOBBYING, IMPORT} SYSTEM IN TABLES 3A AND 3B

	Dependent Variable: IMP/CONS(=(10000z)$^{-1}$)			
	MODEL 1 Imports Eq.		MODEL 2 Imports Eq.	
	coef.	s.e.	coef.	s.e.
NTB/(1 + NTB)	0.067	0.147	−0.056	0.144
FIRMSCALE	−3.060**	0.931	−2.835**	0.934
CONC4	0.231**	0.076	0.223**	0.077
UNSKILLED	−0.258	0.352	−0.310	0.353
SCIENTISTS	−0.535*	0.439	−0.609*	0.442
MANAGERS	−0.850*	0.433	−0.950**	0.435
RERMELAST	−0.002	0.036	−0.005	0.036
CROSSEL1	0.051**	0.162	0.050**	0.016
TAR	0.248	0.266	0.295*	0.267
ELAST1	0.027	0.040	−0.033	0.041
$(K/L)_g$, $g = 1, \ldots, 4$	See Note 2		See Note 2	
Constant	0.216*	0.118	0.245**	0.119
N	242		242	
k	15		15	
R^2	0.167		0.155	
Model F	3.24**		2.91**	

1. ** $|t| \geq 2$, * denotes $2 > |t| \geq 1$. For the model F, ** denotes statistical significance at 1%.
2. All K/L interactions are statistically insignificant at 5% except DMFG × (K/L), which is positive.

Now construct the predictor

$$\hat{E}_i = \overline{E} + \frac{\hat{\sigma}^2_e}{\sigma^2_{u,i}} (E_i - \overline{E}). \tag{A9}$$

Thus, whenever E_i has measurement error variance exactly equal to $\hat{\sigma}^2_e$ (an estimate for the sample variance of e_i, had we been able to measure it exactly), it is presumed to be measured without error. Otherwise, it is scaled down or scaled up according to equation (A9). Very large estimated standard errors on E_i can raise $\overline{\sigma}^2_E$ so high as to lead to a negative value for equation $\hat{\sigma}^2_e$. This points out that estimates of E_i in Sheills et al. with very high standard errors are "inadmissible." We drop E_i estimates with standard error exceeding 9 and then apply the correction in equation (A9). Taking account of the positive values of E_i that were dropped from consideration earlier, we have a sample size of 243. The model in equation (1) is then estimated with the predictor in equation (A9) used in place of E_i. The corrected values lie in the interval [−2.356, −0.524]. Their absolute values, which we call ELAST1, are used in the estimation. A similar correction is applied to estimates of cross price elasticities (CROSSEL0) to obtain CROSSEL1.